

## Keynote address: Mining education and research as a strategic driver of future mining

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This address is about how training, education, and research can be used as strategic drivers for future mining. Somehow it sounds wrong, because we are so used to a reverse model where government and/or industry are the strategic drivers, not education and research. After more than 150 years of mining in South Africa, we find ourselves today in a situation where we cannot continue with a business-as-usual approach. It will end in the death of our industry, despite the treasure trove of mineral resources in the country. Through mining, we built the country and created an economy that can be regarded a success. As an industry we were strategic and successful. But, why does it seem to me that we do not have the answers to take our industry forward? I will try to tackle the issue by attempting to answer some questions.

### Question 1: What does the South African investment landscape look like?

If we ever needed a wake-up call, we have found it in the 2013 PWC report on trends in the top 40 global mining companies. The title of the report reads 'Mine: A Confidence Crisis'. The numbers point to an industry that is not economically sustainable, namely:

- We are mining more for less income
- Our cash positions are falling
- Capital budgets are shrinking, so fewer projects are in the pipeline.

Investment hurdle rates have increased; and according to the report have now reached 25%. Mergers and acquisitions are also not a solution, because shifting ownership through these deals only makes undeveloped resources more expensive. The time span from discovery to development keeps on increasing, resulting in time value of money concepts working against us. The end result is that some projects have become so expensive that they cannot be developed and must be written off.

The 2014 KPMG Annual Mining Executive Forum reinforced the PWC's wake-up call, suggesting that mining majors across all commodities are grappling with sagging profits, despite strong prices. Cost inflation is the biggest threat to sustainability. CEOs are under immense pressure. Those CEOs who do not deliver returns are removed as soon as opportunity arises, and in 2013 the CEOs were replaced at five of the top 10 mining companies. It is getting harder to raise investment from a tough capital market. The 2013 World Investment Report by UNCTAD shows that mining investment inflows dropped by a quarter and outflows increased seventeen-fold year-on-year. Surely, this is another wake-up call. The South African investment environment cannot be considered attractive when capital is squeezed out of the economy at this rate.

Another issue is the poverty problem. Government must

address the root cause of poverty – poor education and too few jobs to finance a middle-class living standard for all. In my experience, half the students dropping out of the university system do so because of socio-economic reasons; the rest do so because they are inadequately prepared for university studies. According to Professor Jansen at the University of the Free State, teachers and learners can ignore 60–70% of the curriculum if they are aiming for just a pass. This is simply not good enough for a mining industry where 'good enough' is not adequate when it comes to sustainability, the environment, and worker health and safety. Our statistics at Wits Mining are startling. On average, before OBE, 50–60% of our intake graduated. After 2008 we still work with a number of 50–60%, but this time it is not our success factor, it is the number of students dropping out from the programme – in the first year alone.

The demand for engineering education in South Africa is at an all-time high. In 2014, 21 410 candidates applied for the 856 first-year Engineering places at Wits. Mining had the highest demand, followed by Mechanical, Civil, and then Electrical Engineering. Why do we have a shortage of skills when demand for mining education is at an all-time high? The high-level mining job market (NQF 8–10) is characterized by high staff turnover, while at the lower levels (NQF 4–6) there is a critical shortage of staff. Our current solution, i.e. excessive salaries at the high levels and standard procedures at lower levels, is not strategic, but does manage risk to a certain extent. More people with the right qualification is the solution – full stop. The percentage of South Africans with HET qualifications is only 5%. FETs are ineffective, and the inadequacy of the NSC is exposed by the lack of student preparedness for university studies. If one explores the numbers, it is clear that something is very, very wrong, with 22% of qualifications being FET certificates, 48% diplomas, and the remaining 22% Bachelor's and higher degrees. While the latter two ratios sound almost right, FETs and other artisan-type

qualifications are unacceptably low at 22% – the triangle must be inverted so that these holders of qualifications total closer to 50%, with the balance roughly 20% graduates and 30% diploma holders. So two things need to happen – we need more holders of HET qualifications and of these, 50% must come from the FET system.

In a passionate plea to encourage mining research, Professor Emeritus Dick Stacey wrote a Mining Weekly opinion piece in March this year entitled ‘*Does rock engineering’s demise spell the end of South African mining?*’ He used words like ‘*tumbled, evaporated, calamity, and sadly*’ to describe the state of mining research in South Africa. Those of us who know Dick will all say that he is dear to us because of his positive state of mind, so what caused this great man to say that we have lost our way? He reflected on a time when South African research was at the cutting edge internationally, the envy of mining research professionals the world over. It is us, this generation, that must fix the problem.

