

Technology, investors to drive cultural shift

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In August, 2014, the Mount Polley tailings facility failed, releasing some 10 billion litres of water and 4.5 billion litres of slurry into Polley Lake, triggering a state of emergency as water levels rose 1.5m and drinking water for more than 300 residents was compromised.

It was the first, major tailings storage facility (TSF) breach in years and, while not a human tragedy, it alarmed the industry with its scale and location – Canada was, and remains, a leader in mining knowhow and best practice.

In November the following year, the TSF at the Fundão iron ore operation in Brazil, a joint venture between majors Vale and BHP, ruptured then failed, releasing some 60 billion litres of tailings fluids and slurry. This time, there was a human cost, with 19 killed and hundreds more displaced.

Then in January this year, the Córrego do Feijão mine TSF, also in Brazil (both Feijão and Fundão were in Minas Gerais state) – and another Vale-operated facility – failed and released some 12 billion litres of waste material downstream. The deluge cleared out a packed Vale lunchroom and the Vila Ferteco community on its way to the Paraopeba river. This time, the official death toll (late May) was 243, with another 25 still missing.

Feijão has been not so much the straw, but the anvil that has broken the camel's back and mobilised industry and stakeholder groups on an unprecedented scale.

But concerns around TSF management have been rising for decades.

According to World Mine Tailings Failures (WMTF), the only publicly available database on TSF failures, the total number of incidents and potential incidents per



decade has tracked a broad, upward trend. Meanwhile, the occurrence of Category 1, Very Serious Failures – a function of release, runout, and deaths – has formed a far more defined upward trajectory.

From two-or-less Category 1 failures per decade in the periods leading into 1958-1967, the rate rises steadily to touch double figures in the 1998-2007 block, and was at 13 for the most-recent period ending 2017.

The TSF failure-related death toll also appears to tell a mixed story. Heavy human losses from 1968-1987 are significantly improved on over the period 1988-2007 but then spike again for 2008-2017. Feijão's inclusion in the current decade suggests it will be another poor period.



The Fundão tailings dam failed on November 5, 2015 (Image: Senado Federal)

This looks worse set against the industry's collective 'Zero Harm' aspirations, which have seen the number of mining-workforce fatalities fall year-on-year despite the number of miners rising. In the US, fatalities have dropped from 182 in 1968 to 15 last year. The International Council on Metals & Mining (ICMM) recorded a drop in the fatality frequency rate among its global membership of 33% since 2012.

So, as mining safety on the whole shows a clear and impressive safety-record gain, it's track record on TSF safety reads poorly.

Central for the TSF-specific challenge has been the escalating scale of mining operations and the ore-to-gangue ratio. As miners have naturally over the decades prioritised high-grade, low-cost deposits, the grades of modern mines are low. Meanwhile, the population density of the world is up 140% since 1960, driving the growing demand profile. This means bigger holes with a greater proportion of waste finding its way to TSFs.

Measuring the response

Industry, government and investor response to the challenge has waxed and waned over the years but is more unified and pronounced than ever before, having been shocked by both the frequency of recent, large-scale failures as well as the loss of life.

Vale, for its part, has been dutiful in its post-Feijão assessments, monitoring and transparency, though many would rightly say that is too little, too late and,

Global TSF deaths vs US mining



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in any case, its actions simply represent cooperation with government - a 6.5% shareholder in Vale directives.

The government, meanwhile, banned future upstream TSFs in February but, apart from that, has been conspicuously measured in its political - as opposed to judicial - reaction, resisting the temptation to install broader, knee-jerk regulation. Instead, it has insisted on a comprehensive round of TSF investigations and focused energies on Vale management, which is now the focus of the country's sweeping, multi-year corruption investigation.

On one hand, this reaction by Brazil's governing Social Liberal Party is encouragingly pragmatic nothing will be resolved without proper investigations into what is clearly a complicated, deep-seated challenge – but it is also self-serving.

"We're talking about an administration that was seeing mining and mining investment as one of the engines for economic recovery," Jimena Blanco, Latin America lead for above-ground risk consultant Verisk Maplecroft, told Mining Journal.

"This administration is looking to reduce the impact by addressing what needs to be addressed but is trying to avoid creating hurdles for a sector it was looking to incentivise.

"They're looking at the technical capacities at the moment and it's that kind of nuanced response we can expect."



