



SAIMM
THE SOUTHERN AFRICAN INSTITUTE
OF MINING AND METALLURGY



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Foreword

Mzila Mthenjane

We need to appreciate the significance of the changes that will be brought about by the 4th industrial revolution – some changes will be predictable, but most will not. What I like to refer to as the ingenuity of mankind will be tested to its limits and therein lies the opportunity for our industry.

Celebrating our centenary in 1994 was something special, coinciding with the first democratic elections of the Republic of South Africa. That year marked the beginning of the path to irreversible change in South Africa. This year, 2019 and 25 years later, marks the 125th Anniversary of the existence of the SAIMM and a continuation of the journey of change in the country for everyone living in it.

I have based this foreword on reading 19 personal recollections and memoirs by Past Presidents from 1994 onward as well as from recipients of the Brigadier Stokes Memorial Awards – actually, 19 plus one, the 20th being my own account of a mining career commencing in 1993. It was a wonderful read of really deep, personal and fond memories of mining and SAIMM experiences during the past 25 years; it was also evident that we all love the industry and our country, with all the accompanying joys and hardships and rewards. There's just something special about the mining industry and after 125 years, and the recent 25 years, there will be much to reminisce about. So, I'll focus on a few common issues that stood out for me.

Firstly, while other industries may claim the same, the mining industry in South Africa has had brave men in the past who established the global status of our industry. Several of the memoirs highlighted some of my favourite characteristics of leadership which are so urgently required today in our industry and country: *vision, boldness, and selflessness* and epitomized in the outlook of these individuals for the mineral potential and possibilities of specific developments for the benefit of the industry. I'm referring here, amongst others, to the technical input provided by individuals such as Roger Dixon, Dr Danie Krige, and Dr Ferdi Camisani in developing SAMREC.

This remains a fundamental achievement for the development of the country's diverse resource base and ability to attract investment, both from local and foreign investors. Accompanying this effort was the need for continuous research and development, which has been

provided by various educational and research institutions such as the University of the Witwatersrand and Mintek. The improved understanding through, and symbiotic relationship between, mineral resource management and processing technology grew the industry beyond the foundation established by the gold mining industry into the diversified mining and mineral commodity industry we see today.

Secondly, the enabling policy role of government in developing a successful mining and metals industry was a common feature in almost all the memories. Today, this has not changed. The year 1994 brought with it a monumental (and necessary) change to policy in South Africa. As mentioned before, it was the beginning of irreversible change.

Given the discriminatory history of the country over more than 300 years and the specific role of the mining industry in this regard, change was inevitable.

Transformation was (and continues to be) a primary and focused drive of the new ANC-led government. Both potential losses and gains drove anxiety – the only unknown was how much and possibly for how long. The BEE-Commission, led then by Cyril Ramaphosa, was instrumental in establishing the foundations of what we now refer to as the Codes of Good Practice and derivatives thereof in terms of various industry charters. The transformation imperative, as espoused by the Codes of Good Practice and industry charters, was a catalyst and transitional solution to the much-desired GDP growth when it allowed entry of the previously excluded and majority population into the economy.

We witnessed growth of close to 5% for a short period in the early part of the years under review. However, it was the lack of forward planning and investment in other sectors of the economy and society that made this achievement so short lived. To name a few: prevailing policy uncertainty and lack of coordination, limited investment in infrastructure to facilitate mine development and growth and possible industrialization benefits; poor education policy and investment to enable

human capital development; poor service delivery which has continued to impose a heavy burden on the standard of living of South Africans, and in particular, the black population; a mining policy environment that largely kept investors on the sidelines resulting in South Africa missing out on the profit, tax and employment benefits of the biggest and longest modern day commodity boom in the late 1990s to the early 2000s. During the past ten years we witnessed and were victims of unprecedented levels of corruption and poor governance which has near-crippled the ability of government to function. We are hopeful that we will now emerge from this disappointment thanks to an independent judiciary, and robust contributions from civil society, and the independent media and business.

Lastly, the decline of the South African mining industry, as measured, amongst others, by contribution to GDP, employment, and total mineral production, has been long in the making, even before 1994. There have been a few positive indicators, but the trend has been in a downward direction unlikely to result in the significant socio-economic improvement that is hoped for and could be delivered by this industry.

So, could the mining and metals sector be a sunrise industry? According to the Minerals Council South Africa's September 2018 Facts and Figures report on the South African mining industry, 'it remains the flywheel of the South African economy'; what will it require to remain such and improve? Considerable effort, focus and discipline amongst the key players in the industry in terms of policy, investment and people development; continued change and adaptation to an evolving global context where technology and innovation are the primary drivers of productivity, profit and progress; delivery on the transformation agenda – as a primary industry, the leverage on growth and development through both mining and processing as well as downstream activities is second to none; and then combined with the necessary and difficult, but broad and coordinated policy changes that can arrest this downward trend of the industry and stimulate the rest of the economy. In addition to all these challenges, we also need to embrace the increasing momentum of technological change brought about by the 4th Industrial Revolution, as discussed at the 2015 World Economic Forum.

We need to appreciate the significance of the changes that will be brought about by this revolution – some changes will be predictable, but most will not. What I like to refer to as the ingenuity of mankind will be tested to its limits, and therein lies the opportunity for our industry.

During my tenure as a young(er) mining engineer, my supervisors always used to say to me that 'mining is a people business'. This remains true today, irrespective of the prevailing technologies. Mining is certainly all about people, both within and outside the mining companies where we work. This fact also speaks to the bigger purpose of mining (and broader business sector) in society, which is about providing (appropriately incentivized) solutions to the challenges of society, and today, to do this in a manner that balances profit and environmental stewardship for the sustainability of society. How can we achieve this? Allow me to share some of my thoughts.

Firstly, we should not seek, nor accept credit for, doing

the right thing. The mining industry has always been characterized by visionary and brave men (and recently, women). We need to acknowledge and recognize that our leadership roles extend beyond the company to the greater society and that our decisions are relevant for a greater stakeholder base. Today in South Africa, which is faced with the triple challenges of poverty, unemployment, and inequality, being a leader means being selfless in one's actions and acting for the benefit of the local and a wider community. The current system of conferring credits on mining companies for doing good is inappropriate and encourages only short-term and selfish thinking. An emerging approach to contributing to society is collective impact through the cooperation of not only neighbouring mining companies, but diverse and strategically aligned entities that together can make the relevant and appropriate contributions to addressing a social challenge for regional development.

Secondly, a true collaboration between business and government is required. South Africa remains an outstanding country in sub-Saharan Africa because of the nature of the relationship that existed between government and business prior to 1994 and the development of the infrastructure that we continue to enjoy today. However, this relationship formerly served only an exclusive community; we therefore need a common agenda between business and government – contrary to popular belief, one cannot do without the other. The common agenda today is not only continued pursuit of transformation as legislated by our BEE legislation, but development and progress for the whole nation, as reflected in our constitution. Let's take what is suitable from the past and build on it for the future. A delayed response to the imperative for collaboration will only result in additional and more severe challenges in a constantly evolving world.

Lastly, the SAIMM continues to be a provider of essential technical knowledge and expertise for the mining and metals industry. The focus on membership and industry relationships with similar bodies locally and globally is a key strength. However, it was notable in the memoirs that the SAIMM has remained a behind-the-scenes entity in an evolving environment. There is a broader stakeholder group that must be acknowledged and engaged for the Institute to continue to thrive and contribute to the development and growth of the industry, both in South Africa and regionally within the African continent.

Recent changes such as the adoption of digitalization and strengthening relationships with the Minerals Council South Africa and ECSA, must continue as a foundation for the transformation of the Institute. In addition to knowledge sharing and technical development, the SAIMM should position itself as a platform for industry-wide stakeholder engagement in order to maintain its relevance and keep abreast of developments in both technical and socio-economic issues, which need to drive both the sector and the country forward.

Thank you to those who took the time to share with us their memories of the past 25 years and contribute to this 125th Anniversary publication. It was a privilege and learning experience for me to research and provide this foreword. Wishing you and the SAIMM a great year ahead to begin the adventure of the next 125 years. ✱

AGENDA

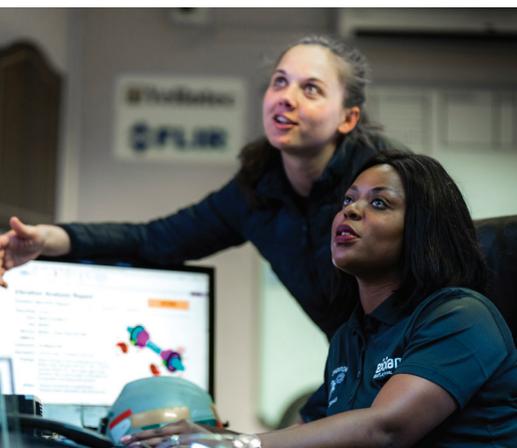
Introduction

- Belfast Coal Strategy House
- Belfast Coal Digital Framework

Integrated Digital Roadmap

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President 2017-2018

Reflections on my Presidential Year

Sehliselo (Selo) Ndlovu

The Institute continued to recognise that the needs of its members always come first and did not compromise on the quality of service offered to them.

The SAIMM is built on the foundations of the mining and minerals industry, and serves the interests of the professionals that work in the industry. It is an institute that has been built on a strong foundation of selfless commitment and diligence from its members; mostly on the basis of volunteerism. It caters for a large membership drawn from the Southern African region and across the world and thus, being a leader of such an institute is both a big honour and a privilege. I had the honour and privilege of serving the SAIMM as the first black woman President during the 2017/2018 term. I will always remember my time as the leader of the Institute with very fond memories.

The 2017/2018 financial year was characterised by a number of activities and initiatives organised by the Institute and supported by a slowly recovering global mining industry. The SAIMM continued to implement strict measures to absorb as much of the financial impact on its operating costs, as possible. However, the Institute also continued to recognise that the needs of its members always come first and did not compromise on the quality of service offered to them. For the first time in over three years, the Institute started to show signs of financial recovery; this being attributed to the hard work and commitment of the SAIMM staff and conference teams.

My term of office was also characterised by a period of SAIMM self-reflection. This was mainly driven by the awareness of the changes in the mining and mineral landscape as the traditional big corporates that had driven the mining industry for decades downsized or changed their approach and focus in the field. New smaller and previously unrecognised junior miners also emerged. The Institute became cognisant of the fact that for it to remain relevant and aligned to the needs of its members and the changing industry, a new strategy for the future was necessary. The SAIMM Office Bearers, on a mandate from the Council, held a number of facilitated strategy planning sessions with the outcome being a vision for the Institute and a number of work

streams, which seek to support the vision and the future performance and positioning of the Institute.

