Introduction

Mineral sands extraction involves ore mining, valuable heavy mineral concentration and then separation into individual mineral products. None of these operating phases involves very complex technology; however, they all need to be properly understood to achieve an effective operation. Some of the common problems discussed in this paper may look surprisingly simple, and the remedies appear obvious, but it is surprising how often a combination of very simple issues combine to affect plant recovery or productivity. A new operator and plant metallurgist will not automatically understand the causes of poor performance, but the answer is more often than not found in a checklist of issues outlined below. Separation of mineral sands employs a limited number of processing techniques, only very few of which change the nature of the sand grains from their in situ state prior to mining. Short-term changes in performance are observed mainly when process conditions change, but much effort is often spent looking for changes in geology when the real culprit lies in the plant. Process troubleshooting necessarily involves consideration of the basic process conditions, and awareness of these ‘background’ effects is essential. In mineral sands, there is no ‘rocket science’, only details.

Mining

Mineral sands deposits are usually amenable to simple bulk mining techniques, so more than half the tonnage is moved by low unit-cost dredging. Individual deposit geography, geology and geometry dictate which method is preferred, with dry mining used where the ore is too hard, too much clay exists, or there is not sufficient water available for dredging. Dry mining is also more accurate, so is preferred on higher grade, shallow and discontinuous orebodies. Where there are several orebodies mined simultaneously, effective blending and proportioning is important to prevent fluctuations in feed composition. Within an orebody, there are often different geological domains or ‘zones’. The presence of these, and any inter-zone differences in mineral mixture, grade and process response need to be fully understood. In such cases proper control must be exercised over mining operations, otherwise there can be adverse impacts on the plant performance. Usually, mining is not responsible for short-term fluctuations in plant performance, and management needs to look beyond the pit to bring performance back to par.

Concentration

Extracting a concentrate from the ore is always performed using gravity separation, usually by spiral concentrators. Transport of the waste minerals back to the mine for disposal is arranged to minimize unit costs, and often necessitates the periodic relocation of the concentrator plant. Maximizing non valuable mineral rejected in the concentrator enhances separation in the mineral separation plant (MSP) by decreasing the impurities to be removed from the products. Secondary concentrators are sometimes added to further prepare heavy mineral concentrate (HMC) prior to the MSP. Concentrators are designed to handle a relatively broad range of feed grades, but must deliver a well-prepared HMC with consistent features, for the more complicated MSP to effectively process. Some sacrifice of marginal recovery may be necessary at the concentrator, in order to achieve the optimum overall

‘Old tricks for new dogs’ Areas for focus in mineral sand processing

P.S. MARCOS and S.K. GILMAN
TZ Minerals International
result. This calls for mutual understanding of plant process capability and a team effort to make the most out of the resource.

**Mineral separation**

Mineral separation is achieved by exploiting the physical attributes of the HMC minerals. Using combinations of classification, magnetic, electrostatic and gravity separation techniques, the different minerals are ‘encouraged’ into their respective product bins in multiple stage, interconnected flowsheets.

**Primary concentrators**

The fundamentals of gravity concentration in the primary concentrator plant (PCP) are simple, but there are basic requirements for obtaining acceptable grades and recoveries in a gravity separation plant. An understanding of the separation mechanism is important to see why the nominated basic conditions need to be maintained.

**Concentration mechanism**

Spirals separate minerals based on specific gravity and size. Minerals with high specific gravity and finer sand particle size are preferentially taken to concentrate. This mechanism of separation differs from other gravity concentrators such as jigs and up current classifiers (hydrosizers), which recover the course high specific gravity particles preferentially. This difference and its implication on circuitry is often misunderstood. Finer sand particles are preferentially taken to concentrate due to the velocity profile of the water. As well as flowing down the spiral, water flows from the centre of the spiral to the outside due to the centrifugal force. The large particles that protrude further into the water flow get pushed further from the centre of the spiral. Figure 1 illustrates this.