Copper grade vs production per decade since 1910



ICMM chief executive Tom Butler has significantly broadened the scope of the organisation's tailings review this time around

But recent failures have not been lost on those beyond Brazil's borders. Governments, particularly those with limited mining experience, will respond differently and many will require far greater assurances going forward when the subject of TSFs is tackled as part of a development proposal. Communities will need even greater attention.

Mining's reputation has, again, been battered and needs intensive care.

How the industry handles itself in the wake of the current focus on TSF failures is central to that reparation effort and, at the heart of that campaign, is the ICMM's review and stated goal to establish an "international standard for tailings dams".

The standard, according to the organisation, would be "informed by a review of current global best practices in the mining industry and beyond", and "create a step change for the industry in safety and security".

It would be: a global, transparent, consequencebased classification system with "appropriate requirements" for classification levels; a credible system of independent review; and include emergency planning and preparedness. The standard was expected to be ready by the end of the year.

ICMM chief executive Tom Butler told *Mining Journal* it would be implemented as soon as practically possible by member companies and the organisation would advocate for industry-wide adoption.

"The danger is we all launch off in different directions to establish standards and practices that may not be aligned and I think it's important to take a step back, be comprehensive and maybe even take a little bit of extra time to get it right so we can deliver something that can be implemented," he said. "It has to be something unprecedented and stakeholders are going to be able, through this classification, to see what companies are doing and compare them across jurisdictions and operations on a like-for-like basis.

"I'm a strong believer that transparency breeds accountability and that should build trust."

IS CURRENT PRACTICE REALLY THE BEST WE CAN DO?

Investigations will be wide-reaching and will naturally focus on how TSFs are currently being designed, built and managed in an attempt to pin-point the critical vulnerabilities.

The first issue investigators are likely to run up against is that TSF practices have seen only incremental change for the past 20-30 years.

"Despite the introduction of thickened discharge technology and filtration, conventional thickenedslurry tailings deposition, mainly to valley-surface TSFs, continues to be the most common method of tailings management," our more technical colleagues from sister title *Mining Magazine* told us.

Management continues to focus on a "degree of thickening ... in the processing plant" to allow transport as a slurry using "robust and relatively inexpensive centrifugal pumps". Thickened or paste tailings that need "expensive and input-sensitive positive displacement pumps" remain rare. Filtration of tailings, meanwhile, is mainly restricted to water-sensitive regions where water recovery for use in the plant provides an economic argument.

Similarly, the TSF models – downstream, upstream and centreline – are well established and the expertise in building them, therefore, (theoretically) widespread.

Downstream: using natural fill or mine-waste materials constructed in the downstream direction. These water-retaining dams require an increase in the volume of fill as the dam is raised. This method is best suited to wet and/or cold climates like the tropics and some parts of Canada, or areas of high seismicity.

Upstream: raises constructed in the upstream direction on beached and desiccated tailings using fill and/or dried tailings. Suited to dry climates such as southern Africa, much of Australia and southwest US that facilitate desiccation of the tailings beach. The rate of rise should typically be limited to 1-2m per year and deposition should be cycled in thin lifts that

are allowed to consolidate and desiccate in between. These factors make it unsuitable in seismic regions or areas with high rainfall.

Centreline: a cross between the former methods, in which the centreline of the dam rises vertically with fill placed downstream and on top of tailings. The centreline embankment can be designed to be stable, independent of tailings characteristics.

This is, however, an oversimplification of the TSF design. As SRK Consulting practice leader and principal geotechnical engineer, Dr Maritz Rykaart, put it: "The challenges and considerations are endless – every single TSF is site specific."

He said primary technical considerations included seismicity, rainfall/climate, available materials, topography and the tailings themselves. These formed a unique mix for each and every mine.

Making life harder for engineers were the immediate economic pressures, which were out of sync with the design needs for a piece of infrastructure likely to stand for several decades.

"It's all about the upfront capex at the scoping stage and anything post-10 years can sometimes take a backseat because it doesn't impact the NPV of the project," he said. "The total life cycle cost of a tailings facility is not well looked after.

"The one constant in mining is that mining is never constant – we know every single project will change from the moment we start mining so, when it comes to designing facilities it has to be done with some blue-sky ideas about how big it will need to get, recognising that this will change over time.

"You need to reconsider the challenges as the dam grows and, in the event of an unexpected expansion, you have to decide if expanding the dam is the right option or is it safer to start somewhere new, but always with the costs in mind. That's the reality."