Another highlight during this period was the advancement of the SAIMM Journal into the digital world. This included the introduction of the Open Journal System (OJS) for managing and reviewing the papers submitted for publication in the Journal. This brought the Journal on par with international standards and allowed the submission and reviewing process to be much more efficient and easier for both the authors and the reviewers. In the same period, the Journal was indexed in the Directory of Open Access Journals (DOAJ), which helped the Institute and its members to benefit through increased dissemination of published papers and better visibility for the authors.

Being a woman President is a role that cannot be taken lightly. It's a role that inspires and motivates all the female professionals working in an environment that has traditionally been male dominated. As such, the issue of the challenges faced by women in the industry was bound to come into the forefront. This topic will likely continue to be of interest for many more years to come. This is because although the mining industry has made significant steps towards the inclusion of women and the role they play in the sector, women still face many challenges. During my term as the President and in recognition of a need from our members, we established the Committee for Diversity and Inclusion in the Minerals Industry (DIMI). The objectives of the committee are to advance diversity (gender, ethnicity, religion and or other diversifying factors) and inclusion in the industry through initiatives and activities that address the professional needs and aspirations of persons actively pursuing a career in the minerals industry. The idea is to bring awareness to the mining industry on the importance of valuing the contributions brought by diverse individuals.

On the home front, after a couple of years of unrest at universities, the South African government announced a free education dispensation for students at institutions of higher learning. Students warmly welcomed this

dispensation and flooded universities with applications in order to gain skills that would form the foundation of their careers. On the other hand, institutions and other members of the public received the same dispensation with concern, mostly about, its sustainability. Still on the education front, the advent of big-data technologies, the Industrial Internet of Things or the fourth industrial revolution, prompted questions of whether the mining and metallurgical graduates from the institutes of higher learning were geared for the changes that are inevitable in the industry that they would serve. Technological innovations and disruptors, for example robotics, self-driven cars, and virtual assistants emerging at a rapid pace, are being seen as a competitor for some of the traditional mining and metallurgical career roles, while new jobs that currently do not yet exist are yet to be created. The challenge then becomes the preparation for, and the development of skills for, career roles that will exist only in the future. All this pointed to the institutes of learning and the mining industry needing to be conscious of the fact that it was not a case of 'business as usual' any more. A new level of system thinking is required to ensure that the industry is not blindsided by the future.

Although the SAIMM offices have been housed at the Chamber of Mines building for a long time, no close ties had previously existed between the two organisations. The Institute embarked on discussions to foster close ties with the Chamber with a view of a partnership that could leverage the position of the Chamber in the mining industry for the benefit of SAIMM members. At the same time, while the debate on the possibility of relocating the SAIMM offices to a new location continued within the SAIMM Council, the Chamber of Mines South Africa rebranded itself as Minerals Council South Africa. This rebranding was done with the aim of moving the organisation from the historic issues that did not reflect or meet their mandate of repositioning South Africa's mining industry and making

mining the country's most prominent sector. The rebranding therefore, represented an opportunity to recalibrate the former Chamber brand and ensure that it was relevant and rejuvenated to reflect a new mining era and dispensation; one of inclusiveness, shared value, and a future that all South Africans could benefit from and be proud of.

The proposed new Mining Charter also continued to dominate the industry. The sweeping changes in the political front, with the changes in the leadership of the country from President Jacob Zuma to President Cyril Ramaphosa, brought renewed hope that engagements with the Government would see new developments in this regard. The Presidency announced its commitment to resolving the impasse on the Mining Charter and facilitating

a process of developing a Charter inclusive of all stakeholders, and in the interests of the industry and the country as a whole. In the words of the South African President, Cyril Ramaphosa, 'By working together in a genuine partnership underscored by trust and shared vision, I am certain we will be able to resolve the current impasse and agree on a Charter that both accelerates transformation and grows the vital sector of our economy'. The words of the President also highlighted that the mining industry needs stakeholders who are not only committed to the vision of the future, but who also work together to establish a stronger, more competitive, more resilient and prosperous industry.

The value of the Institute as a home for professionals in the minerals industry cannot be underrated. As the Institute turns 125 years old, it remains young, vibrant, active and strong. It continues to be dynamic and forward-looking. The source of its strength remains in its members; members who selflessly participate at all levels as well as leaders of the Institute who dedicate enormous effort and time to ensure that the values and missions of the Institute are kept alive. I have no doubt that we will still see another successful 125 years. This Institute is a gift and a legacy to our children. *



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**SAIMM CONGRATULATIONS
FROM WITS CHMT**

The School of Chemical and Metallurgical Engineering at the University of the Witwatersrand congratulates the SAIMM on its milestone 125th anniversary. The School has had a long association with SAIMM through several of its staff members and alumni being presidents and office bearers throughout the history of the SAIMM. Names like Prof. G.H. Stanley, first professor in Metallurgy at Wits (1905-1939), other HoDs like Prof. D.D. Howat and R.P. King, as well as the well-known Prof. R.E. Robinson, come to mind. The School most recently produced the SAIMM's first black female and only second female president of SAIMM, Prof. Selo Ndlovu.

We wish the SAIMM all the best for the future and the important role it plays in the industry and professions associated with it, and assure the SAIMM of our continued strong support in future.



President 1994-1995

Looking back: Our Centenary Year—1994

John Anthony Cruise

1994 was a tumultuous year. It was our centenary year, and then came the first democratic elections in April. To our surprise we all came through unscathed.

1994 President's Message

'This year has been a tumultuous one for our members. Firstly, it was our Centenary Year, then came the April Elections and finally we hosted the 15th CMMI Congress.

To our surprise we have come through it all unscathed and can look back on the year past with pride and satisfaction. All the dire predictions came to naught and we are left with a feeling of accomplishment.

This is akin to mountain climbing. At the beginning the task ahead looks so daunting that it appears insurmountable. During the climb, a lot of strain is taken. But, finally, when the peak is conquered, there is a glowing feeling of achievement.

This glow is not long-lived because there is the slow realization the next mountain has to be climbed - the next accomplishments attained'.

Looking back

I wrote the above President's Message in the SAIMM Journal at the end of 1994 and re-reading it brings back happy memories of that time. What a year that was for the country and the SAIMM!

The planning for the Centenary Year began four years earlier, when in 1990, at the 14th Council of Mining and Metallurgical Institutes Congress, South Africa was granted the honour of hosting the 15th CMMI Congress to coincide with our Centenary Year.

The date chosen to hold the Congress was April 1994!

However, the best laid plans of mice and men often go awry - or in the original poem by Burns "The best laid schemes o' mice 'an men gang aft a-gley". How, in 1990, were we to know that, after the release of Nelson Mandela, South Africa would hold its first democratic elections in April 1994, therefore, clashing directly with our CMMI Congress? To say that there was much scrambling around to find an alternative date was the understatement of the year. It was finally decided to hold the Congress in September 1994. This meant that the President of the SAIMM chosen for the Congress would not be the person that it was originally planned for, as the office traditionally changed hands at the SAIMM AGM in August each year. This was remedied by making the Past President the Chairman of the Congress.

The Centenary Luncheon for Past Presidents

A Centenary Luncheon for Past Presidents was held on 24 March 1994 at the President's Room at Gold Reef City. In attendance were 20 of the 28 surviving Past Presidents (of the eight absent, five were overseas and three too frail to attend) so one might say that we had a full house of Past Presidents. When looking up the collective noun for presidents I found the one most applicable to the SAIMM was - a succession of presidents.

In his address to the Past Presidents, the SAIMM President, praising the group as 'cardinals' or 'wise men', reminded them of the fact that the very first President of the SAIMM was dropped from the list of Past Presidents in the Journal for a number of years because of his associations with the Boer War. 'He was also found dead in the veld. So, Past Presidents can be censored and worse!'

The first page I look at when I receive my monthly copy of the SAIMM Journal is the list of Past Presidents. If there is an asterisk after your name, then you are dead. The only two things that are certain in life are taxes and the dreaded SAIMM Journal asterisk.

Of the 20 Past Presidents who attended the 1994 luncheon, six are still with us today.

The Centenary Distinguished Lecture

The Centenary Distinguished Lecture was held on 24 March at the Convention Centre of the Sandton Sun, Johannesburg. The Distinguished Lecture was delivered by the Chairman of Gold Fields, Mr Robin Plumbridge.

He was introduced by Mr Peter Janisch, who used the occasion to summarize the achievements of the mining industry, and the role played by the Institute over the past century.

Mr. Plumbridge then delivered the Distinguished Lecture, which was entitled 'Mining in a global context - can South Africa compete?'

Whilst acknowledging the achievements of the past century, Mr Plumbridge gave a resumé of the current

state of the mining industry in 1994 against a background of the new political dispensation and the decline of the South African mining industry over the past few years:

'Given all the strengths of the South African industry, you will be forgiven for questioning the doubts about the future that are inherent in the title of my lecture. Since the great euphoria that followed the dramatic increase in the gold price in the 1970s and its final blow-out in 1980, the industry has been under increasing pressure and steadily losing its competitive edge. At first this was not recognized but, over the past couple of years, the industry has started to react.'

Mr. Plumbridge gave advice to the incoming government of what the ordinary man and woman in the street wants.

'In very simple terms, they have only two priorities: The establishment of law and order, and the provision of employment opportunities. The first is a precondition for economic growth, and the second is the natural consequence. It is imperative that economic growth becomes the top priority, thereby encouraging investment. Thus the government must be encouraged to adopt enabling economic policies and not control structures, which have been shown to fail throughout Africa.' As one African Minister of Mines said 'We have learned that it is imperative for government to get out of the way'.

In proposing the vote of thanks to the Distinguished Lecturer, Past President Dr. Robinson, picked out a few components of the lecture, which he felt deserved special emphasis, namely the Collegiate Culture, the Enabling Economic Structures, the National Priorities,



John Cruise, Master of Ceremonies at the Centenary Banquet

Lip Service and Research. He emphasized the national priorities, namely 'the provision of job opportunities, which is second only to the maintenance of law and order. Without law and order, there can be no stable jobs.'

The Centenary Banquet

The Centenary Banquet was held the following day, the 25 March 1994 in the Ball Room of the Carleton Hotel.

One of the traditions which was established early in the life of the Institute was the Annual Dinner, which became a major event in Johannesburg's social calendar. It was always attended by people of stature in the industry and in the community and was often addressed by a high-ranking Government figure.

For the 1994 Centenary Banquet, the State President of South Africa, the Honourable F.W. de Klerk, was invited to be the guest speaker. This was to be his last official function of this nature in his term of office. A month later, on the 27 April 1994, Nelson Mandela would be elected as the new President.

