Will a lack of professionals restrict industry growth?

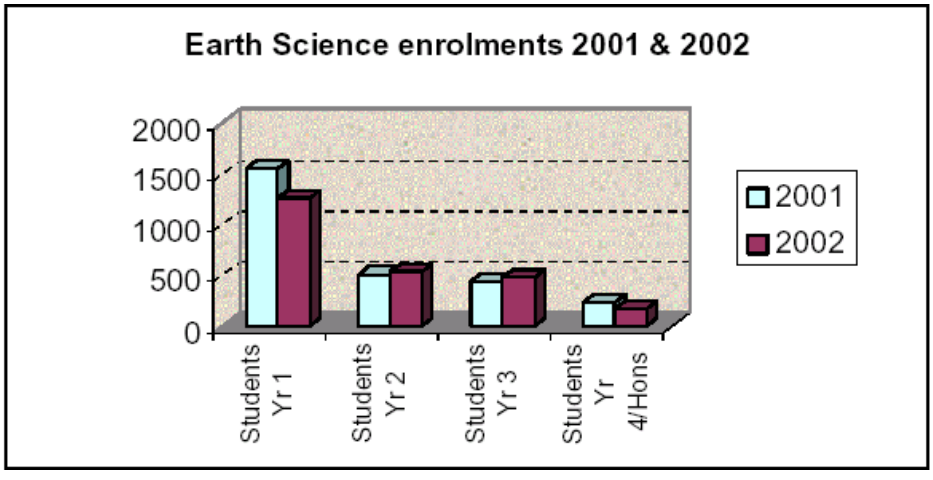
Author: Andrew Okely

The Australian mining industry is presently in the midst of a significant period of capital investment and growth. Many believe the appetite of China will ensure this growth continues for some years to come. With iron ore, coal, gold, copper and nickel prices all strong at present, there are many green- and brownfield projects in the pipeline. All of this has highlighted the growing problem of a lack of professionally trained engineers and scientists in the industry. This article will review the tertiary training landscape, consider some factors impacting existing employees and propose a number of ways in which managers can supplement the technical capability of their operations.

Tertiary training

The Minerals Council of Australia formed the Minerals Tertiary Education Council (MTEC) in 2000 to study the existing level of enrolments in Australian Universities. In February 2003 MTEC produced a report which reviewed the fields of Earth Sciences, Mining Engineering and Metallurgy. The results point to a grim picture for the professional capacity of our industry.

In the chart below, for example, we see well over 1000 students enrolled in 1st year Earth Sciences, each with the potential to become exploration or mine geologists. Of these, approximately 10% reach honors year and thus become suitably qualified to enter the industry. Is this enough for existing operations, new operations and, importantly, a sustainable level of exploration?



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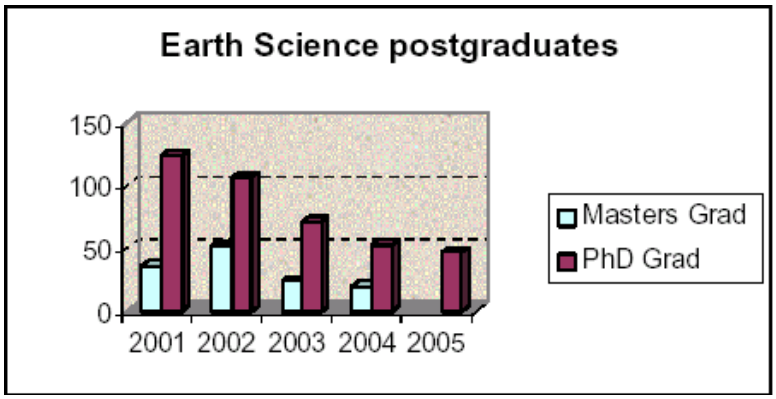
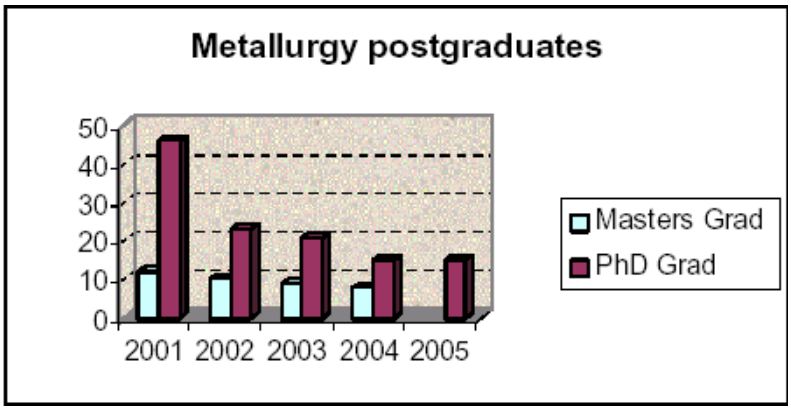