To answer my first question – the situational landscape is not rosy at all. Are we strategic enough, and as a country, do we have the leadership and capacity to turn this sad state around?

### **Question 2: How does society see us in mining?**

The public’s perception of mining ranges from one extreme, that mining is dangerous, dirty, and an industry of the past; to another extreme where mining is viewed as beneficial because it makes a positive difference to society. This contradiction is of course not new. An Imperial Order banned all mining in China in the 11th century. An extract of the 1078 AD Commission report reads ‘*Nature has provided us with excellent deposits. These deposits were capable of producing much profit to the people. The officials, thinking that there was much money in mining business, wished to take it for themselves...*’ How often do we still hear this today, nearly 1000 years later? More than 600 years after China closed its mining industry, the spotlight was again on mining – this time in Britain. Health and safety suffered from a government policy that left ‘markets to work themselves out’ – the opposite of what happened in China. By 1650, death was considered part of working on the mines in Britain. By 1800, the government had started to regulate the industry, inspectors were appointed and the the Royal School of Mines was founded under the Coal Mines Inspection Act to train the inspectors. Interestingly, education was acknowledged as the solution to the problem – setting a trend that still exists today, where government and the mining industry are the collective drivers of education.

Gold rushes were sparked by different events in history. A gold rush (or platinum rush for that matter, but I will stick to gold) can be triggered in more than one way. The most cynical view is that it can be done by taking gold from those who already have gold. Apart from some politicians who still believe in nationalization, there are other examples of this type of rush e.g. what happened in the Americas in the 16th century during the Spanish occupation. Following this era of looting, a time arrived when it was better to look for new supplies of gold that were still in the ground. The first modern gold rush of this type took place in Siberia in 1832. Another example is the USA, with the significant gold discovery in California in 1848. Europeans everywhere began to move into what were then considered the ‘unoccupied’ lands of the world. At

first, Africa was regarded principally as a source of slaves, but then mineral discoveries changed the colonial process. Although the phrase ‘resource curse’ was coined only at the turn of the 21st century, Africa provided many examples to illustrate the curse before then, and mineral discoveries will mostly be remembered for the wrong reasons, namely:

- Profit above all else
- Land degradation
- Indigenous communities pushed aside.

While the first two examples of gold rushes are negative and reflect badly on our industry, it is the third-generation rush that should excite us ... and that is the rush to mine old gold better. This depends on skills and technology, but more of that later. Mining allowed Britain to lead the Industrial Revolution. The growing industrial base in England created a buoyant demand for metals and the industry soon realised that downstream processing facilities for metals are the fuel to industrialization. By 1840 the Swansea smelters dominated world trade in processed metals. The use of coal resulted in other technological breakthroughs, e.g. steam engines and mechanical pumping of water from mines, which gave new life to the ageing coal and tin mines in Britain. Are these not lessons for our ageing gold and platinum mines?

To answer my second question – mining is likely to attract extreme points of view, but the public’s perception of mining is mostly negative. Despite this, there is consensus that technology and skills can turn its image around.

### **Question 3: What drives mining in South Africa?**

In a perfect world the availability of orebodies should be the only driver, but it is not. Political events are shaping the global mining industry and access to orebodies. Recent examples are the removal of the iron curtain in Germany, democracy in South Africa, and the rise of China as an economic powerhouse. A further sustainability issue is unfolding in the form of resource nationalism. We have not seen the end of this, and it has re-surfaced in a new shape fuelled by a new energy – and we do not know where it will end. Government, or rather its policies, rule of law, and attitude towards investors is therefore a key driver of future mining.

Uncertainty and inconsistency caused by the Regulator will soon be reflected in the magnitude of investment. Current problems are aggravated because the ANC does not trust the markets and government’s current solution is to intervene more in the economy. The result is that government then creates an overlap between political and line department matters.

Another driver is stakeholder relations. These are the relations between investors, mine owners, mine operators, labour, and communities. Mine employees have strong and aggressive unions, and the situation is aggravated by politics, an inability to instil worker confidence in the bargaining system, and a poorly informed South African society on how difficult mining really is and the contribution it actually makes. The way forward is not obvious. Concepts like ‘motivate stakeholders to maximize the wealth pie’ are crowded out by immediate and short-term needs. Education, research, and innovation in mining, geology, and metallurgy led to the technological breakthroughs that have often prolonged the lives of mines. Indeed, modern gold ‘rushes’ are no longer the result of

major discoveries, but of changes in policy, skill, and technology. To this effect, we should also understand why the USA grew so quickly at the turn of the 20th century. Refining of mostly copper in the Americas escalated to a scale previously unknown to the world. This was because, firstly, a significant R&D effort was expended on smelting and refining technologies, and secondly, because the USA exploited the 'economies of scale' concept on a grand scale, which lowered the unit cost of production. As goods became cheaper, more people could afford them, which caused the birth of the mass-consumption era. The net result – through R&D, demand for mineral and metal products picked up, prices increased, industry remained profitable, and mines were given a new lease of life through technology.