There was a buzz of expectation around the Ballroom. The Banquet had been meticulously planned to the minute. Past President Ben Alberts of Iscor had drafted the speech for the President and therefore he had the honour to reply with a vote of thanks. Having

drafted the President's address, Ben had his reply neatly typed out and therefore was confident of his delivery. We thought that nothing could go wrong. After all we were past masters at planning and execution of events far more complex than a simple banquet that we held on an annual basis.

But – all the best laid plans of mice and men...

We had decided that it would be a nice touch to have the Past President who was President for the 75th Centenary propose the toast to the Institute, thus establishing a connection with the past. As luck would have it, he would be speaking just before the State President.

To everybody's acute embarrassment, he became stage-struck, and instead of proposing a simple toast, he proceeded to give a monologue of his life. As the minutes ticked by, everyone was wondering where all this was leading. After 20 minutes and he had only reached the 1930s when he was a young mining engineer, it was clear to all and sundry that he was a bit confused about the nature of his toast and, that at this rate, we would be up all night. Eventually, after many attempts to stop him and stem the flow of his reminiscences, the Master of Ceremonies managed to escort him from the dias.

Next it was the State President's turn. He took the sheaf of notes which had been meticulously drafted by Ben Alberts, and said that he didn't think that after that long toast we would want him to read out a prepared speech (note that there was no tele-prompter for presidents in

The first page I look at when I receive my monthly copy of the SAIMM Journal is the list of Past Presidents. If there is an asterisk after your name, then you are dead. The only two things that are certain in life are taxes, and the dreaded SAIMM Journal asterisk



Hugh Scott-Russell presenting the commemorative memento to F.W. de Klerk

those days), and that he would like to speak to us from his heart.

Where upon he tore up the prepared speech and spoke from the heart.

Poor old Ben panicked. His prepared reply was now useless and he now had to start from scratch preparing a reply whilst the State President was speaking.

The sweat on Ben's forehead was patently visible. In his mining career, Ben had never been under so much stress.

It is amazing how resilient the human being is. The State President finished his address and Ben delivered his scribbled reply. No one was any the wiser and the SAIMM President heaved a huge sigh of relief.

The next year I was asked by one of the attendees if we couldn't perhaps invite the Past President of the 75th anniversary back as he had only gotten halfway through his lifetime reminiscences!

The 15th CMMI Congress

The 15th Council of Mining and Metallurgical Institutes Congress was held in September 1994 at Sun City. The theme of the Congress was 'Resources and Technology'. Delegates were exposed to the then current technical developments by means of 133 papers presented at the



The commemorative centenary memento

Conference of which 30 were on geological subjects, 45 on mining, 29 on extractive metallurgy and 29 in the field of metals technology.

In his opening address, the Chairman of the Congress, commented that 'The last decade has been difficult for the mining industry in general. Over the last six or seven years more than 140 000 gold mining jobs have been lost in South Africa'. He also stated that 'We have the resources, both human and natural, and we have the technology. Given the right economic and political climate, the future should be very bright indeed'.

In the official Opening Address of the Congress, the Premier of the North-West Region, the Honourable S.P. Molefe welcomed all the delegates from around the world to South Africa. He concluded with saying 'It is important to emphasize that the North-West Provincial Government is fully cognizant of the need to maintain business confidence at a high level which can be so easily undermined by economic indiscipline. In other words we want our investors to feel comfortable, to be happy and eager to do business in the province'.

The following Keynote Addresses were presented during the Congress:

- >> The South African mining industry: An overview by J.J. Geldenhuys
- >> Gold - the ultimate metal by R.A. Plumbridge
- >> Some future challenges for South African mining by B.P. Gilbertson
- >> Coal and progress: The South African story by A.B. Cook
- >> Diamonds by E.P. Gush.

The Official Closing Address was presented by the Minister of Mineral and Energy Affairs, the Honourable R.F. Botha.

As the minister was delayed in arriving for his address, the Master of Ceremonies, in an attempt to keep the audience amused, quipped that the minister had appeared to have forgotten his appointment. There was a roar of laughter from the audience at this witticism from the MC, and he was pleased to have the audience in his hand, and was thus feeling quite proud when to his chagrin he saw that the minister had already entered the hall and was close to the podium.

The minister had heard every word!

And so, the joke was on the MC - the best laid plans...

True to form Minister Botha ignored the MC's comment and launched into a laudatory appraisal of miners, metallurgists, and the mining industry. A veritable tour de force which would be remembered by the delegates present for years to come.

Afterthought

1994 was an auspicious year for the Institute and South Africa. It is still remembered fondly by those of us who were there. Despite all the complications and technical problems, we embodied the SAIMM motto, and we, the capable, rose to the occasion - *Capaci Occasio - 'to the capable the opportunity'*. *

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Brigadier Stokes Memorial
Award Winner—2017

25 years of evolution: a view from the Minerals Council

Roger Baxter, Chief Executive Officer, Minerals Council

By looking at the past 25 years since South Africa's transition from apartheid to democracy, we may be able to provide a snapshot of the extent to which the industry, and in particular the Minerals Council South Africa, has transformed.

The Southern African Institute of Mining and Metallurgy (SAIMM), is synonymous with the industry itself. Although its founding came 27 years after the discovery of diamonds, it was just eight years after the discovery of gold. At the time, South Africa may have earned its reputation as the world's newest mining frontier, but it was still finding its way in terms of how this industry would be governed. The first Johannesburg Exchange was only six years old, and the second Chamber of Mines (the first had floundered and had to be re-established) was still in its infancy.

In 1894, when the SAIMM came into being, the industry had only recently started making use of the cyanide process to solve the problem of recovering gold from pyritic ore. This new technology set gold mining in South Africa on a new trajectory, and the moment was marked in the Institute's Journal, which has recorded major processes and developments in mining in the 125 years since.

Here, we have neither the space nor the scope to examine the past 125 years of mining in South Africa. It is a history too dense, too convoluted and too embroiled in social, economic and political shifts that forever altered the fabric not only of the country, but also of its neighbours whose workers flocked south.

Instead, by looking at the past 25 years since South Africa's transition from apartheid to democracy, we may be able to provide a snapshot of the extent to which the industry, and in particular the Minerals Council South Africa within it, has transformed. The Chamber of Mines' renaming as the Minerals Council in mid-2018 was symbolic of wider, more systemic changes in our approach to accountability, transparency and industry leadership. It is a story we are proud to tell.

Becoming the Minerals Council

Although only officially launched in May 2018, the Chamber of Mines had been evolving into the Minerals Council for several years. We have undergone a period of reflection and introspection for some time, one that has led to a clear acknowledgment of the industry's legacy

issues and a renewed commitment to addressing them proactively and permanently.

The mining industry in South Africa has not been without its flaws. Its implication in hardship and injustice cannot be overlooked, particularly during the apartheid years. In the 25 years since, however, and especially in the years leading up to the establishment of the Minerals Council, we have looked at the past critically, have strived to correct legacies and are endeavouring to make positive, long-lasting changes going forward.

The new Minerals Council has emerged more focused, more strategic, and stands taller in its role as the industry's primary representation and strongest voice. A big component of this role has been the leadership position we have assumed in our dealings with government. Among other things, in the past year, the Minerals Council has engaged extensively with government over a new Mining Charter. Though the new charter was published in September 2018, engagements continue with a view to having amended a couple of remaining problematic areas.

Going forward, the Minerals Council intends to cement its position, and to consistently enable the industry it represents to achieve its real potential for investment, growth, transformation and development. We aim to do this by living up to our values of responsible citizenship, respect, trust, honesty and accountability and by driving a positive reform agenda.

Caring for our people

Since the advent of democracy, the mining industry has made important strides in caring for both the employees and communities on whom it is so wholly dependent. This includes their health and safety, their financial wellbeing, and the implementation of initiatives aimed at equality and inclusivity.

Safety

In 1996, the Mine Health and Safety Act was passed and the Mine Health and Safety Council was formed to direct safety in the mining industry and to respond to safety



The Mineral Council building (rebranded)

challenges. In their formation, the Act and the Council both made use of a tripartite approach, involving industry, unions and government in a move that was fairly radical at the time.

The efforts of industry and its tripartite partners have made a significant impact on the health and wellbeing of employees over the past 25 years. Between 1993 and 2016, the number of fatalities across the industry declined by around 88%, while fatalities as a result of fall-of-ground incidents declined by 92% over the same period. In 2009, the Mining Industry Occupational Safety and Health Learning Hub was established to help companies learn from pockets of excellence and, in 2012, the CEO Zero Harm Forum was founded, which emphasizes the importance of leading by example in all safety-related initiatives.

Although these efforts have been significant and worthwhile, the industry experienced the first regression in its safety performance in 23 years in 2017 and this continued into the first half of 2018. Following major new interventions by the Minerals Council from August 2018, we believe we have seen a reversal of those deteriorating trends. We will continue to focus all of our energy into obtaining the goal of zero harm, and will forever encourage our members to do the same.

Health

The prevention and treatment of HIV/Aids and occupational lung diseases (OLDs) such as tuberculosis (TB) and silicosis have been an abiding priority for the Minerals Council for decades. We are proud of the partnerships we have made to this end. One such partnership, Masoyise iTB, includes the Minerals Council, the departments of Health and Mineral Resources, all four labour unions, UN agencies and the South African Business Coalition on Health and Aids, among others. All of these entities are committed to screening for TB and HIV in South Africa's key populations, including mineworkers.

Recent results have been positive. In 2017, 79.3% of mine employees were screened for HIV and 90% were screened

for TB. The next step is to achieve the target of screening all mineworkers every year for both of these diseases.

Unclaimed benefits

In dealing with past issues, the Minerals Council has also had to look at problems relating to the paying out of pension funds, as well as compensation for OLDs, which were poorly managed in the past. In a relatively short period of time, industry players have rallied together to develop innovative and effective solutions to ensure pensioners and OLD claimants are tracked, and that the payments that are due to them are expedited. This concerted and collective effort has improved the industry's reputation among long-standing claimants, and has demonstrated, in practical and tangible ways, that the Minerals Council is dealing with the issues it promised to address.

Women in mining

In 1996, South Africa denounced a 1935 International Labour Organization convention that prohibited the employment of women in underground mining work. Instead, the industry started to make headway in integrating women into every aspect of mining, including underground positions. Over the course of the last 15 years, the number of women working in the mining sector has increased from around 11 400 in 2002 to over 53 000 in 2017. As a result, women currently represent approximately 13% of the mining industry employment.

The move towards modernisation is expected to increase the opportunities available to women in mining. As mines become more mechanised, the need for stamina and physical strength still necessary in deep-level mining will be replaced by the need for fine motor skills, dexterity and problem-solving. Women entering the workforce are ideally suited to fill these positions.