The movement of sand particles along and across the slurry flow is determined by a combination of physical effects, such as water viscosity, spiral surface geometry and smoothness, and the size and relative specific gravity of the sand particles. The slurry density and volume also affect the flow patterns. These effects all translate into individual trajectories for each particle, and thus determine the delivery to concentrate, middling or tailings streams at the bottom of the spiral. For a specific mixture of minerals being presented to a spiral, given that the geometry of all the spirals in a bank should be similar, the deportment of a sand grain of a particular size and specific gravity should reliably be to the same stream. However, the background conditions for separation are not always the same on each day, and therefore the target mineral grain, albeit having the correct size and specific gravity, can travel a modified trajectory, and report to a different product bin. This effect can be multiplied by hundreds of individual streams, and result in either poor recovery, or ‘off-grade’ HMC.

The two most significant impact agents affecting normal PCP performance are water viscosity and spiral loading changes. Slime content of the water in the feed influences the former, while distribution inaccuracy and feed density controls affect the latter.

**Slime content**

Ineffective desliming is the most common cause of poor mineral recovery at the PCP, and usually affects the rougher stage. Although material less than 53 micron is often defined as slime, it is the very fine naturally occurring clay minerals (less than 10 micron) that cause the recovery losses. The clay minerals increase the viscosity of the water, and retard the normal movement of sand particles. Because the bulk of water reports to the tailings bin, high slime in the water is accompanied by heavier mineral reporting there also.

After many years of observing PCP performance around the globe, TZMI has concluded that a universal ‘rule of thumb’ applies to slime effects. This is depicted in Figure 2. Once water carrying sand to the rougher spirals reaches a slime content of 3%, there is already a noticeable drop in recovery at that stage of the plant. Once 4% slime content in the water is reached, the losses become a major cause for concern. Assuming the plant has been designed correctly, it should always be possible to manipulate the feed preparation circuit to keep slime in the rougher water below about 2%. A high slime levels in the ore is the most common reason for having elevated slime levels in the feed to the rougher spirals, and some ore blending may be possible when the recommended limits are being experienced. Unfortunately it is also common to observe desliming equipment that is poorly operated or maintained.

Cyclones must be included in the PCP feed preparation flowsheet unless slime content in the ore is very low. Many designs also rely on overflowing slime from the main plant spiral feed tank as a secondary desliming step. Rarely, the slime content in the ore is high enough to require two stages of desliming cyclones with interstage washing. To achieve the desired conditions for the spiral feed, maintenance and correct operation of the desliming cyclones is required. Cyclones will operate effectively over a range of feed conditions; however, it is important to determine the conditions when operations or maintenance adjustments are required. Feed volume to cyclones needs to be kept relatively constant, which requires the feed pump water cycles to be understood and maintenance performed in time to prevent low cyclone feed pressures. Cyclone inlet pressure should be measured locally at the cyclone cluster, and the correct operating range maintained. A well designed plant will have a spare cyclone in the cluster, with the ability to isolate individual units while the plant is operating. Isolation of additional units might also apply if the feed volume is down, and therefore pressures are too low. The cyclone spigot size affects the volume of water,
**Spiral feed distribution and control**

The optimum performance of a spiral separator occurs when the deslimed feed is delivered at a constant volumetric flow, and at a constant slurry density. If the feed density is too high, inter-particle interference increases, affecting sand particle trajectory. If the feed volume is too small, lower grade sand can report to the concentrate product box. Sustained changes in feed volume and slurry density can be dealt with in part by adjusting product splitters, but short-term fluctuations in either of these are impossible to manage.

A prerequisite for steady feed to the rougher stage of spirals is an effective surge tank at the end of the feed preparation circuit. Fluctuations emanating from mining equipment delivery or sequential arrival of ore from multiple feed sources can be tempered by having a significant capacity surge bin ahead of the spirals. The surge bin must be operated so as not to run empty, otherwise its intended function will be negated. Assuming there is feed in the surge bin, and an effective density and flow control system, the feed to the rougher spirals must then be evenly apportioned to a multitude of individual spiral feed points. The correct design and operation of the spiral feed distribution system is the next important background condition for effective PCP performance.