Technologies that drove the mining industry started with the agricultural revolution (around 8000 BC), which triggered the market for tools and building materials because of urbanization. The Industrial Revolution (beginning around 1760) sparked the mechanization era, which required education to supply skilled workers to the system. The Information Revolution (started around 1940) led to digital technologies like television, computers, and wireless communication. The next step is likely to be the concept of an intelligent workplace, e.g. a digital mine that can sense, analyse, and communicate decisions. For this we need a more advanced education system to supply thinking workers for smart mines.

To answer my third question – political economy, skills, and technology drive today's industry. Technology is the ultimate driver of successful industries, but we cannot have technology without quality education, research, and innovation institutions. Are these collectively, then, not our most strategic mining driver for 21st century mining in South Africa?

#### **Question 4: What does the future of mining look like?**

Azaar Jamine at CoalSafe 2014 explained that the world demand for minerals is at a high and future supply will come from Africa. Barring unforeseen circumstances, we should see a sustained, long-term demand for minerals, with the world's mineral production estimated to grow by 3% per year. China will continue to play a major role in the extractive industries, with significant risk to mineral producing countries if growth in China slows. China is very much at the centre of our medium-term future.

Competitiveness gives the strategic advantage in business. In South Africa, if we do not do things differently, we will lose our advantage because costs are rising faster than income. In addition, significant revenue will be lost due to inefficiency and industrial action. The role of emerging and developing markets in the world economy is expected to grow, and in time, Africa will systematically take over from China as the most important player in the extractive industries. The awakening of Africa as the growth continent of the future is the 'next big thing'. With instability in the Far East, East Asia, the Middle East, and Europe, we in South Africa cannot be in a better geographical position.

It is not possible to predict what the industry will look like 50 years from now, but the critical issue is to ensure its sustainability – so that we have an industry 50 years from now. As price-takers we must become better in tactical issues like managing costs, improving productivity,

optimization, planning, and evaluation methods. High-level strategic matters affecting industry profitability include the resource nationalism drive, innovatively extending the life of current mineral reserves, and developing new areas. Mechanization is not a 'silver bullet' to solve today's problems, because of the challenges posed by old mining layouts not designed for mechanization and workers not equipped with the skills to support it. We should start with a better understanding of the mining environment, while simultaneously addressing the skills problem for mechanized operations. We can use technology to communicate matters that affect worker safety and production flow for real-time decision-making so that we can optimize. This will produce the cash flow for fundamental research on future mining methods, ready for implementation 20–30 years from now. For now, we must equip mine workers at all levels with the ability to do their jobs better. Then we can convert resources into reserves – one ounce at a time.

Let us assume that the investments will be made in training, education, and research. We have a remaining problem! We can only mine in one direction, grades are falling, volumes are going up, and profits are shrinking. Mineral resources are finite, and technology and skills set limits to what level we can optimize. So there will come a time when we will again have to look for new resources that are still in the ground, and the chances are that these will be in more remote locations e.g. the sea bed and outer space. Obtaining the social licence to operate will become more difficult, resulting in immense societal pressure on company margins.

To conclude, we don't know what the future of mining will look like, but we know what it will *be* like. It must be safe, profitable, productive, and optimized – and we should use technology and skill to convert resources into reserves – one ounce at a time.

#### **Question 5: Can skills and research drive future mining?**

A competitive industry led by a knowledge sector, where mining skill and innovation drive the sector, is possible. However, the window for innovation is shrinking every year as current mining methods deliver smaller and smaller margins over time. For this reason, we need to invest heavily in research aimed at developing new technologies, new methods of mining, and a new skills set for workers.

Let us look at the internal challenges for mining schools. High demand caused enrolments in mining education to increase over time. The quality and quantity of intake necessitated more resources and effort to maintain the quality of our outputs. The final challenge is the ageing academic population and the need to develop the next generation of academics and researchers. This requires strategic planning. Fortunately, we are not alone in this and we have strong educational partnerships to support us.