Rethinking mining

Since the beginning of mining in South Africa, the methods

used, particularly for the extraction of gold and platinum group metals, have remained largely unchanged. For the most part, stoping – drilling, blasting and cleaning – is still the order of the day. However, as mines deepen and economically viable orebodies extend further and further from shafts, workers are required to travel greater distances and to negotiate ever-narrower reefs and steeper gradients. Safety, health, productivity, production and costs are all negatively affected as a result.

To mine these increasingly low-grade and inaccessible orebodies, new modernised approaches and interventions are necessary. Critically, the envisaged modernisation process involves retraining people currently at the rock face performing arduous, repetitive and potentially risky tasks to operate low-profile, multi-functional machinery remotely or from a safe distance. In time, the industry will be in a position to train an entirely new generation of mineworkers to undertake these tasks, including more women. In this way, modernisation efforts are as much about developing people and enhancing transformation as they are about implementing technological innovations and improving processes.

Without a shift in mining methodology, the industry will fail to mine South Africa's deep-level complex orebodies profitably. This could result in resources being sterilised, the accelerated and premature closure of mines, and job losses. Research suggests that without modernisation, 200 000 jobs could be forfeited by 2025, affecting 2 million people indirectly.

The move towards modernisation and greater innovation is fundamentally people-centred and has economic development at its core. Not only will it help to improve safety and health, but it will also contribute to increased skills development, employment, exports and revenue, all of which will have a knock-on effect on local communities and the country's economy as a whole. Modernisation is a key strategic priority for the Minerals Council and we are in the ongoing process of creating an enabling environment for industry-wide change.

Using our resources to preserve our environment

Implementing initiatives that minimise the impact of mining operations on the environment, and ensuring that rehabilitation efforts subscribe to the highest standards has been, and will continue to be, a priority for the Minerals Council. But as technology evolves, there are ways of using the resources the industry mines for the betterment of the environment around us.

The Minerals Council has gone so far as to bring this technology home. Since 2014, our building in the heart of Johannesburg's central business district has been powered

by a fuel cell that uses just 40 ounces of South African platinum and low-pressure natural gas. This 100 kW fuel cell produces 70% of our electricity through a highly efficient and ultra-clean power-generation system that produces a minimum of harmful emissions.

Through this installation, the Minerals Council not only demonstrated the industrial application of platinum in a significant new market, but emphasised the commercial potential of environmentally responsible mining applications, too.

Holding our members to account

The Minerals Council's efforts to transform the industry are only as strong as the efforts of our members. We need to act as a united group if we are to effect change where it is most needed.

Although the Minerals Council never encroaches on the autonomy of its members, we do require them to subscribe to a Membership Compact as a condition of their membership. The Membership Compact is a mandatory code of ethical business conduct that focuses on building relationships with key stakeholders, transforming the mining industry, and partnering with communities surrounding existing and future mining operations and those in labour-sending areas.

Looking ahead

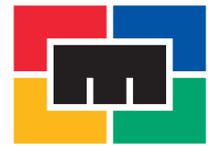
What does the next 25 years hold for the Minerals Council and the mining industry at large? While there are no guarantees, we believe that the changes achieved over the previous quarter-century have equipped us with the resources – if you'll mind the pun – to reposition the South African mining industry as the country's preeminent industrial sector.

A crucial component of our strategy going forward is to reignite the sector through a conducive policy and operating environment, one that fires up exploration and drives new long-term investment into the industry. This will require real partnership between government, organised labour and the industry, as represented by the Minerals Council, as well as ongoing engagement with other long-standing, prestigious and important organisations like the SAIMM.

Together, we believe we can continue to develop a modernised, mechanised, safe and responsible sector that is competitive, attractive to investment and continuously relevant. In everything we do, we will work towards realising the true economic and transformational potential of the mining sector for the benefit of all of South Africa's citizens. ✱

Officially launched in May 2018, the Chamber of Mines had been evolving into the Minerals Council for several years. We have undergone a period of reflection and introspection for sometime, one that has led to a clear acknowledgement of the industry's legacy issues and a renewed commitment to addressing them proactively and permanently

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Company taxes and royalties **R30 billion***



Employment **453 543 people***



Employee earnings **R127.4 billion***



PAYE paid by employees **R21 billion***



Skills development and training **R7.5 billion***



Transformation deals completed of **up to R282 billion** in 14 years***



Local procurement **R222 billion***



Community development **R2 billion***



Research, development and innovation **R676 million****

* 2018 statistics / ** 2017 statistic / *** dependent on valuation

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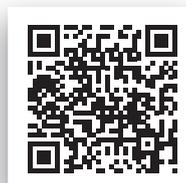
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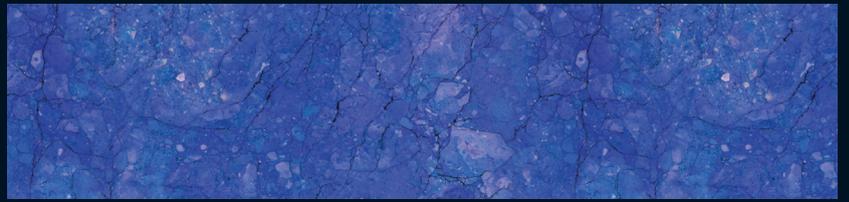
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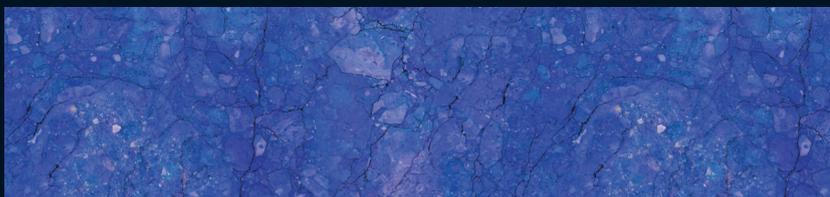
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Reflections on the past 25 years in the mining industry

Con Fauconnier

It is perhaps fortuitous that the centenary of the SAIMM, on 19 May, 1994, came a mere 22 days after the first democratic elections in our country, as the changes since then have impacted our country, our industry and our Institute in irreversible ways, mostly good but in recent years, often less so.

'It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of light, it was the season of darkness, it was the spring of hope, it was the winter of despair.'
These are the opening words of Charles Dickens' novel, *A Tale of Two Cities*, which is set in the time of the French Revolution in the late 1700s and in which Dickens was sympathetic to the overthrow of the French aristocracy but highly critical of the reign that followed. Looking back today one may be excused for thinking he was referring to the monumental events of 1994 that accompanied the dawn of true democracy in our country and, by extension, our industry and our august Institute.

It is fortuitous that the centenary of the SAIMM on 19 May, 1994 came a mere 22 days after the first democratic elections in our country, as the changes since then have impacted our country, our industry and our Institute in irreversible ways, mostly good but in recent years often less so. In the case of the SAIMM, I believe the way in which we were impacted by, and responded to, these changes has resulted in a more robust and representative industry body better reflecting the demographics of our country than in the past and steadfastly making an invaluable contribution to the well-being of our industry. I believe we continue to live up to the aspirations of the first President of our Institute, Mr W. Bettel, who 125 years ago, at his inaugural Presidential Address, expressed the aspirations of the Society as follows: *'It will be our endeavour to promote good fellowship among its members, and by social intercourse, exchange of ideas and research, ... enable us to keep abreast of scientific progress ...'*. Since our centenary we have continued to soldier on in this spirit.

1994 was a time of great hope and excitement for most South Africans, tempered by a modicum of understandable anxiety about the uncharted waters we were entering. The mining industry, as one of the major contributing industries to our national wealth, was no

exception. Today there is general agreement among most South Africans that we were blessed to have had in our first President, Nelson Mandela, a person who preached, practised, and promoted unity, tolerance, and nation building, and who steered us through turbulent change with calmness and aplomb.

However, the reality of 1994 was that change was necessary and inevitable and in many ways the mining industry was to become a forerunner in this regard. The reality of this revolutionary, yet peaceful change was fully entrenched with the adoption of the South African Constitution and its attendant Bill of Rights in May 1996 as the solid foundation on which change would be built. With this as background, the biggest change, to my mind, that would affect our industry and our country was the dynamic shift in the ownership, management, and development of the country's substantial mineral heritage as ultimately embodied in the *Mineral and Petroleum Resources Development Act of 2002 (MPRDA)* and its much-publicized Broad-Based Socio-Economic Empowerment Charter. The major impact of the Act, breaking with the past, was that the state became the custodian of all mineral rights in South Africa to facilitate the attainment of government's objectives for the industry.

While the MPRDA was preceded by normal regulatory processes, kick-started by the establishment in 1995 of a Mineral Policy Steering Committee by none other than the inimitable former Minister of Foreign Affairs, Minister Pik Botha, then Minister of Mineral and Energy Affairs (DMEA), the formulation of the new Mining Charter had a much more colourful and rocky history which remains disappointingly unsettled to this day. Section 100 (2) (a) of the MPRDA stated that the Minister of the DMEA had to, within six months from the date on which the Act took effect, develop a Broad-Based Socio-Economic Empowerment Charter to ensure the attainment of government's objectives of redressing social and economic inequalities of the past, as stated in the Constitution.

The government's first controversial draft of the Charter, dated 18 June 2002, was leaked to the press on 25 July 2002 via well-known journalist, David McKay of Miningweb. The main concern with this draft was the proposal that control (51 per cent) of all new mines would have to be in the hands of black business within ten years. To this day the source of the leak remains unknown but it set the proverbial cat amongst the pigeons. Investors unceremoniously dumped South African mining equities and within days some R50 billion was wiped off the market value of shares listed on the JSE. There was pandemonium and the industry, the financial markets, and the country were in turmoil. However, sometimes adversity brings to the fore the best in people, as the Roman poet Horace once noted: *'Adversity has the effect of eliciting talents, which in prosperous circumstances would have lain dormant'*. This proved to be the case when the fallout from the leaked Charter galvanized the main stakeholders in our industry into action. A comparatively small multilateral team, consisting of representatives from government (DMEA), large employers (Chamber of Mines of South Africa), emerging miners (South African Mining Development Association), labour (National Union of Mineworkers), and traditional communities got together under the Chairmanship of Sandile Nogxina, then Director General of the DMEA, and went into self-imposed lockdown at Mbulwa near Sabie in Mpumalanga, to try and salvage what they could from the crisis caused by the leaked Charter. Within days a new conceptual Charter, representing the consensus view of the main stakeholders in the industry, was drafted and formed the basis of further detailed negotiations, including the drafting of an appropriate scorecard for the Charter. On 11 October 2002, all parties signed the final document entitled *'Broad Based Socio Economic Empowerment Charter for the Mining Industry'*, which became the first Charter of its kind in South Africa. I was privileged to be part of the initial negotiating team at Mbulwa and eventually, in my capacity as Vice-President of the Chamber of Mines at the time, to sign the final Charter on behalf of the Chamber.