However great the economic pressures, Rykaart insisted the technical expertise was there to engineer safely and within the fiscal constraints. Even the seemingly high-risk decision to build upstream dams in tropical Brazil, such as those at Fundão and Feijão, could have been done safely.

It was a similar story for monitoring.

Historically, the technology for monitoring TSFs has been limited to piezometers (read monthly) and settlement plates (surveyed every six months), however, Rykaart said the instrumentation available



How tailings are treated and sent to the TSF hasn't changed in decades (Image: Brian Brown Images/iStock)



today for geotechnical and water monitoring had grown and ranged from basic visual observations to advanced telemetry stations and technology uploaded through satellite links.

He said the greater challenge currently was interpreting the data to improve decision making. Rykaart's colleague and principal civil geotechnical engineer, Adriaan Meintjes, said the procedures here, too, had evolved and were robust.

"In southern Africa they have a Trigger, Action, Response Plan system with predefined trigger levels at green, yellow, orange and red," he told *Mining Journal*. "So, the alarm relates to the trigger and an appropriate response is initiated. A variation on this is in place in most major mining jurisdictions worldwide, driven by the majors."



Visual inspection along with piezometers and settlement plates have remained the mainstay of TSF monitoring (Image: AusIMM)



Sitting over these procedures is regulation. These rules differ for each country but are generally fit for purpose, according to Rykaart. While few would argue with authorities in Brazil moving swiftly to outlaw upstream TSFs, he warned against changing the rules for the sake of appearance in Brazil, or anywhere else.

"We're at a crossroads right now. There is a desire to change regulation and make it a lot more prescriptive but I think that's dangerous and we risk going down a slippery slope.

"The regulation we have in place is good. There are differences between jurisdictions and some are better than others but, overall, it is adequate."

Just do it better

Stronger enforcement of the rules would therefore seem to be the answer but regulation must retain enough flexibility for engineers to be innovative with design as the TSF evolves over its life.

The issue, then, comes down to the governance practices within the miners, which are meant to ensure staff adhere to best practice and the spirit of the regulation.

Mark Berry, senior projects lawyer and co-head of the European Infrastructure Group at international law firm Norton Rose Fulbright, told *Mining Journal* the governance practices should be established at the design stage for a TSF to cover the life of the facility.

He said the engineer of record – the individual charged with overall responsibility for the TSF – should be involved from the construction plan, through the physical construction of the facilities, with a provision in the contracts to cover the actions necessary to retain knowledge and continuity of monitoring when that professional inevitably moved on.

Berry said the scope of responsibility for the engineer of record varied from mine to mine, which was not a problem in itself, as long as the contracts clearly identified who took on any responsibilities not retained by that central professional.

"Where the engineer of record doesn't have complete oversight, any gaps need to be clear, along with who is responsible for filling those gaps," he said. "This is one of the most challenging areas: whether the engineer of record has the full scope to manage, control and advise on the tailings facilities.

"If they do, they're professionals and will carry out those duties to the extent of the contract. The challenge comes when the company divides the scope of responsibilities between experts."

Good governance also required an individual sufficiently senior in an organisation – essentially,



Communicating governance practices to ensure there are no gaps between teams and during personnel transition is a major challenge (Image: Startae Team/Unsplash)

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Discussion

C-suite – to ensure tasks were done and the people with the right skills sets were available to execute on recommendations.

When these governance procedures were not in place within a company and individuals were left to their own devices to interpret data, follow regulation and deliver on best practice, the risk of failure increased. Rykaart said those risks grew over the life of a TSF.

"We run into problems when facilities run for a long time and people get complacent and we don't do all the necessary day-to-day operational checks to make sure everything is still going the way it's meant to be going," he said.

"It is exacerbated when tweaks are made to the operational plans beyond the original design. That's unintentional but it happens nonetheless, so, that is a concern.

"You need generations of professionals that care over the life of a TSF. You get different management and owners with different philosophies, so you need to make sure knowledge and information is passed on and that the aspect of care is consistent – and that's hard to regulate."

Rykaart said the post-mortem on TSF failures often showed up deficiencies in communication and knowledge transfer that should arguably not have existed if good governance procedures were in place.

"People remain people. Information and regulation are there, and engineers are smart enough to design good dams and monitor them, but time and again we fail because we don't follow through."

WE'RE CUTTING YOU OFF

Company governance, therefore, feels like the key area where the ICMM standard needs to step in.