Poor spiral distribution increases loads on some spirals while decreasing loads on others, with sub-optimal separation the result. It is not practicable to adjust product splitters on an individual spiral basis to deal with ephemeral feed distribution upset conditions, so the correct approach is to fix the feed flow.

Feed hoses run from the primary distributors to the spiral distributors, and uneven back pressure will deliver different volumes to each spiral bank. Pipes do wear out, and it is important that maintenance cost imperatives do not compromise the correct delivery of slurry volumes. Delivery hoses of different lengths and diameters are the most common cause for poor distribution to the spirals distributors. The bank distributors are often prone to blockages at the individual spiral feed outlet, particularly if one of the screening stages in feed preparation has failed. Clearing blockages is messy and time consuming, but the consequence of not attending to such upsets is more poor performance.

The experienced and alert operator or technician will spot poor circuit or individual distribution at a glance, and set about correcting the problem as soon as possible. Distribution to spirals is easily checked by measuring the flow from individual spiral starts. Minimal equipment is required, only a set of scales, a large bucket, a stopwatch and hence slime, reporting to the cyclone underflow. As the spigots wear more slime reports to the underflow. It is essential that cyclone spigots are not allowed to wear excessively, so maintenance routines must be in place to enable these units to be operated correctly. After that, it is up to the operators to do so.

To illustrate the effect of a worn spigot or underfed cyclone, consider the following example:

For simplicity assume that slime follows the flow of the water. Starting with an ore containing 15% slime, water is added to feed the cyclones at a slurry density of 1.35 and achieves an underflow density of 1.85, or 70% solids. Operating at these densities 75% of the water would report to the overflow taking with it 75% of the slime. Make up water is added to the cyclone underflow to give slurry feed density at the rougher spirals of 1.35 so the slime in the water to the rougher spirals would reduce to 2.8%. As seen in Figure 2 as slime in water increases over 3% the recovery of HM decreases significantly. If cyclones were performing poorly causing the underflow density to fall to 1.65 (60% solids) the slime in the water to the rougher spirals would increase to 4.3% with a recovery decrease of over 5% due to the extra slime.

Tables I and II summarize results for the above example.

Desliming problems typically extend well beyond the length of a shift, and should be picked up in reviewing daily plant feed assay results. Experienced operators will also recognize the signs of spigot wear with a wider underflow spray pattern, and the “feel” of the slurry on the spirals. Swapping the worn cyclone for the hopefully refurbished spare set; ensuring the surge tank is overflowing extra slimy water; and taking the time to report poor cyclone feed pump performance are all steps the operators and technicians can take to restore plant performance.

**Figure 2. Rougher spirals stage HM recovery vs. % slime in water**

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**Tables I and II**

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<th>Table I</th>
<th>Cyclone operating at 15% slime by weight and underflow</th>
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<td>Feed</td>
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<td>Make up water</td>
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and a metallurgist or trained technician who is willing to leave the office and get a little dirty. Sometimes the latter is the hardest characteristic to acquire.

**Spiral cleaning**

For efficient operation, spirals require a clean surface to avoid disturbances in the flow. Build up of slime and sand on spirals, especially in the centre of the spiral and on the product splitters leads to reduced recoveries. It is a time consuming and often difficult job to clean spirals, but it is vital that it is performed. In many plants the task of keeping spirals clean is the principal activity of the operators. To make the job easier operators have been innovative with basic methods to help them clean the inside of spirals. This ranges from the use of toilet brushes, through to the use of high pressure water spray guns with purpose-built nozzles for reaching between the spirals.