For me this first Charter was one of the major events/turning points in our industry in the past 25 years. It was

also a very positive time for our industry under the capable guidance of Minister Phumzile Mlambo-Ngcuka. The aftermath of the leaked Charter and the creation of the first Charter left us with a spirit of cooperation, common cause, and a willingness to resolve industry issues through positive discussion. Unfortunately, much of that spirit has been lost in recent years in the attempts to create Mining Charter III. This was particularly discouraging during the Zuma presidency, especially so during the tenure of Minister Mosebenzi Zwane whose actions amounted to nothing less than a Faustian farce which turned speculation into a fine art and inflicted incalculable damage on our industry and country. It is my hope that the current regime of President Cyril Ramaphosa will lift us from this nadir of despair and restore mining to its former glory and its ability to contribute positively to our national prosperity.

On a more personal note, the biggest change for me over the past 25 years came in the form of the unbundling of the iconic Iscor Limited in 2001 to create Kumba Resources Limited and the subsequent unbundling of Kumba Resources in 2006 to create Kumba Iron Ore Limited and Exxaro Resources Limited, the latter as one of the most successful black-empowered companies today.

I joined Iscor in late 1995 when the change of 1994 was gaining momentum and propelling us to an uncertain future at seemingly breakneck speed. Iscor, for various reasons, was in the thick of things. The inimitable Hans Smith, then Executive Chairman of Iscor, and the late Ben Alberts, Past President of our Institute and Managing Director of Iscor Mining, persuaded me to join Iscor at a time when the company was in dire straits financially due to severely depressed steel prices, ageing infrastructure, and a bloated workforce, a legacy of its parastatal past. Iscor had been privatized only six years earlier in 1989 and Hans Smith, who in 1993 was appointed as its first Managing Director from outside the company, realized that drastic action was necessary. He immediately started with a programme of infrastructure renewal in the steel mills and offering voluntary severance packages to employees over the age of fifty as emergency actions. It was also decided to limit steel

On 11 October 2002, all parties signed the final document entitled 'Broad Based Socio Economic Empowerment Charter for the Mining Industry', which became the first Charter of its kind in South Africa. I was privileged to be part of the initial negotiating team at Mbulwa and eventually, in my capacity as Vice President of the Chamber of Mines at the time, to sign the final Charter on behalf of the Chamber.

production in its existing plants and to develop its mining arm as the growth vehicle for the company for the future, hence my appointment in 1995 as General Manager, Business Development for Iscor Mining.

The above actions, although necessary and helpful, were insufficient to stem the tide and in 1996 we embarked on a comprehensive re-engineering programme for the whole group which, by the year 2000, had resulted in the retrenchment of some 30 000 people out of a workforce of about 56 000. Amazingly this reduction was achieved without any labour disruptions but, as can be imagined, it was not a pleasant time for anyone in the company. However, it had to be done and the net result was that the company not only survived but prospered through events that followed.

On the positive side, during all this turmoil, Iscor and the IDC in a joint venture decided to proceed with the construction of a modern, state-of-the-art steel plant in Saldanha Bay, which was designed to produce high-quality ultra-thin gauge product, using as underlying steelmaking technology a combination of a Corex liquid ironmaking unit and a Midrex direct iron reduction shaft, with the latter using surplus Corex off-gas as a reducing agent.

Although the existing steel plants had improved their productivity tremendously through re-engineering and there was the excitement of new steel capacity at Saldanha on the horizon, mining was still the mainstay of earnings for the group. Despite this, Iscor was regarded as a steel company and treated as such by investors. As mining stocks were generally more favourably regarded by investors, the

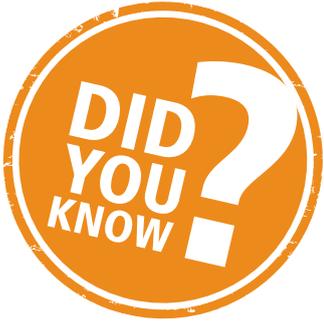
board of Iscor in early 2001 decided to proceed with the unbundling of Iscor into a mining and a steel company in order to unlock value for its long-suffering shareholders.

In the course of 2001, the unbundling of Iscor was mapped out and on 26 November 2001 Kumba Resources Limited was born as a new mining company and listed on the JSE, while on the same day Iscor Limited was re-listed as a pure steel company. I was privileged to be the first and only CEO of Kumba Resources, as 5 years later, on 27 November 2006, we unbundled Kumba Resources to list its iron ore assets as Kumba Iron Ore Limited and merged its non-iron ore assets with Eyesizwe Coal, a black empowerment group headed by Siphon Nkosi, to form and list Exxaro Resources Limited as the largest black-owned mining company in the country. I was appointed CEO of Exxaro for the first year of its existence, after which I handed the reins to my good friend and colleague, Siphon Nkosi who very ably led the company to greater heights until his retirement in 2016 when he passed the baton to Mxolisi Mgojo, the current CEO and member of the original Eyesizwe Coal team.

One of Shakespeare's plays has it that *'All's well that ends well'* and so it is with the SAIMM and the progeny of Iscor today, having survived and prospered despite the turbulence of the past 25 years. The SAIMM is stronger than ever and the original Iscor, which had a market capitalization of some R8 billion before unbundling in November 2001, today has in Exxaro Resources, Kumba Iron Ore, and Arcelor Mittal SA (Iscor renamed) a combined market capitalization of some R140 billion. Good memories indeed! *



Con Faucommier and Siphon Nkosi at the JSE on the day Exxaro Resources Limited was listed on the JSE (27 November 2006)



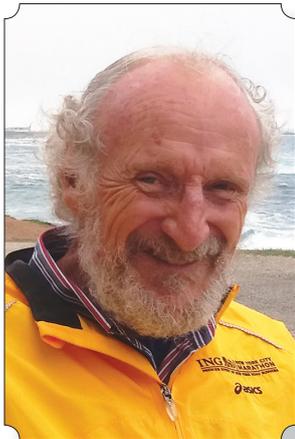
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President: 1995-1996

Mining engineering. Some perspectives on managing risk

Don Ross-Watt

Mineral resource deposits are what they are and are where they are and each brings its own particular challenges to the table.

The title of my Presidential Address was *Mining Engineering, a Discipline for the Future*. The focus was largely on South African-based operations, deep gold mining, and other underground mining.

Twenty-three years later, I shift that attention onto a broader scale. What is the current real driver behind mining engineering? The focus needs to be on world minerals demand and for the medium term at least. Even after netting off possible reductions in demand due to more responsible and efficient future behaviour patterns, and also reductions due to development of suitable substitutes, the demand for minerals is likely to far outstrip foreseeable resources, mining projects, and mining operations.

The boundaries will be significantly stretched for the location and characteristics of prospective mineral deposits, for the technologies required in identifying and exploiting mineral deposits, for achievement of safety excellence, for achievement of excellence in environmental interaction, and for achievement of excellence in social interaction.

Competent mining professionals will be required, and in adequate numbers, including geologists and resource evaluators, mining engineers, and virtually all engineering disciplines, and the metallurgical processing disciplines, also professionals in Earth sciences and social practitioners. Much input is required in conceptualizing, identifying, evaluating, developing, and exploiting sufficient viable minerals production capacity.

Up to my presidential year, I had been involved in deep gold mining and underground base metals mining, with some limited international exposure. Since then I was involved in surface and underground mining for a range of technologies and mineral products, in project development, in new business opportunities and also gained much wider international exposure. I would like to share a few thoughts on the risks and constraints of developing increased minerals production capacity, some obvious, all certainly pertinent.

Mineral resource deposits are what they are and

are where they are, and each brings its own particular challenges to the table.

Well recognized risks include that the resource may not be of the size and quality evaluated, capital blowout in cost and time, inability to meet the anticipated mining selectivity and unit cost, inability to achieve the anticipated processing recovery, quality, and unit cost, and inability to achieve the anticipated revenue stream, as well as the range of infrastructure, safety, environmental, and social risks. Now let's move on from here.

'Unidentified or unforeseen issues' may constitute a serious risk to viability, or to safety, or to the environment, or to social interaction, or may even become a fatal flaw. It is necessary to diligently and exhaustively review and attempt to identify all such possibilities upfront using whatever specialist input and broad experience is available. 'What could possibly occur?' Even then you will invariably miss something, so recognize this risk in your planning. A most daunting task, and so often neglected.

(While this note addresses the risk, the 'upside or blue sky dimension' may equally occur in large steps rather than incremental opportunities. The ability to recognize both is a recipe for success.)

Digital modelling is an indispensable tool in evaluation, mining, processing and throughout the operation. It is also used to assess risk and impacts. Serious risks, however, tend to occur in significant step changes rather than incrementally, and must be considered in terms of scenarios and not merely in terms of sensitivity distributions. Scenarios need to include extreme cases. For example a prolonged period of drought immediately prior to process start-up, a prolonged period of excessive rain for a flood-sensitive project, a significant change in employee or social or political relations, or the impacts of a seismic event on a waste or tailings storage facility. And so many other circumstances.

Significant positive breakthroughs in mining and processing will be required if production is to come

anywhere close to meeting world minerals demand. Consider for example earlier developments of heap leaching of gold from very low-grade weathered resources, the solvent extraction/electrowinning process (SX/EW) enabling scavenging of copper from very low-grade resources and marginal waste materials, the massive scale-up in surface mining equipment size and major advances in equipment control and monitoring, significant advances in exploration tools, progressive improvements in underground mechanization, monitoring and communication, on-going improvements in accuracy and efficiency of mining methods, and significant digital contributions all round. What lies ahead?

Feasibility studies may, and very often do, turn out to be some long distance from reality for a variety of reasons, including significant unidentified or unforeseen issues. This must be recognized. Planning and operations need to be sufficiently robust to cope.

Capital cost and capital schedule overruns are again likely to involve significant step changes rather than incremental impacts, so it is necessary to run some extreme scenarios to assess the extent of any possible embarrassment and the necessary remedial action.

Risk consists of the probability of occurrence and the consequences of occurrence. The probability of occurrence is the minor issue, what is really important are the consequences. Consequences require exhaustive evaluation no matter how remote the chances are of actually happening. Consider for instance a most unlikely tailings wall overtopping or failure that actually takes place with devastating consequences. Consider backfilling a very large void in the upper levels of an operating mine. Despite whatever controls are put in place, the consequence of failure would be devastating. Consequence identification and management is the name of the game.

Environmental requirements have become truly internationalized, and are equally challenging wherever your operation. (In the United States, I understand new mining operations are effectively not permit-able. Now many other countries come close.) Cyanide is always an emotive issue. The impacts however of acid mine water drainage via mining and processing operations or via waste rock and tailings storage are difficult to control, are becoming just as emotive, and involve a much a longer period of impact. (Interestingly certain environmental contaminant constraints are now approaching levels so low that reliable measurement itself becomes difficult.) Well-established industry information describes the risks and requirements that may be encountered. But always consider carefully what you may have missed, it is almost inevitable that you will walk past something.