The concern for many would be the organisation's legislative impotence in forcing change. After all, Golder Associates reviewed tailings management guidelines and made recommendations in 2016 under ICMM direction following the Fundão failure, only for the same ICMM member company to oversee an even greater atrocity.

There are, however, two central and related differences between the 2016 and 2019 ICMM efforts.

The first is that this year's review is a joint initiative with stakeholder groups including civil society, communities, industry, investors, and multilateral



Professor Bruno Oberle is independent chair of the ICCM review, which will be co-convened with the Principles for Responsible Investment and the United Nations Environment Programme (Image: Rama)

organisations. It will be run by experts of appropriate disciplines and co-convened with the Principles for Responsible Investment (PRI) and the United Nations Environment Programme. Professor Bruno Oberle, a highly regarded Swiss-based environment and governance expert, will act as independent chair.

The second is that hovering above the review are very real threats in the form of finance withdrawals and legislative actions should the recommendations not live up to expectations or the industry fail to act on them.

One of the PRI representatives is the Church of England, which has separately formed an Investor Mining and Tailings Safety Initiative. Its involvement in the ICMM-led review is one of two active roles it has taken on the matter. The second was to gather an institutional-investor contingent with more than US\$10 trillion in assets under management collectively, which has directly requested full disclosure of TSFs operated from 683 mining company executives in order to build a public registry. Some 31% had disclosed or had asked for an extension by the June 7 deadline, including almost 60% of the largest miners.

Richard Martindale is a principal consultant and tailings engineer for SRK who sits in the UK office, which has a strong investor focus. He said the level of investor interest around TSFs in recent years had increased markedly on the back of high-profile failures.



Investors will cut off the fiscal oxygen from mining if governance standards don't improve (Image: Sharon McCutcheon/Unsplash)

"We get a range of questions from investors and they are becoming more technical," he told *Mining Journal*. "Investors are doing specific reading on tailings and are using relevant language. Some are further along the road to understanding the sort of cultural shift needed than miners are."

Martindale said investors basically wanted to know if the companies to which they were exposed had higher-risk TSFs and whether all TSFs were being maintained adequately. If the second part of that equation was questionable, the investment was likely to come under severe scrutiny. He said investors were also more likely to back companies signed up to a code of conduct that they had helped deliver, such as the current ICMM review.

"The pressure to make changes to company governance needs to come from investors because it is a lack of money that hurts miners. Regulations are never going to close all the gaps."

Verisk Maplecroft Latin America lead Blanco agreed, adding investor attitudes had migrated to align more with communities. She said civil society groups struggling to affect a transformation in mining culture were now seeing investors as an ally with the "ammunition for change".

"It's not theoretical anymore," she said. "There are failures that have resulted in death and investors are saying they've had enough – this doesn't meet investment criteria. That's a powerful message for society groups to reiterate with government."

Blanco said mining culture was changing but not fast enough for investors who understood the importance of strong ESG culture.

"Social, environmental and governance considerations are no longer seen as boxes to tick but as issues that make or break assets and investments," she said. "You can have a great resource and a probusiness administration, but if your community is not on your side then whatever you have is worthless – if your investment is stalled by 10 years then chances are you've lost your profit.



Investors want to know which tailings dams within a company portfolio pose serious risks (Image: iStock)



"Investors are telling us they can't invest in companies that can't demonstrate they are getting these things right – if they can't explain plans for mitigation of risk and execution of ESG plans.

"The industry is changing but it's changing slowly, and some companies are better than others."

Courting disaster

Community groups are not entirely reliant on investors for support. They've long enjoyed NGO backing and in recent years have been able to express themselves through social media. However, both these avenues are easily brushed aside by profitdriven company executives.

Less easy to ignore are fines and legal suits for abuses. Both of these are on the rise.

The industry has witnessed a growing trend for communities from the developing world that have experienced environmental or human rights offenses to organise themselves and seek satisfaction in firstworld countries with better-established judicial institutions. An example would be the April decision by a London supreme court to hear a case against a UK subsidiary of India-listed major, Vedanta, brought by more than 1,000 Zambian villages following alleged pollution around the city of Chingola.

Milana Chamberlain is a corporate partner with Norton Rose Fulbright and leads the firm's global ESG group. She said there was a greater willingness of the courts to look at cases in their entirety and consider if the rights holders would get appropriate remedy and protection in the country where harm had occurred.