**Sampling and periodic plant surveys**

All PCPs rely on assay results to gauge the past performance of the plant, and the relevance of assays depends on correct sampling, at appropriate frequencies. Daily operations rely on shift composites taken at three or four key locations. Usually these results are insufficient for major ‘tuning’ exercises, and following permanent changes to ore feed characteristics, or in response to a protracted deterioration in performance, a detailed plant survey will need to be conducted. This is a major exercise, requiring active participation of all the plant operators, technicians, metallurgists, and even laboratory staff to make up the required numbers. Prior sanction and process capacity must be arranged at the assay laboratory so the results are available in a reasonable time after the survey. The results and attendant actions should be communicated to all participants and others needing to understand the results as soon as practicable. While these special surveys are required from time to time, the majority of responses to assay results needed to control plant performance emanate from the shift samples. Therefore it is important to make the sampling procedure foolproof and ensure the samples are accurately taken.

Poor sampling causes incorrect recovery results and misleads metallurgical troubleshooting. There are many reasons why sampling may be inaccurate, and this seemingly simple process should be understood by the technical and operating staff to avoid misdirected effort.

Slurry flows within concentrators are large. In order to obtain a representative sample the flow must be taken so it is not biased. To obtain a manageable size sample, a large flow such as tailings is split a number of times. This can be achieved by initially taking a bleed of the total flow from a T-piece situated close to the pump discharge. Taking the bleed stream near the pump discharge ensures the sample is well mixed and the bleed stream representative of the flow. If the bleed it taken some length from the pump discharge or after a bend the sample will be biased due to stratification and separation in the pipe. For the same reason, it is preferable to sample from a vertical pipe section.

The bleed stream taken will still be too large to be passed over a sample splitter, and the design of this device can impart bias due to the design being a compromise between cost, operability and reliability.

**Other performance issues**

PCP spiral circuits are interconnected by an amazing number of pipes, many of which are flexible hoses, and often these need to be moved or replaced for sampling or maintenance reasons. Pipe work can be accidently redirected to the wrong sump, and the experienced operator will routinely follow through the circuitry to ensure all pipes are reporting to the correct sumps. Some of the most heroic recovery improvements have resulted from putting the concentrate pipes back in the correct launder.

**Recirculating loads**

Middling cuts, which are recirculated within the PCP, makes the operation more forgiving, but if cuts become too large or are made in the wrong places, will overload circuits and lead to poor HMC grade or reduce recoveries.

Middling steams are often recirculated over the stage of spirals from which they are taken. This creates a buffer between the concentrate and tailings cut, allowing fluctuations to occur in the grade to the spirals without a large effect on the concentrate and tailings product from the spiral. The middling stream in these circumstances should only be large enough to act as a buffer in the case of a surge in the feed grade to the plant. It should not be used as a buffer a poorly performing plant. When middling cuts are used in an attempt to compensate for a poorly run plant (due to overloading, slime, etc.) recoveries are further reduced.

It is good plant practice for the loadings on individual spiral stages to be known by metallurgists to allow the proportion of feed from ‘new’ sources, and the proportion from recirculating loads to be distinguished, to allow fast assessment of the recirculating loads.

**Up-current classifiers (hydrosizers)**

Due to the opposing modes of separation on spirals compared to up-current classifiers (hydrosizers) it is possible to use a combination of the equipment synergistically. Hydrosizers are often used to reject fine light minerals towards the end of spiral circuits. Overflow from the hydrosizer can be effectively scavenged with a dedicated spiral bank due to the feed having a favourite size range.

Hydrosizers are also used to classify feed prior to spiral separation when the size range of mineral to be treated is large. This use of hydrosizers is more prevalent in the mineral separation plant, but it is also practised at the end of some PCPs. Splitting a wide range of particle sizes into two fractions before treating each portion on dedicated spiral banks is a very effective processing technique, because it removes one of the negative influences on separation. These principals can be neglected in the PCP where the focus is understandably on spiral performance.

Use of the additional separation equipment within the concentrator allows reduced recirculating loads and higher selectivity to reject lighter ‘trash’ heavy minerals, and could be considered as a retrofit where such separation issues exist.