Consider the often quoted 'in-perpetuity commitments' regarding contamination mitigation or other protection requirements which may be contained in an operation's

closure documents. What does this really mean, 10 years, 20 years, or literally in perpetuity? How can this realistically be achieved? This needs to be carefully considered, and defined and documented and understood.

While formal environmental permitting requirements may be clear, the importance of 'informal social permitting' is not always fully recognized and is at least as critical to an operation. The ability to achieve the latter may be project defining or even project excluding. This requires extensive work on the ground in consultation with local communities, rather than with higher authority. (You first need to walk the walk and talk the talk in the hills.) Social permitting commitments may be challenging, for instance when considering large-scale relocations, or in addressing extensive informal mining, or in water management commitments. Be aware that apparently minor issues can trigger serious social confrontation.

Consider communities becoming wiser to relocation 'opportunities' the second time around, may be exclusionary. Consider informal miners being paid elevated prices for gold as part of underworld money laundering. Consider also the responsibility for the safety of informal mining operations

on the property. Stability of underground rat-holes, or people swarming over surface blasted rock.

A further example was the requirement that in excess of 75% of the capital contractors and operating employees of a project had to be drawn from local communities, (where hardly anyone even owned a motor vehicle). This situation resulted for instance in anyone capable of operating (more or less) a back-actor became a contractor overnight, often as a front for an outsider investing in the equipment. So instead of maybe

five major contractors on site, in addition 30 or 40 smaller contractors had to be managed. Mining equipment and process operators had to be sourced from local villages and extensive training had to be implemented. Eventually it all worked.

There are any number of site-specific issues that must be tied down (formally) through (informal) social permitting, and with no short cuts.

Water supply is a multi-faceted risk facing most projects, and often a nightmare, sometimes sinking an otherwise 'viable' project. Overall, demand for water is increasing and supply or access to supply is more than likely to decrease in the future.

Provision of water is often 'the most important issue'. The massive water processing and delivery infrastructure provided for some large high-value projects (which can afford it), makes for sobering and enlightening reading. Also consider the importance of extracting the maximum amount of water from process tailings. The seasonal impacts on water supply for a smaller project may be highly significant. Caution is required when dealing with more complex water rights agreements. Excess water, surface or underground, can also be project defining.

“ **Unidentified or unforeseen occurrences can constitute a serious risk to viability, or safety, or the environment - or even become a fatal flaw. It is necessary to exhaustively review and identify all possible occurrences upfront, with whatever specialist input and broad experience is available** ”

Any impact on local/traditional water supplies is an extremely emotive issue in most project developments. (Just don't mess around with anyone's streams.) An example was a very large project involving impact on streams supplying the town and local villages. Appropriate and permit-able reservoirs were included in the planning, however, public opinion was strongly negative, resulting in lengthy periods of resistance and even substantial violence. The project was cancelled and the town was left to ruefully contemplate the lost opportunity for employment and for the local economy.

Then there is pollution through discharge or seepage. Broadly speaking, such pollution is supposed to be a well understood risk, but the devil is in the detail. Contain or treat and discharge? Specialist input and broad experience is required. This may involve a very high cost and long-term commitment. This can be project defining or even a fatal flaw, and certainly can lead to serious social confrontation. Environmental constraints to contaminant levels will inevitably tighten over time and must definitely not be underestimated.

Characterization of waste rock (and any other potential construction material) may be somewhat overlooked. In fact it needs to be very thorough, including an adequate drilling programme. Wall stability and contamination issues are better established. Waste rock as an early construction component or for longer-term construction requirements of the ongoing operation can be critical.

Characteristics of the surrounding host rock, as well as the water table and the local topography need to be very well understood. Absolutely there is potential for a fatal flaw. Such an example was an extensive network of complex finer karst structures quite capable of transporting contamination for kilometres, and which then reappears somewhere as surface seepage. (Even seepage equivalent to the flow of a garden hose would be quite unacceptable.) The role of project elevation and of water table in this case was decisive. The potential social impact could have been massive. The issue became project defining and without very high-cost ongoing mitigation measures involving a thick lining of compacted material to the tailings storage facility, may well have become a fatal flaw in the project.

Space for accommodating waste rock and tailings storage may be constrained to a lesser or greater degree. This can in more extreme cases limit the total exploitation of mineable ore and the life of the operation. An example is an operation where tailings dam capacity limited ore available for extraction to the extent that life of mine planning, cut-off grades, and process optimization had to be altered so as to extract only the more payable ore. (Maybe 15% of potentially available metal was excluded.) Waste rock storage constraints followed closely those of the tailings storage.

Mining companies, especially in South Africa, have scaled down on in-house technical expertise. The use of external consultants on a wide scale is now an inescapable part of the industry and works well.

We must recognize that specialist consultants, (world class), may be required in certain circumstances. An example is a review board, representing the appropriate disciplines, interacting on a regular basis over a long period of time for the construction of a large tailings storage

facility. Also in association with a specialist ground water consultant to ensure continuity of community springs and water supply from streams. Also in this case a specialist consultant (from Belgrade) on karstic structures. (Karstic systems are massive in the Balkan countries). Such review boards may be essential, (but must also be recognized as not infallible). Specialist consultants in environmental and social issues were also on board, making vital contributions.

We learn time and time again, that if in doubt, consult an appropriate specialist right away.

Instances of non-standard capital construction and of non-standard operating procedures are very real. Clearly adequate controls need to be in place, however, provision for such instances happening must be made through design, construction and operations, and in contingency planning. Examples include significant seepage from even a small defect on a tailings dam, loss of viability due to deviations in selective mining, severe risk to the underground workings arising from deviations in backfill material preparation, inappropriate robbing or poorly planned pillar stability, and inadequate rock-breaking discipline. Any discontinuity between process plant backfill production and mine backfill placement creates a significant area of risk as a number of severe examples have shown.

Responsible mining requires benchmarking and then more benchmarking. This can only be achieved through studying up-to-date literature, attending professional conferences, engaging appropriate consultants, having direct communication with operators, and visiting operations to gain on-the-ground information and guidelines. You must identify both the best and the most vulnerable practices in order to see your planned operation in perspective. If your planning is outside of the norms, question it, is this due to improvements on the one hand or to shortfalls on the other. Test also 'has it been done before' or 'at this scale' In my own experience, this is an essential and invaluable activity.

The SAIMM and similar professional bodies certainly play a strong benchmarking role.

It is always necessary to find a functional balance between extreme conservatism on the one hand and an operation that may be considered aggressive or even vulnerable on the other.

I suggest that it is necessary to define contingency planning for a range of scenarios, including extreme examples, at an early stage of the planning process. Once construction and operations commence and are ongoing, you will quickly move from planning to reality, maybe some way apart. (You can't then afford to be caught with your pants down when circumstances/opportunities change.)

Always try to identify and define the 'key issues' for the particular project? Very often we don't get this right.

So there it is, my few thoughts on risks relating to a minerals demand driven, and potentially development intensive industry. Now, twenty-three years later, the industry will more and more demand well qualified and diligent professionals capable of clear, exhaustive and incisive thinking, and with the ability to put this thinking into practice. *



LOCAL PASSION GLOBAL COMMITMENT

Sandvik Mining and Rock Technology congratulates the SAIMM Journal on 125 years of service to the mining and metallurgical industry.

Through the varying changes and advancements in industry, we have both remained committed to providing solutions for our customers and we salute you for the informative impact you have made in industry.



President: 1998-1999

About a rights-based health and safety dispensation to developing the SAMREC code and more

Roger Dixon

'...fatality rates such as those currently prevailing will not be acceptable to investors in deep level mining projects. Not only do mining projects have to be financially viable, they have to conform to acceptable standards of safety risk exposure.'

The SAIMM has seen many turbulent times during its 125 years, and my tenure during 1998-99 was no exception. South Africa's legendary mining house system – in which I had spent most of my career – was being dismantled, with impacts on the SAIMM's membership and role. At the same time, there were positive moves in the industry itself to meet the demands of change: we were applying a new rights-based health and safety dispensation; we were developing our own ore reserve reporting code; and I was building the country's first underground mechanized mine. It was a heady time.

The industry was in the grip of substantially reduced profit margins – as our mining costs increased and the gold price dropped in real terms. South Africa was also facing aggressive competition from gold producers in Australia, Canada, and the United States. From its historic high of about 1 000 ton in 1970, SA's annual gold production had dropped to 621 ton by 1988 and further to just 493 ton in 1997. Staffing at mining house head offices was being cut, and executives were not as readily available to serve in the SAIMM as they had been in the past.

During my term as SAIMM President, I was a consulting engineer at Anglovaal Mining – one of the six large conglomerates that dominated the local mining sector. The foundations of the mining industry were shaking, however, and my role would soon be one of those levels of management that the company was forced to shed in its efforts to cut costs.

Besides my family, there were at least four key responsibilities that occupied my time: the SAIMM, the Mine Health and Safety Act (MHSA), the South African Code for the Reporting of Exploration Results, Mineral Resources and Mineral Reserves (the SAMREC Code), and the development of the ground-breaking Target Mine near Allanridge in the Northern Free State. Each of these in their own way gives a flavour of the challenges and opportunities that were facing the Institute and the industry at that time.

Staying relevant as an institute

In my year as President, we spent a great deal of time in strategic planning to stay relevant to a fast-changing environment. Despite the industry upheaval, the big mining houses were still mainly located in the same area of downtown Johannesburg. When I began my involvement with the SAIMM, the Institute's office was in the old Stock Exchange building in Hollard Street. Staying in touch with the sector was easy; most of the industry representatives on the SAIMM were mining company executives, and you just had to walk up the road to attend meetings.

The contraction of the sector was already taking its toll, though, and we needed to reduce our overheads by moving to cheaper premises. At a Past Presidents lunch – which we used to hold at Gold Reef City – my former boss at Anglo American Gold and Uranium Division George Nisbet (SAIMM President in 1981-82) advised me to consider moving in with the Chamber of Mines, which we did.

To deal with impact that the industry's challenges were having on the SAIMM, I worked closely with my successor Mike Rogers (SAIMM President in 1999-2000) to find a way forward. With the shrinking of the membership of the professional associations related to mining, we had lengthy discussions with organizations like the Association of Mine Managers SA, the Mine Ventilation Society of SA, the Institute of Mine Surveyors of SA, the SA Colliery Managers' Association and the Geological Society of SA. The idea was to group them together under one umbrella to share resources and become more sustainable – speaking with one voice to represent mining professionals.