Enrolment postgraduate statistics for Australian universities

Mining Engineering graduation numbers were approximately 170 in both 2001 and 2002. Due to the impact of common 1st and, in some cases, 2nd year engineering courses, it is difficult to forecast future graduation numbers from 2nd and 3rd year student numbers. Based on 1st year enrolments in 2002, MTEC believes graduation numbers could be as low as 100 in Mining Engineering by 2006.

The field of Metallurgical teaching proved complex to analyse. Some schools specialize in metallurgy, whilst others offer elective courses in 3rd and 4th year via materials or chemical engineering. In the last three years Australian universities have produced about 100 graduates per year with the skills and education that would allow them to practice as metallurgists. Given that 1st year enrolments fell from over 200 in 2000 to approximately 150 in 2002, it would be reasonable to assume less than 100 graduates in metallurgy in 2006.

Couple these apparent declines in the number of undergraduates with a decline in post-graduate completions and the picture for higher level activities, such as fundamental research and development, is quite bleak.



Enrolment postgraduate statistics for Australian universities

Existing professionals

The issues surrounding employee retention within both individual operations and the industry itself have been documented by many organizations. These issues range from the disruptive nature of fly-in/ fly-out rosters on peoples' personal lives to working in remote locations with restricted cultural, social and further education opportunities. The net result of these many and somewhat unique factors is that only a small number of professionals will spend a major part of their career working on remote sites. Some will be retained in the main cities in either head office functions or the engineering and services sector of the industry, but many will find other industries and be lost to mining.

Those that do stay are presently being "hunted" by other mining companies in an effort to staff new operations. A recent salary index study indicated contract rates for professions, from mine manager through to metallurgist, had increased by 20-50% between September 03 and March 04. The net result is that some positions for more experienced engineers are proving extremely difficult to fill. Two of the consequences of this general shortage are an inability to carry out on-site process improvement and optimisation projects and also a lack of time for professional development. Both factors will have a long-term impact on the viability of the industry.

Some solutions…

Having recognized this problem, it is also obvious that there is no quick fix. We cannot instantly train professional engineers. However, we can better utilize the resources that are currently available, whilst groups such as the Australian Minerals Council look at longer term solutions to address these issues. In the meantime, three current possible sources of

professional support are (1) technology providers, (2) cooperative research groups and (3) industry-sponsored training seminars.

(1) Technology providers can be a useful source of technical expertise that might not be readily available in times of scarcity of professional resources. Three possible examples of where they could help are:

• Where specific experience is a key competency of a technology provider, use them to partner with mine owners and engineering companies to define flowsheets and process designs

• Use them to provide full service maintenance contracts for the technologies they offer

• Use them to provide engineering design services for smaller brownfield expansion projects which incorporate their technology

It is not difficult to imagine other areas where the experience and expertise of the technology provider could assist with either the day-to-day operation of a plant or its ongoing improvement.

(2) Cooperative research centers such as the JKMRC, CSIRO or Ian Wark Center are useful vehicles for looking at fundamental research projects. These centers typically have resources, which can be directed at specific site-based issues, to achieve a higher level of understanding of a particular principle. The centers also consistently attract overseas students to undertake postgraduate programs, thus increasing the professional capacity of our local industry.