This principal of using up-current classifiers in combination with spirals or wet tables is discussed further and illustrated in the MSP section of this paper.

**Mineral separation plants**

The minerals separation plant uses a combination of physical techniques to separate the individual minerals contained in the heavy mineral concentrate. These different techniques are discussed outlining the common problems and issues encountered in the MSP.
Electrostatic separation

Electrostatic separation depends on the relative electrical conductivity of surfaces of the mineral sand species. It also relies on the grounded part of the separator to be readily available to transfer conductive charges to or from minerals. Accordingly, both the mineral grains and the separator contact surface must be clean and dry. Effective particle charging also depends on the high voltage system on the machine, and the atmospheric conditions in the separation zone. Momentum, inertia, gravitational and centrifugal forces are applied to mineral grains, and the resulting trajectories are affected by grain size and specific gravity. The combined effects of these forces superimposed on the electromotive forces are exploited to provide the required separation.

Surface staining

Mineral sands have a varying degree of surface contamination, usually dependent upon the geological setting of the deposit. Staining ranges from humic deposits in swampy conditions, through ferruginous and siliceous coatings deposited from circulating groundwater, clay coatings and evaporated saline coatings. The cleaning of mineral surfaces employs a variety of techniques, some with reagent additions, but all involve water attritioning. The harshest surface cleaning practised involves hot acid leaching, but even these sand particles need to be water attritioned before electrostatic separation.

Attritioning is undertaken at high densities to obtain strong particle on particle contact. A typical reason for dirty mineral grains is attritioners being operated at low densities. This makes for trouble-free attritioner operation, and reduces maintenance cost, but can have a severe effect on the electrostatic separation. Slime liberated by the attritioning process must be washed out between stages of attritioning, and before drying. Slime in the water ‘lubricates’ the minerals reducing the friction between particles reducing the attritioner efficiency, and drying the clean mineral in the presence of the liberated slime particles only serves to reattach them.

A quick method to determine whether attritioners are operating effectively is to feel the outside of the cell. High density attritioning evolves heat, so the cell should be warm to hot if it is operating properly.

Salt on mineral surface

Some operations are unable to secure sufficient fresh water resources, and rely on saline ground or sea water for primary concentration. Prior to the first stage of electrostatic separation, the mineral must be washed with fresh water to remove residue salts that render all minerals conductive. Monitoring salt level is simple. The conductivity of the water that is last in contact with the mineral should be measured. This is often filtrate from a filter belt or overflow from a stacker cyclone. Measurement of the conductivity gives an indication of the salt that will be present on the mineral surface once dried.

Typically, the MSP process water is thickened or filtered, and returned to the circuit to conserve water. Each MSP has a threshold of soluble salts building up in the circulated process water, beyond which the evaporated process water leaves sufficient salt during drying to adversely affect the separation. Once the threshold level of dissolved salts has been determined, periodic checking should determine whether flushing is required.

Dirty high tension roll (HTR) separator surfaces

A build-up of insulating material on the roll surface of electrostatic separators is a common cause for poor efficiency. Brushes must be maintained in good order, but the root cause of such build-up is dirty sand surfaces in the feed. If the HTR performance deteriorates over a few weeks and the brushes are still in good condition, then the attritioning circuit is the most likely cause.

Blocked launders

Launders in the electrostatic machines have small pipes to remove the products. Pipes are usually only 50 mm in diameter and can easily become blocked, resulting in the launder overflowing into the adjacent product bin. This can lead to the entire conductor or non-conductor stream misreporting, and throwing the product off grade. Because the blockage is usually not visible from outside the machine, an experienced operator will realize that this is a possibility that must be checked by viewing the machine outlet flows.

Electrodes

Power to electrostatic machines is supplied by high voltage rectifiers supplying a bank of electrostatic machines. When arcing occurs at a single electrode the entire bank of machines supplied by the rectifier lose voltage and therefore separation. Continued arcing must be prevented by setting voltages at below the point at which arcing will occur. If this is unusually low, or insufficient to allow effective separation, the cause must be identified and fixed. It is never acceptable to operate below the proper separation voltage.