As it turned out, this did not happen, but the Geological Society did move its premises to join us in the Chamber of Mines building, and we collaborated closely in the formation and operation of the SAMREC Committee – which has been a vital contribution to keeping SA in step with governance standards in the global mining sector.

Now, with the mining house structure all but dismantled, the ranks of the SAIMM executive and council is no longer made up primarily of mining house leadership. Today, there is far more representation from academia and consultancies.

Workers and safety

During my tenure, we had just been through the development of the MHSA of 1996, and I had been on the Chamber of Mines' team negotiating with the Chief Inspector of Mines, and the National Union of Mineworkers. We spent weeks in the portfolio committee in Parliament prior to the publication of the MHSA in June 1996. I was still at that time a member of the tripartite Safety in Mines Research Advisory Council (SIMRAC), where I represented the gold and platinum producers alongside Ian Watson from Gold Fields from its inception in 1992.

The Mine Health and Safety Council (MHSC) was also formed around that time, and we were all coming to terms with the new law – which had introduced safety representatives among workers and gave employees the right to refuse to undertake dangerous work. This was the beginning of a transformation of the safety management culture on mines and, needless to say, there were many of the old-style managers who took some time to come to terms with the new rights-based dispensation.

In my Presidential Address in 1998, I had in fact highlighted the poor safety performance of the gold sector in comparison to our competitors abroad: '... fatality rates such as those currently prevailing will not be acceptable to investors in deep level mining projects. Not only do mining projects have to be financially viable, they have to conform to acceptable standards of safety risk exposure.' This was relevant to the industry's efforts and research into mechanization of mining operations, one key impact of which is to remove personnel from hazardous areas – especially as our mines became deeper and more prone to falls of ground and rockbursts.

Alongside greater productivity, these safety concerns were among the motivators behind the development of the Target mine, to which I shall return later.

The tripartite basis for decision-making was a breakthrough in many respects for the longer-term sustainability of the sector. I noted at the time that this concept seemed to epitomise true democracy, even though

it did mean that many decisions took much longer and thus delayed necessary action. I even expressed concern about whether the industry could afford to use so much of its scarce resources in these time-consuming engagements between stakeholders. Perhaps in retrospect we have not invested enough time, or at least our efforts to foster the tripartite approach have not been as effective as we had hoped.

Raising the bar for reporting SA's mineral resources

It had been suggested in 1994 – at a Council of Mining and Metallurgical Institutes (CMMI) international conference in Sun City – that SA develop its own reporting standards for Mineral Resources and Mineral Reserves. A couple of years later, in a session on reporting standards at the conference of the Prospectors and Developers Association of Canada, I listened to Ken Grace – who used to be with Johannesburg Consolidated Investments (JCI) – who spoke about reporting codes in Canada. It was clear that SA was considered as rather 'second class' for not having its own code, and I made up my mind that this must change.

In conjunction with some of the sector's leading minds, we began the development of the SAMREC Code in 1996. Among those involved were leading geostatisticians Dr Ferdi Camisani, who worked with me at Anglovaal, and the world renowned Dr Danie Krige – also at Anglovaal. It was convenient that Ferdi and I were in the same building; Ferdi and his committee did most of the slog work, and I did the editing! It consumed much of our time for the next few years, but we were finally able to publish the SAMREC Code in April 2000 – giving SA's mining sector a reporting standard for the first time.

By that time, companies like Anglo American were encouraging their relevant professionals to become members of the Australasian Institute of Mining and Metallurgy (AusIMM) so they could follow the Joint Ore Reserves Committee (JORC) code – the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves. So, the release of the SAMREC Code was not a moment too soon.

Grasping the nettle of mechanization

A useful marker in the technological evolution of the SA mining sector was Anglovaal's Target Mine – pioneering the

The tripartite basis for decision-making was a breakthrough in many respects for the longer-term sustainability of the sector. I noted at the time that this concept seemed to epitomise true democracy

first mechanized underground mine in the country's long history of mining. SA was certainly out of step with global competitors when it came to mechanization; we had only recently launched the R70 million, three-year 'Deep Mine' research initiative, and I voiced some concern at the time: 'Given the lead times for technology development, it could be too late.'

Mechanization of stoping operations had already been identified by Dr Horst Wagner (SAIMM President in 1986-87) as a prerequisite for successful mining at depth - along with the reduction of heat load using backfill and the effective control of rockbursts. But stoping mechanization remained elusive, as did rockburst control. Technology for mining below 3 000 metres also had to be cost-effective; our main technological achievements as an industry - refrigeration, winding systems, and seismic monitoring - were remarkable forerunners in the field but the first two remained very expensive solutions.

Developing the new technology was a challenge in itself - demanding considerable funding and world-class research expertise. In my Presidential Address, I warned that: 'If sufficient funding is not made available on an ongoing basis, then the chances of any success in development diminishes as the quality of research facilities available deteriorates.' Sadly, that is exactly what has unfolded in the two decades since I wrote those words, notwithstanding the more recent efforts of academic and other institutions to give new impetus to technology-focused mining research.

Be that as it may, the Anglovaal team in the late 1990s - led by the visionary Gerry Robbertze as part of his Phakamisa ('lift up') initiative - had visited leading experts, companies, and mining sites in the UK, Canada, Sweden, Ireland, and Australia to see leading-edge mining technology at work. What we saw was eye-opening, especially in comparison to our conventional mining methods. In 1998; I particularly remember visiting the underground Stobie Mine near Sudbury in Canada, where the Canadian Prime Minister had been able to operate one of the mine's load haul dumpers remotely from Ottawa the day before we visited. We realized we had a long way to go, but the potential for

improvement seemed huge.

Predictably, the development of the new Target mine was a real challenge; as much as the new technology drew the attention of the industry, the novelty of it meant that misgivings abounded among many of the stakeholders - outside and inside the company. Innovations included the first man-riding conveyor in the country, and the replacement of inefficient compressed air with electro-hydraulic and hydropower drilling. All the hard work finally led to production, however, and Target achieved its expected mining rate of 5 000 ton a day in 2001.

Technology as the future of mining?

In 1998, we were beginning to glimpse the possibilities of mechanization. While I was fully committed to the Target project, and am immensely proud of what was achieved, I was also so bold as to opine in my Presidential Address that: 'The South African gold industry's record would suggest that technology is not going to come to the rescue of the deep miner.'

I pointed out that the SA mining industry was spending at the time only about 0.23% of its turnover on research - compared to a nickel mining company like Inco in Canada, which invested 1.18% of its turnover in research to keep it at the cutting edge.

I also highlighted that, for research and technology to be effective, our innovative ideas needed to be actually transferred into the workplace and applied in the operation. For this to happen, I argued, 'the culture of the organization must first be receptive to change and new technology. The challenge in South Africa is to create this climate through the correct use of graduate engineers and in particular mining engineers.'

Today, as then, this remains a pressing priority. The digital revolution now offers even more opportunities for mines to step into a new era of safety and productivity. But they have to want to take that step, and this requires a cultural leap of faith that many mines appear reticent to take. *



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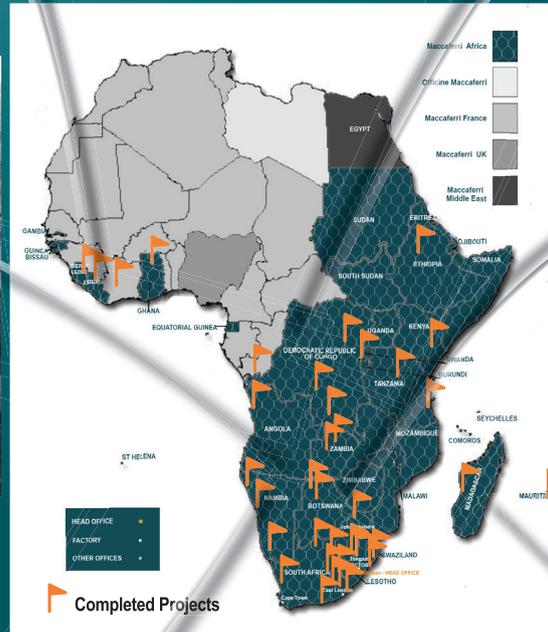
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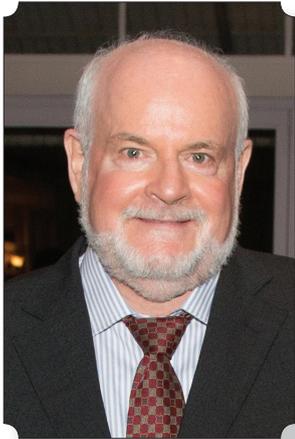
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President: 1996-1997

A perspective on how our mining and metallurgical industry has progressed over the past fifty years

Nicholas Adrian Barcza

The best interests of the country and its peoples are sadly often not well-served for various unfortunate reasons.

What affects and influences one's perspective of the mining and metallurgical industries?

One's perspective of the industry we work in changes over time as a function of our experience as well as from the interaction we have with colleagues locally and probably even more so with those internationally. Furthermore, the ever-changing environment continues to impact the context in which one sees things. Living mostly in South Africa through its changes in the past fifty years but also having the opportunity to travel extensively and work on projects abroad adds an invaluable richness to this more global perspective. One of the greatest challenges is how best to use this experience to endeavour to support the many potential opportunities in southern as well as sub-Saharan Africa. However, one has also to face the realities of how the best interests of the country and its peoples are sadly often not well served for various unfortunate reasons. Investment, education, regional stability, and good governance are some of the most critical considerations for the prosperity and survival of the region.

The mining and metallurgical industry in southern and sub-Saharan Africa changed significantly during the post-colonial and apartheid eras as a result of global and regional developments that have impacted the ownership of businesses, the technologies used, and products produced in a manner that was not envisaged even fifty years ago. Southern Africa's mining and metallurgical industry has progressed from one based mostly on diamonds and gold in the late 19th century to a much more diverse one that involves the production of a variety of other precious, base, and ferrous metals and minerals as well as coal and industrial minerals. The infrastructure and manufacturing capacity was largely developed to meet the needs of this industry during its growth phases, but even though the dynamics have changed there is still a need for more efficient and effective support systems in the region.

The rapid growth rate in Europe and North America after the end of the Second World War has been

superseded to a large extent by the even more rapid rate in Asia over the past twenty-five years. This has impacted the development of mining and increased the export of raw materials from South Africa such as iron, chrome, and manganese ores, whereas conversely the gold industry has shrunk considerably.

There has been growth in the amount of local beneficiation into some intermediate added value products such as ferroalloys and steel and stainless-steel products, but this trend started to diminish by the early 2000s. However global growth in stainless steel has more than doubled since the mid-1990s reaching 50 Mt/a in 2018 with Southern Africa supplying much of the chromite, mostly to China, which now produces even more ferrochromium than South Africa based exclusively on imported ores. It's therefore doubtful as to whether China has a longer term sustainable competitive advantage in this product unless Southern Africa can't get its act together. South Africa's share of global stainless-steel production has also decreased instead of increasing, as was anticipated back in the 1990s when insufficient investment was made to achieve the necessary economy of scale of 1 to 2 Mt/a as well as not forming the international business partnerships with Asian companies in addition to those that already exist with some producers in Europe.