(3) Industry-sponsored training seminars are workshops organized to examine specific technical issues. The organizers might be bodies such as the AusIMM, with dedicated workshops attached to a conference, or technology-specific workshops organized by technology providers. In many cases, there can be a great benefit in improving the skills of para-professional people, such as plant operators via specific training seminars. Apart from an increased productivity and greater job satisfaction, another benefit of having a more skilled operations team is that scarce professional resources can concentrate on higher-level tasks.

So, back to the question, will a lack of professionals restrict growth in the mining industry? I do not believe it will, as the historical tenacity of the Australian Minerals Industry suggests we will find ways to better utilize the resources we have. It could, however, see a lowering of professional capability over time that will ultimately harm Australia's position in the global minerals industry. It is important that we continue to make time for research and the on-going training of our professionals if we want to maintain our ability to innovate and lead.

The attraction of rare earth magnetic separators

Author: John Elder

Higher quality products, all at lower costs. These objectives are typically contradictory, however, in the case of rare earth magnetic separation, they are, in fact, complementary. Since the first commercial unit was commissioned in 1982 in South Africa, rare earth magnetic separators are commonplace in many industrial minerals operations. They typically process, amongst many others, mineral sands, glass sands, garnets, refractories, ultra-high purity materials - allowing mineral processors to have their cake and eat it too.

As is common with many new technologies, initial installations of rare earth magnets were introduced at the end of the circuit, as a 'patch' to clean up or improve inefficient technologies. This included tailings retreatment operations from electromagnets or new applications where standard electromagnets could not cope. Over the past two decades, however, rare earth magnetic separators have been recognized as the superior solution in many cases, replacing the bulk of induced roll magnetic separators due to their greater separation efficiencies and lower power consumption. Thousands of separators are now used in industry. Rare earth rolls and drums are available in a variety of different designs and with magnetic force far exceeding prior art separators.

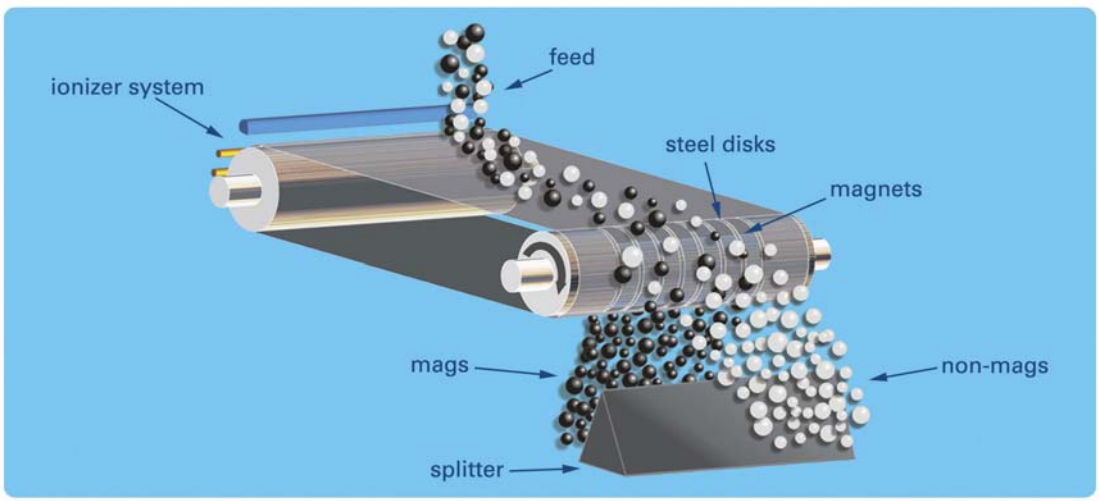
How do rare earth magnets work?

There are two main types of rare earth magnets – rare earth rolls and rare earth drums. Process widths are usually 1m to 1.5 m, with 2-4 magnetic stages.