Incorrect electrode positioning may occur after routine maintenance due to the electrode being knocked or not returned to its required position. There are many other reasons why an electrode may become set incorrectly. The important point is that the electrodes should be routinely checked to ensure that they are positioned correctly.

Distribution and feed rate

Electrostatic machines are very susceptible to overloading and uneven feeding. Distribution to electrostatic machines needs to be as even as possible, and the sand load spread evenly along the separating surface. Very low feed rates also cause problems. The low thermal mass present allows feed temperature to drop, causing reduced separation efficiency. It may be better to switch off one machine in a bank, to ensure that the remainder are properly fed. Any surplus will build up in the feed surge bin until it is prudent to re-engage the additional machine.

Splitters

Splitters on the HTR machines need to be positioned correctly and should be straight. Splitters can be bent during maintenance such as roll replacement. Bent splitters may look like they are positioned correctly when inspected at the side of a machine, while in fact only the edge of the splitter in view is in the correct position.

Electrostatic machine maintenance

HTR maintenance

HTR maintenance is important for maintaining separation efficiencies. Brushes that remove pinned non-conductive
minerals must not be allowed to wear past the bristles, and must be tensioned enough to keep the roll surface clean. If the surface of the roll is not clean, the conductive minerals are unable to release their charge and are pinned to the roll with the non-conductors.

As HTR corona wires age the separation efficiency drops and wires eventually fail. Wire electrodes should be changed on a regular basis.

Older style HTR machines use a single motor on either side of the machine to drive the rolls. V-belt pulleys are used in most occasions, but as these wear the roll speeds change. Roll speeds should be monitored and pulleys changed when differences in roll speeds become excessive.

**Electrostatic plate**
Electrostatic plate machines do not have moving parts, and maintenance is minimal. The plates within the machines should be replaced if arcing becomes excessive. Arcing causes the plates to become pitted, which in turn become more prone to arcing. This restricts the operating voltage of the machine.

**Temperature**
The lack of temperature control in electrostatic machines is a common cause of poor separation efficiency in the MSP. Lower temperatures are more comfortable for operators and maintenance personnel, but higher temperatures create conditions where surface electrical conductivity difference between rutile and zircon are maximized. Low temperatures result in less efficient separation, requiring many more stages to achieve acceptable product grade and recovery. High circulating loads are a typical reason for the mineral temperature to decrease, and operating HTRs with the feed hopper covers open also allows heat to escape.

**Humidity**
Humidity in the machine operating space affects separation, and each MSP has a preference for a particular range of atmospheric conditions. When there are strong diurnal or seasonal swings in humidity, the plant must be reset according to the current conditions. Good practice has pre-ordained settings for frequent humidity settings, and may even use remote weather data to preempt the changes.

**Mineralogy**
Mineralogy and changes in mineralogy affect the MSP. Minerals such as leucoxene, garnet, staurolite, kyanite and sillimanite are all difficult to separate from ilmenite, rutile or zircon. HMC containing larger amounts of these minerals will incur valuable mineral recovery losses in the MSP. Ore blending and deliberate suppression of HM minerals will incur valuable mineral recovery losses in the MSP. Ore blending and deliberate suppression of HM recovery at the PCP can help the overall recovery of valuable mineral. Experience shows that geological domains in the mine are associated with regimes of process results. It is therefore important to understand the metallurgical implications of orebody geology when designing the MSP flowsheet.

**Magnets**
Overloading of magnets due to poor distribution and poor feed arrangements is the most common cause of poor separation. When roll or belt style magnets are overloaded the large bed of mineral causes non-magnetic material to become entrained between the magnetic material and magnetic material to be thrown to the non-magnetic stream.

Lift magnets such as Cross Belt or Rapid magnets are equally susceptible to overloading. In addition to the entrainment issue, these magnet types can physically scrape the feed material into the magnetic product chute.