"Where they are not satisfied, they are increasingly assuming jurisdiction," she said.

She also warned those aggrieved had started pursuing parties most likely to pay out, as opposed to just the operator. That included the lender.

"In regard to negligence, we have seen cases where they have gone after the lender.

"In the area of human rights, you can either cause, contribute or be linked to, a human rights impact. Human rights frameworks mean that you should be providing remedy if you have caused or contributed to an impact and some of the rights holders are beginning to realise that if there is a banking institution saying it understands the risk and has governance and due diligence processes to ensure these impacts aren't happening ahead of financing, then if those impacts occur, there may be an avenue for remedy." The first such case was against the International Finance Corporation, which would – should the case continue – be decided in the US courts after it was ruled by the US Supreme Court the IFC did not have absolute immunity from suit.

Ultimately, the industry is likely to be split between those who make the required step change in their ESG practices and therefore attract funding and community support, and those who choose to live in the past and continue to repel investors, communities and society as a whole.

TECHNOLOGY COULD UNDERWRITE NEW STANDARDS

The good news for companies keen to reform best practice and governance is they have never had more technology solutions to help them achieve their goals.

Joe Carr, mining innovation director at mobile satellite technology leader Inmarsat, told *Mining Journal* the standards demanded by investors should be considered the base case and technology would take a key role in delivering whatever the ICMM proposed and, potentially, more.

He said mining had traditionally been a reactive sector but had, encouragingly, seen an increasing number of proactive voices more recently, which would be vital to delivering the necessary step change.

"We have to change the way we do things," Carr said. "It may get to the point where you have regulators and governments saying, 'We don't care what you're telling us, we want to see it – you've had your chance to manage them yourselves, now we want to see all your TSFs and we're going to use our own auditor'.



Technology experts see TSF monitoring as an area ripe for disruption (Image: iStock/Galore777)



Sensor

Inmarsat's remote TSF monitoring solution (Source: Inmarsat)

"And, if they don't think we're doing a good job, they'll shut us down."

Carr, like others, believes the instrumentation being used currently is, in many cases, adequate. He said the majority of problems arose from collecting, processing and presenting the data.

As touched on earlier, piezometers, settlement plates and visual inspections are currently the central monitoring and management tools for miners. The issue is these are generally read manually at frequencies that differ across mines – and sometimes even at the same mine, if access is seasonally difficult. Data could be collected with a USB stick or with paper and pen, then could be entered into a database or filed in a cabinet.

"It is near impossible to guarantee you are going to take the same readings at the same time every day when people go on rotation, human error creeps in, people record things in different ways, different instruments are used from site-to-site, etcetera." Carr said.

"Having engineers driving around collecting data from 10 different piezometers when they should be managing the core aspects of TSFs adds zero value.

"The current model of having auditors go to site absolutely has to continue. The current model of



A tablet view of the Inmarsat dashboard (Image: Inmarsat)

having engineers drive to the dam for visual inspections every day has to continue. What we want to do is supplement that with a layer of intelligence that will bring greater transparency, greater capacity and higher standards.

"The way things have been done is ripe for technology disruption and, as a technology company, totally agnostic to the mining industry, we want to provide something that's never been done."

What Inmarsat has proposed is remote TSF monitoring with real-time analysis, which draws on the company's roots as satellite-based safety guardian in the maritime and aviation sectors.

In a nutshell, Inmarsat would connect any TSF instrumentation delivering an output to a lowrange wide area network (LoRaWAN), which is essentially far reaching Wi-Fi. That data would be fed to an aggregation base station at the mine, with its own standalone power and communication infrastructure.

Data would be aggregated in real time using edge computing then pushed through Inmarsat's L-band satellite system to a secure cloud-hosted application. The cloud application would present the data in a dashboard view, fully customisable to the user and made available to whichever parties needed access. This could potentially allow a company to visualise all its TSFs, globally, in one place. Dashboards would be customised with appropriate settings and alarms to flag up anomalous changes that needed attention – as they happened.

The system is described as "instrument agnostic" so could incorporate data from basic current measurement systems and improved versions of these existing instruments, but also include other data sources such as camera feeds or satellite imagery, using techniques such as interferometric synthetic aperture radar, which is being operationalised for tailings applications as part of the UK government part-funded Satellite Applications Catapult.



Steve Spittle, the emerging-technology lead in the Catapult digital team, told Mining Journal the imaging technology could feed into a monitoring system like Inmarsat's.