In a rare earth roll, material is fed evenly on its separator belt and is transported over a uniquely designed magnetic roll. As the feed material moves through the magnetic field, all magnetic particles are attracted to the roll. Depending on the magnetic susceptibility of the particle, it either:

1. Becomes attracted to the surface of the belt and is subsequently released as it travels away from the magnetic field; or

2. Is drawn towards the belt and its trajectory is altered from that of non-magnetic particles as they



Principle of operation of rare earth roll

are thrown from the roll.

The separation is optimized with the proper selection of magnetic roll design, belt thickness, roll speed, splitter position and number of stages of separation.

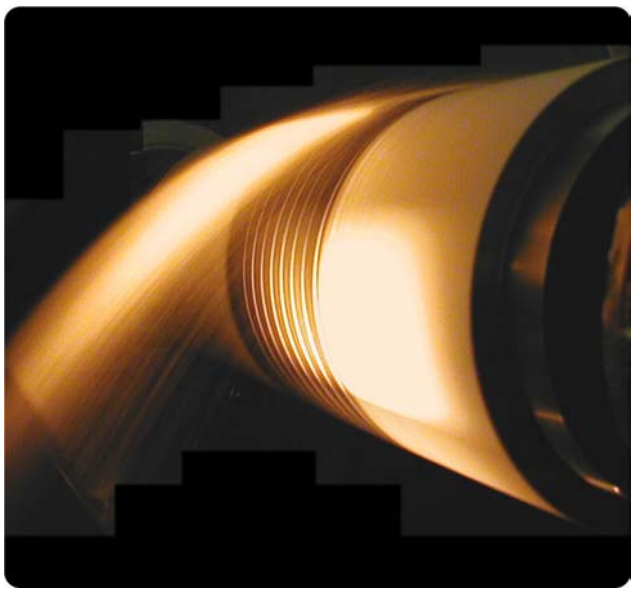
With a rare earth drum the principle is somewhat similar. The feed is introduced onto a rotating metal shell and the magnetic particles are deflected towards the rare earth magnets in the drum, with the non-magnetics carried away from the drum by their centrifugal force.

With both separator configurations, magnet design and magnetic force are customized for each application.

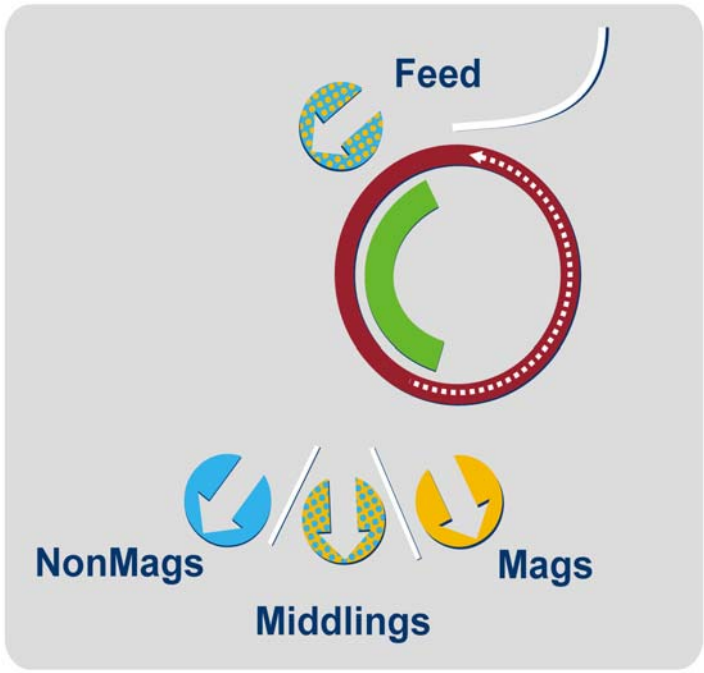
Where are rare earth magnets used?

There are two main magnet configurations - configurations according to maximum selectivity and those according to highest strength. Maximum selectivity configurations are used in concentration applications where more magnetic material is present, such as ilmenite. Highest strength configurations are used in cleaning applications, as with zircon or glass sands.