Our first partner that deserves to be mentioned is the Minerals Education Trust Fund (METF), which has for many years subvented salaries of lecturers and funded strategic initiatives. The objective is to provide stability in the mining and mining-related schools, which is a strategic mining industry initiative. In addition to the METF, the Mining Qualifications Authority sponsors students and lecturers with a developmental and transformational objective. Other existing partnerships include industry and state participation on advisory boards; scholarships and

vacation work opportunities; staff and student development; sponsorships for improving infrastructure; and strong relationships with learned societies and professional bodies. The end result of such partnerships is relevance, sustainability, and matching the demand for graduates with industry requirements. It seems that educational partnerships have become the new driver for mining education, no longer government on its own.

So, we are strategic when it comes to mining education. We have quality mining schools despite an under-performing education system. There is a steady delivery of mining graduates at several exit points; and the programmes are relevant to today's industry requirements. However, all these good-news items are at a high level. What about the education and training up to NQF level 6? The system of mining qualifications is well established, but there is a weakness in that it is poorly integrated, with little flexibility to enable moving between programmes, which leads to insufficient outputs at the lower levels. In my view, our biggest plus point is the METF showing that South African mining companies are strategic and forward-looking when it comes to mining education.

What requires work? Firstly, the weak link between postgraduate research and innovation at universities and secondly, the absence of a significant applied mining research facility. Unlike education, industry and government are not sustainable drivers of research. We at the universities have recognized this gap, and we are now entering a space that we quite frankly do not understand well enough. So, we have become tacticians without a strategic framework, creating more Centres, more Chairs, and more Institutes. Although this is not wrong, the high barrier to entry for research initiatives causes Centres and Institutes to be inadequately funded for innovation – ending up with the second prize – a focus on course work and consultancy-type research with few or no innovation outputs.

#### **What should be in our mining industry strategic plan?**

First, we must keep on doing what we are doing with the mining schools, because what we have is special. The partnership system is working and in fact should be extended to include lower-level skills and high-level applied research. According to Professor Hall at Curtin University, only 20% of the estimated 250 mining schools in the world are regarded as 'strong'. Regular, tough interaction of partners is crucial so that we understand and deliver on each other's expectations for continuous improvement. We need stable, motivated, and committed academic staff lecturing in relevant programmes that are accredited by our professional registration bodies. Graduate development is an issue, and it has several phases to be considered, namely what happens during learning, after learning, and (something hardly ever considered) students not coping and dropping out of the system. Currently drop-outs are wasted resources and it is not them failing us – it is us failing them, and ourselves. Considering the critical

lower-level skills shortage, we should take on the challenge of converting these human resources into proven and skilled reserves.

Secondly, addressing transformation. The good news is that we can have both competitiveness and transformation – in fact we already have this at the student level. But transformation goes beyond student demographics to include women in mining, student integration in the workplace, and industry demographics.

Thirdly, applied research must be strategic and coordinated – similar to what we had with COMRO, but this time not repeating its mistakes. As partners, the role of government and industry must change from driver to enabler. The partnership should be the collective driver, similar to the model of the mining schools. This will require buy-in from all stakeholders – with the common goal of facilitating step changes in problem areas. Establishing more Centres and Institutes is not a solution because it spreads support over too many thin initiatives. Fewer, better coordinated innovation facilities is the way to go – the China way. It seems to me that our fundamental opportunity is training, education, and research. To quote Mark Cutifani at the 2013 Mining Lekgotla '... education is the one right- thing-to-do that we are all in agreement. So it has the most likelihood of success'. What I am saying is that we must expand this working model to include lower-level skills and higher-level applied research. In the past we relied on our orebodies and the markets to rescue us during difficult times ... and it worked. This time around we need to build capacity at all levels and then, to quote a team room discussion with Professor Emeritus Huw Phillips, '... use our collective intellectual horsepower to pull us out of this hole'.

**In conclusion**, if we want a gold and platinum industry 25 years from now, the following tactics are required:

1. Develop a new understanding on what sustainable development means to gold and platinum mining. We also need a government strategy on SD and an industry plan to respond to several resource nationalism scenarios
2. All of us must develop an everyday mind-set of using skills and innovation to convert worthless resources in the ground into valuable ounces in the plant – one ounce at a time
3. Invest in FET-type institutions to the same extent as is the case with the strong mining schools. Our current educational partnerships must include lower-level skills, and establish a system that will remove the word 'drop-out' from our vocabulary
4. Develop a national strategy on mining research so that we can invest in a significant applied research institution that feeds on a partnership of the major role-players. Then we can reclaim our place on the world's research stage and convert resources into reserves, this time on a grand scale.



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