**Induced roll magnets**
Induced roll magnets (IRM) are employed in most MSP. Feed rate, pole gap and the condition of the roll should be checked routinely to ensure separation efficiency is maintained. The smaller the pole gap the more intense the magnetic field. Worn IRM rolls reduce the overall efficiency of the magnet. Roll speeds should be routinely checked and pulleys changed if incorrect roll speeds are decreasing separation efficiency below an acceptable level.

**Rare earth magnets**
Rare earth magnets have been widely embraced since they were first introduced in the 1980s. Separation efficiencies were improved over the conventional magnets of the time, but they do also need to be maintained in order to maintain their efficiency advantage. Belts on roll magnets need to be correctly tracked to avoid wrinkles and premature belt failure. Kevlar belts are used on rare earth roll magnets when higher magnetic strength is necessary to separate weakly magnetic materials from one another. Some non-conductive minerals such as zircon collect a static charge, causing them to stick to the kevlar belts and misreport to the magnetic fraction. Zircon losses on these belts due to the static can be excessive. Thin PVC belts are available to overcome this issue.

**Wet gravity circuits**
The same principles and issues that apply to wet gravity circuits in concentrators apply to wet gravity circuits used in MSP.

Wet gravity circuits in MSP will often use hydrosizers to separate mineral based on size and specific gravity prior to gravity separation on spirals or wet shaking tables. This is illustrated in Figure 3.

The operation of the hydrosizer plays a pivotal roll in preparing feed for downstream separation and a poorly performing hydrosizer has been known to reduce overall zircon recovery by up to 5%. Spray water injection ports to the hydrosizer should be routinely checked to ensure the flow is even. Feed to hydrosizers should ideally be 65–75% solids to avoid excess water disrupting the bed.

**Centrifugal jigs**
Centrifugal jigs do an extremely good job of separating minerals that have only small differences in specific gravity. Due to the high forces exerted on the machine and the large number of moving parts, centrifugal jigs are maintenance intensive. It is vital that the metallurgy departments ensure jigs are optimized for mineral recovery and not optimized to reduce maintenance. The operating parameters of centrifugal jigs can be misunderstood, and indeed are not often well understood unless metallurgists have been specifically trained in their operation. For this reason many centrifugal jigs are run poorly, and end up being decommissioned because they are not seen to be beneficial, besides having high operating costs. In today’s high price zircon market, every effort is being made to get the most from these machines.
Other general points
Metallurgists should not be afraid to question plant operational strategies. Sometimes operations are constrained by ‘plant urban myths’. It is all too common that equipment will be run at certain setting for many years without optimizing simply because ‘this is the way we always run this equipment’.

The optimal performance from the resource to final product will at times require one or another to sacrifice unit performance measures for the overall good. An appreciation of the interconnecting influences is always preferable to an isolated approach where individual endeavour and sectional success may disadvantage others either upstream or downstream. Almost every long running operation has had problems with both unexpected changes in mineralogy, as well as controllable plant problems. Knowing what feed the plant will receive is very important, but the temptation to divert responsibility must be avoided.

Conclusions
Ensuring ‘the basics’ are correct in a mineral sands concentrator or mineral separation plant is vital in order to maintain recovery, quality and production levels. Neglecting the basics will always see a decline in plant performance. Experienced personnel who sense rather than see that something is amiss are unfortunately becoming a rare breed, so the new practitioner must learn to look beyond the data system electronic results. Many of the background conditions necessary for successful process operations are mundane, and perhaps appear trivial. However, simply because a concept or machine is uncomplicated is no reason to expect that it will look after itself. Covering the basics should be seen equally or more important to ensuring the accuracy of monthly metallurgical balancing or plant project work. The amount of additional recovery benefit to having a plant well run is often underestimated.

Convincing new metallurgists that these basic details are worth their attention is a challenge, particularly in today’s resources industry where there is such a shortage of trained professionals.