The major applications include mineral sands, refractory raw materials, fillers, glass and ceramic raw materials, potash, salts, ultra-high purity materials, phosphates, abrasives (diamonds and garnets), graphite and iron ore benefication.



Outokumpu's Inprosys 100 mm RER in a zircon cleaning duty



Principle of operation for rare earth drum

Why do rare earth magnets make sense (and save dollars)?

Apart from their processing efficiencies, because they are permanent magnets, rare earth separators require no power to generate a magnetic field. The only power consumption is in the roll or drum drive. Compared to electromagnets, rare earth magnets operate at a fraction of their cost. Other influencing factors are the high availability of rare earth magnetic separators and the relatively low maintenance costs (up to 40% lower than with electromagnets). On the next page, for example, you can see the large cost differences in operating costs for ilmenite processing.

Advantages of rare earth magnets

By maximizing the use of rare earth magnets in process flowsheets, the following main benefits have been established:

- Reduced operating costs, often in the range of 30-50% compared to induced roll magnets, and even lower compared with cross belt separators
- Enhanced product qualities
- Optimised product yields

Magnetic separator type	Cost %
Cross-belt	100
IRM (induced roll)	50%
Rare earth roll	15-25%
Rare earth drum	15-20%

Comparative operating costs in ilmenite processing

• Augmented economic recovery of valuable minerals from waste materials

• Combined with more efficient mineral sands gravity circuits, they may eliminate the need for WHIMS (Wet High Intensity Magnetic Separators). This further reduces process complexity and costs, whilst at the same time producing final grade products often after only one stage of magnetic separation. In essence, they can often produce a far purer product at a relatively earlier stage

• Increased overall dry processing efficiency

• Decreased plant size and lower capital costs

• Reduced need for operators as well as the associated skill levels

• Enhanced ore reserves due to overall greater efficiencies, resulting in a greater pit to product yield

• Reduced equipment footprints of up to 90% over electromagnets

• Optimised capacity – Outokumpu's larger diameter rare earth roll magnets actually allow mineral processors over 300% more capacity versus other prior-art rare earth magnetic separators

What else is important?

Testing is crucial to ensure the optimum result for client needs. Testing allows product qualities to be assessed, tonnage rates determined, flowsheets generated and, ultimately, engineering and costing to be done on projects. For example, Outokumpu's

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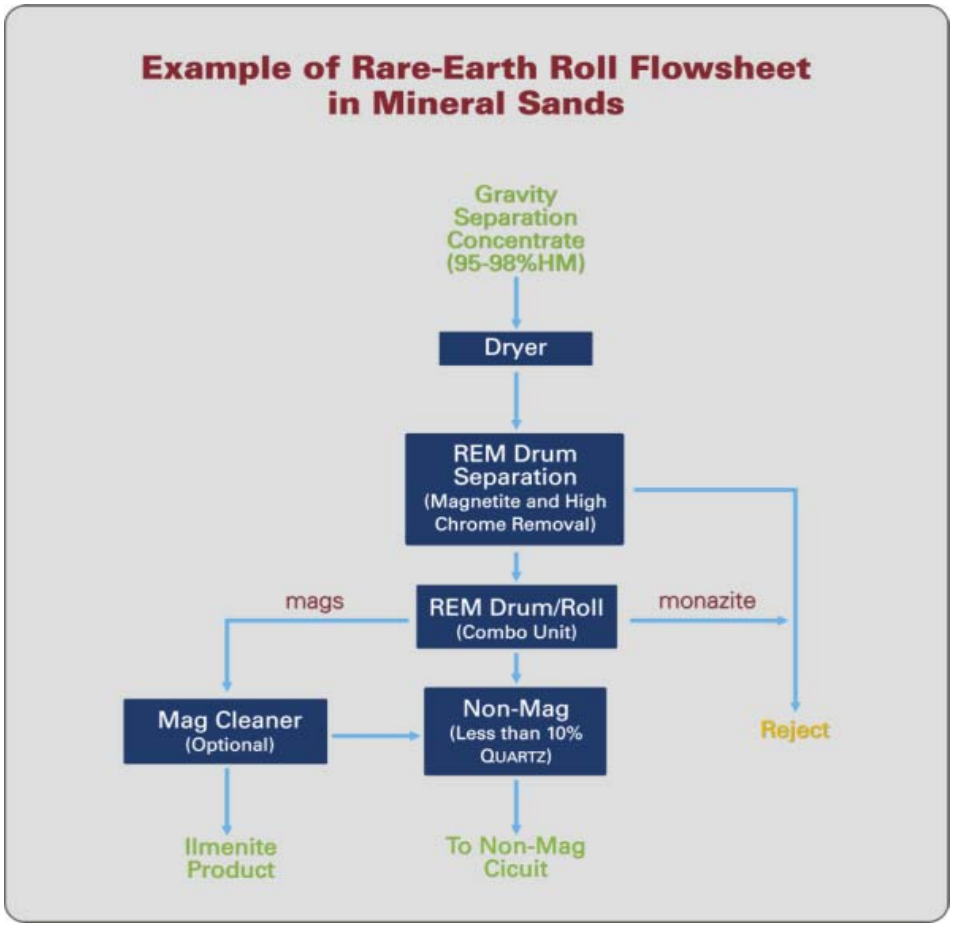