"Using openly available data from radar satellites today it is possible to get data every 12 days globally," he said. "As the number of observational satellites being launched continues to rise, the availability and temporal repeat of data will increase, resulting in more derived intelligence and insights."

Spittle said satellites could also help with TSF and mine rehabilitation by drawing on data collected some 40 years ago.

"Satellite gives you not just local but regional context around decision making and it gives you that at close, regular intervals," he said. "You get that time-series – and historical – indication of what might be happening."

Three central aspects of the Inmarsat technology represent a game-changing departure from current industry practice. First, it removes the data collection, aggregation, interpretation and presentation inconsistencies for a single mine or, in the case of a major miner with TSFs dotted across the world, a portfolio of mines. Second, the monitoring happens in real time, so that informed management decisions can be made quicker than previously possible. Third, the resulting enlarged body of consistent, normalised data from global TSFs could potentially revolutionise predictive analytics.

And, though designed as a tool for companies to improve safety, the Inmarsat technology has obvious applications for regulators and can help rebuild trust with communities. In fact, the Minas Gerais government signed a memorandum of understanding with Inmarsat in May to investigate options to improve awareness and transparency around TSFs.

It has been suggested such conversations may lead to the integration of network solutions such as Inmarsat's with community monitoring stations, where dashboards displaying key information



Satellite imaging is likely to play a central role in future TSF monitoring (Image: iStock/ratpack223)

complete with alarms are set up for local stakeholders to see and understand the risks at any given time.

These solutions are very much in line with ICMM chief executive Butler's views on transparency and accountability driving superior practices.

Aiming for dry nights

Smart TSF monitoring combined with more and improved instrumentation will be a core part of improving TSF best practice but the innovation for improvement also includes the tailings themselves.

Thickening technology has been improving for some time but, as mentioned earlier, requires more expensive infrastructure to clear and deposit. More recently, engineering groups and miners have been focused on removing as much water from the process as possible.

Two leading technologies in this area are being pushed by GoldCorp and Anglo American through the EcoTails and Concentrate the Mine initiatives, respectively. Both aim to dramatically reduce freshwater consumption and, ultimately, eliminate conventional slurry tailings.

EcoTails uses fast filtration and stacking technologies developed by engineering firm, FLSmidth, to blend filtered tailings with waste rock in transit and create a geotechnically stable product they call 'GeoWaste'. When blended properly, 'GeoWaste' is easy to convey and has high strength when stacked, according to FLSmidth.

"EcoTails and GeoWaste makes dry stacking possible for large-scale mining, even in areas with high seismic activity," the engineer stated. "In many instances, it is both economically and environmentally a competitive solution to wet tailings dams."

Concentrate the Mine combines course-particle flotation to concentrate the mineral and dry stacking technologies to dewater the residual waste. This produces dry, stackable tailings.

"Essentially, it allows us to float particles at sizes twoto-three times larger than normal making it easier to extract water from the process and leaving a waste stream that is dry and stackable," Anglo said. The



The Goldcorp-FLSmidth EcoTails solution is one of a handful of innovations looking to remove water from tailings

major is also looking at "innovative methods" for dry separation.

Dry tailings still present a risk, but it is a far more manageable one.

In it together

Spittle and Carr both actively promoted greater integration of technology and collaboration – Carr invites companies and regulators to push for different styles of integration that help the Inmarsat solution grow. EcoTails, meanwhile, was a joint development and Anglo said it had been working with "global leaders in science innovation".

This proactive attitude to finding solutions together is necessary and knits well with a previously recorded view from Mining Safety Round Table chairman Peter Larsen, who reported a 60-70% reduction in incidents and fatalities at member mining operations that used toolkits developed through open collaboration.

"We didn't want to have regulations driving our agenda: we wanted to look over our shoulders at regulations, knowing that we had set standards for ourselves that were above and beyond," he said.

With the aid of new tools in the form of technology to aid best practice – pushed by clear-cut, brutal consequences in the shape of capital withdrawals and legal challenges for insufficient governance – this time, things might actually be different.

It is with regret and sadness we report the sudden and untimely passing of SRK Consulting practice leader and principal geotechnical engineer, Dr Maritz Rykaart, only weeks after being interviewed for this review. Maritz' energy, integrity and commitment to technical excellence meant he was trusted by clients and revered by colleagues. He will be sorely missed.

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