physical separation laboratory in Perth provides the full gamut of testing and flowsheet requirements for clients.

The separator's final design is most often determined by client-specific separation requirements, combined with the results of the testwork facility. This early collaboration between client and technology provider ensures the performance of the delivered separator is of the greatest efficiency and value.

If you would like further information on rare earth magnets or have any other Physical Separation queries, please contact Steve Benson at steve.benson@outokumpu.com

Roll or drum, it's your choice

Criteria	Roll Separator	Dry Drum Separator
Ferromagnetic material (magnetite, tramp iron)	Scalper model (low strength) with long-lasting thick belt	Small amount tolerated (<1%), using release bar
Highly paramagnetic material (ilmenite, garnet)	Moderate-strength with high capacity, thick long-lasting belt	High-strength, release bar required, high feed rate, less separation sharpness than roll
Moderately paramagnetic (biotite, leucoxene, monazite)	High efficiency, higher grade and recovery compared to electromagnets.	No Use
Weakly paramagnetic (muscovite, amphiboles, pyrite) Cleaning of quartz, feldspar, zircon, rutile	High efficiency, higher grade and recovery compared to electromagnets.	No Use
Operations and maintenance	Low attendance. Belt change easy.	Minimal operator attendance. Replacing drum shell requires qualified shop work
High Capacity	300 mm and 150 mm versions providing 3-4 x and 1.5 x capacity of 100 mm roll	Very high capacity with 610 mm diameter drums. Larger drums are also available.
High Temperature	120 + degrees C if needed	Up to 100 degrees C
Process Control	Wide range of parameters, great control flexibility	Moderate range of adjustments

Training – an investment in your plant's optimisation

Author: Frankie Standley

The foundations of a successful process plant consist of quality technology and quality personnel.

You would not give an unlicensed driver the keys to your car, just as you would not give untrained operators control of your multi-million dollar plant.

It is recognised that a lot of time and money needs to be invested in technology and personnel during the various stages of getting a plant up and running. However, once the plant is fully operational, it is then important to regularly review and optimise plant performance.

Once a concentrator is commissioned by the contract engineers, it is handed over to the mine owners. From this point onwards, it is the responsibility of the owners to ensure the proper operation and optimisation of the on-site technology. This is an on-going, dynamic process as the plant ages and the ore body changes. And plant optimisation not only involves processes, but people.

Employee retention

It is a well-known fact that the mining industry in Australia has a very high employee turnover (the highest of any industry sector, according to a study on Labour Mobility conducted by the Australian Bureau of Statistics, 2002). This problem is obviously of concern to mine managers who are hard at work trying to maintain site productivity.

Due to the nature of the mining industry (arduous rosters and fly-in/fly-out situations to remote locations), this problem will not soon disappear. However, training may help reduce the turnover rate by addressing one of the numerous reasons for its magnitude; cross-training of operators can help reduce the monotony of repetitive duties. Having a challenging role and variety at work will go a long way to retain the skilled and experienced personnel on-site.

As a result of the high turnover of operators, the overall skill level of personnel has to be maintained through regular training. As operators move from site to site, they acquire knowledge on different processing equipment. However, the majority of plant equipment and technologies is specifically designed and installed according to the plant's process requirements. Therefore, new plant operators, even though they have been in the industry for a while, need to be trained on their current plant's equipment to ensure optimum process results are achieved, and to help them keep up with any technological progress in the industry.

Increased efficiency

It is not uncommon to notice large variations in the output of a thickener, for example. The cause of this is very simple; different shifts of operators have different opinions on how the thickener should be operating and change the flocculant dosage, bed level or underflow withdrawal rates as they see fit. The overall result is an average process output, instead of an optimized one. Understanding the basic operating principles of a high rate thickener or flotation cell opens the door to understanding the control variables and operating limits of a specific technology, and how its operation affects the resulting plant output.

There is also an added benefit in the transfer of knowledge between trained and untrained personnel. Obviously, this is no proper substitute for an untrained operator – but can help familiarize an operator on key issues prior to his own individual training. Good work practices which are carried out by trained personnel have a tendency to 'rub off' on others, particularly when the process/operational benefits are so evident.

Metallurgists and operators attending the same training course results in everyone receiving the same information, directly from the source. Group discussions involving troubleshooting and process optimisation issues help resolve problems in a relaxed environment. It is sometimes more effective to conduct the training session off-site to get the participants out of their everyday environment as well as out of the "plant hierarchy" frame of mind.

Evidence of good training is the confidence displayed by operators when making decisions about the operation of plant equipment. Also evident are the significant improvements in operator reaction time when things go wrong. With some minerals processing technologies, it may take a while to notice a malfunction or a change in the output. Well-trained and experienced operators become sensitive to changes in the process and react much faster than their untrained and inexperienced counterparts.

Another direct result of training is the reduced number of calls received by customer support engineers regarding minor problems which could normally be resolved by on-site personnel. There is no doubt that plant equipment maintained by trained personnel has an increased longevity and usually operates at the peak of its efficiency. In cases where parts have to be replaced due to normal wear and tear, shutdowns of short duration can be scheduled well before the worn parts cause a breakdown.

An investment in greater profit

All the decisions made daily at plant level eventually amount to significant results on the balance sheet. A factor that is not easily quantifiable, yet evident through the impact on plant process, is the continuous return that a small investment in training can bring. One way to maximize recovery is to ensure that the process can be optimised by plant personnel through the proper setting of control variables. A trained operator knows how to operate and maintain a flotation cell at its peak efficiency. The skill acquired by this operator will remain intact for a good many months, until a refresher course is needed to re-emphasize some points and keep any bad habits at bay.

It is important to keep a balance between specific technology and equipment training, business skills training and safety training. Training sessions such as OH & S are mandatory for all employees. However, employers are recommended to offer a variety of training opportunities to their employees to motivate them and to demonstrate participation in their career advancement. Trained personnel are confident, more productive and more likely to show enthusiasm in helping in other areas of plant operation.

It was as a direct result of customer feedback that Outokumpu Technology now offers training on all aspects of theory, operation, maintenance and calibration of its minerals processing equipment.

Training can be either conducted on-site in the site's training facilities, or off-site as a regional seminar.

Conclusion

Investing in the training of one's personnel results in many long term benefits, all of which ultimately affect the optimisation of a plant. All good technology providers should offer training on aspects of theory, operation, maintenance and optimisation of their particular technologies. Using this resource effectively to optimise their operation is clearly the challenge and goal for all plant managers.

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