Added value creation in the mining and metallurgical industries and what has been achieved.

Drs Robbie Robinson and Peter Jochens had a major influence on Mintek becoming closely involved in the early days of the ferroalloy industry in South Africa in the 1960s and 1970s. The Pyrometallurgy Research Group at the University of the Witwatersrand was established at that time followed a few years later by the Pyrometallurgy Division at Mintek, largely due to their foresight and endeavour. The timing was driven by the needs and opportunities in Southern Africa for the rapidly growing international demands for ferrochromium

and ferromanganese, mostly in Europe, North America, and Japan during that era. A further consideration was the realization that the economics of production were favoured by building larger furnaces close to the sources of the ores, electrical power, and coal needed for reducing agents such as coke and char. However, these rapid developments resulted in a number of technical challenges that the suppliers of this equipment, who were mainly from Europe, could not fully resolve as they too were going up a learning curve in terms of scale-up and the application to different ore types. The demand for appropriate research and development work to support the industry grew significantly during this period and Mintek as well as several of the local Universities was involved in addressing and assisting to resolve these problems. The Mintek Minstral (now FurnStar) furnace controller is a prime example that contributed to major improvements in performance, especially of the larger high-power submerged arc furnaces.

The Ferroalloys Producers Association (FAPA) was also instrumental in supporting this research and development initiative and the instigation, together with the SAIMM and Mintek, in founding INFACON in 1974 that has its fifteenth Congress in Cape Town in March 2018 and has been an invaluable vehicle for technical exchanges that benefitted the ferroalloy industry globally.

Dr Louw Alberts followed Robbie Robinson as Mintek's President and very much supported Mintek's continued role as one of the Science Councils, namely to foster research and development in the mineral and metallurgical sectors of the country. This resulted in him obtaining funding for several major initiatives. One of these was the establishment of the DC plasma arc furnace pilot plant facilities that set the stage for a number of breakthrough technologies in the following twenty-five years and beyond this. This led to Mintek, together with Samancor Chrome, being presented with the AS&TS award for the successful implementation of DC furnace smelting technology of chromite fines, which has now been scaled up to over the 65 MW power level and continues to be improved.

Dr Aidan Edwards, also a Past President and CEO of Mintek, led the way during the 1980s and 1990s with the promotion of the potential benefits of added value in terms of job and wealth creation. He initiated a very significant effort to motivate added value in many areas of the mining and downstream industries and had to try to overcome the challenges of investment in the local production of added value products and the manufacture of industrial components for export. The stimulation and encouragement

of a number of added value intermediate and end products was supported in a number of areas by both government and industry. However, this progress was sometimes tempered by the comment of local producers who often raised the concerns of not wanting to compete with their customers. This issue still appears to persist to some extent for historical reasons and due to overseas ownership of local mining and metallurgical operations.

Dr Paul Jourdan was also very much involved in encouraging job creation with a focus on the development of industrial zones in strategic areas, especially those that had not received as much support in the past as the more developed regions. A number of initiatives were proposed and studies carried out especially in underdeveloped areas such as the Eastern Cape, with the emphasis on the Coega Industrial Zone and Western Cape Coast. A number of major projects were evaluated in these regions with the involvement of the DTI and a number of industrial participants with valuable support from Mintek. However, only a few of the metallurgical-related projects have been implemented so far due to lack of investment and the global markets as well as a lack of competitiveness, especially when compared with producers in the rapidly growing Asian region.

This situation has in some ways become even more challenging as the price of most of the variable cost items to produce these products has increased significantly in Southern Africa owing to issues such as a lack of adequate longer-term planning, insufficient management experience, and an apparent shortage of funds to invest in these critical areas. The road to recovery needs to receive even more urgent attention if the situation is to become more conducive to investment and growth in these industries that have a large multiplier effect in terms of employment opportunities that the sub-Saharan region so badly needs.

Several added value projects that were evaluated and successfully implemented even though the reasons were sometimes not that apparent at that time included the following:

Aluminium in effect as a means of exporting electrical energy produced from coal but based on imported alumina, chromium chemicals (but not chromium metal), manganese chemicals (EMD) and metal, vanadium chemicals and alloys, titania slag (but not titanium metal), and zirconium ceramics and alloys. However, the further development of similar opportunities has been negatively impacted by the rapidly increasing electricity tariffs in recent years.

Southern Africa's mining and metallurgical industry has progressed from one based mostly on diamonds and gold in the late 19th Century to a much more diverse one that involves the production of a variety of other precious, base and ferrous metals and minerals as well as coal and industrial minerals.

Added value products from precious metals, including three-dimensional coloured gold and platinum jewellery and automotive catalysts, achieved some success, the latter with some export incentives. More recently advances in nanotechnology have been creating new opportunities but have a long way to go if a significant impact is to be made.

Other initiatives that were advanced in the 1990s include magnesium-based products for the automotive and aerospace industries that could be produced from dolomite resources located along the Western Cape coast. The technology is based on using locally produced ferrosilicon as the reducing agent using Mintek’s atmospheric DC furnace and splash condenser technology (MTMP). This initiative was well supported by Anglo American, Eskom, and government, reaching the large pilot plantscale; but it requires a larger demonstration-scale facility to provide the design parameters and confidence for an industrial-scale plant. Magnesium steering wheels were produced in Atlantis but from magnesium imported from Brazil; local production on a larger-scale could stimulate a wider range of products being developed.

The strategic and critical minerals and metals eras and related technology developments

The strategic metals and ferroalloys of the 1970s up to the 1990s, such as chromium and vanadium, have largely given way to the current focus on critical elements such as rare earths, tantalum, and some of the others shown in the Table below. Many of these are driven by advanced technologies and the range of high-tech products that we use in our everyday life. Another reason is the need to increasingly use energy from renewable resources and for the more effective storage and transportation of electrical energy that has

driven the so-called electric vehicle (EV) metals such as nickel, cobalt, lithium, and vanadium, as well as graphite in terms of purity and demand.

Abiel Mngomezulu succeeded Dr Paul Jourdan as President and CEO of Mintek and with his background in geology and experience in industry and also government, ensured that Mintek continued in its role as a leading provider of research, development and technology transfer. He also encouraged Mintek’s involvement in overseas based initiatives such as the EU’s Framework and Horizon 2020 programmes where Mintek was and continues to be a significant participant in a number of consortia-based projects - some of which relate to critical raw materials and technologies referred to in the EU initiatives (1). There are numerous ongoing benefits from interaction with leading universities and institutions as well as commercial organizations in a several counties within the EU where Mintek has built up special relationships.

Research and development together with the necessary experience can go a long way in ensuring we do better in the future, with some trial and error being inevitable as a consequence to some extent in testing the limits of science and engineering technology.

We need to capture the whole learning and experience curve in an effective manner for the future and the development of intelligent dashboards that have the ability to provide the advanced strategic inputs as well as support for complex decision-making processes for the future without the human race becoming overly dependent and losing the ability to still think for itself.

Some of the more advanced technologies that were identified in the 1980s and 1990s have progressed to the

Table

The list of selected critical metals as defined by the EU

Global supply of the CRMs - selected individual materials (1)									
	Material	Stage ¹	Main global supplier	Share		Material	Stage	Main global supplier	Share
1	Antimony	P	China	87%	23	Natural graphite	E	China	69%
7	Cobalt	E	DRC	64%	28	Phosphate rock	E	China	44%
8	Dysprosium	E	China	95%	30	Platinum	P	S. Africa	70%
10	Europium	E	China	95%	32	Rhodium	P	S. Africa	83%
11	Fluorspar	E	China	64%	33	Ruthenium	P	S. Africa	93%
13	Gallium*	P	China	73%	35	Scandium	P	China	66%
14	Germanium	P	China	67%	36	Silicon metal	P	China	61%
19	Iridium	P	S. Africa	85%	37	Tantalum	E	Rwanda	31%
22	Magnesium	P	China	87%	41	Vanadium	P	China	53%
Africa dominant					Africa potential				

stage where their successful implementation is widely accepted, but in other cases there are some aspects of the work that is still in progress. One area is advanced sensing and sorting of minerals as a means of preconcentration of the ore; increasing the head grade can make a significant impact on the economics of a new project or improve the performance on an existing operation. Another is computer-based modelling and control of large submerged arc ferroalloy and DC arc furnaces, largely pioneered in South Africa during the scale-up from the designs and applications in several regions and the progression to open bath technologies for smelting fines. The consolidation of these models and what has been learnt from their application should be advanced by developing so-called intelligent dashboards that capture the integrated learning curve to support future generations working in our industry.

Lessons learnt and potential future opportunities

In spite of all this progress we still don't seem to be learning as much as we should from the experience of lessons learnt in the past fifty years; with several mega projects failing at a cost of tens of billions of dollars for reasons that, in many instances, could and should have been avoided. It would have only taken a small fraction of these losses to have been invested up front to avoid many of these failures had we

asked and answered the right questions in the first instance. How can we get this right in the future?

One of the most important requirements of the engineering and related scientific fraternity's capabilities is the ability to apply the necessary level of judgement. This appears to have been sadly lacking in a number of projects over the years for various reasons, where hindsight indicates that the problems experienced could in principle have been avoided or minimized.

These projects, most of them outside South Africa, include the following: direct reduced iron and preheating of ilmenite in fluidized beds, the production of nickel intermediates in certain hydrometallurgical processes, carbothermic reduction for aluminium production, magnesium production from asbestos tailings, open bath smelting of silicon, electrolytic titanium production, and zinc metal recovery from electric arc furnace (EAF) dusts. The investment in these and other projects probably amounts to well over US\$25 billion that could have been better spent on de-risking the technologies or establishing what the fatal flaws are before incurring the major capital investment costs. It seems as if there is never the money for this critical type of assessment in many such projects in advance. However, there is increasing hope for the future.

Things still to do on the metallurgical technology bucket List

- ➔ Preheating and prereluction of chromite fines prior to smelting in an open bath with 'cloud cover' to minimize energy losses in a DC furnace and achieve a power consumption of less than 2 MWh/t ferrochrome to support the further local growth of this industry.
 - ➔ Demonstrate the continuous vapour phase transfer of magnesium between a DC furnace and a splash condenser at an operating scale of 25 MW with a high overall availability to support the establishment of a new local industry.
 - ➔ Scaling up of FeMn smelting to over 100 MW in a DC (SAF) submerged arc furnace using the optimum level of manganese ore pretreatment to achieve the economy of scale to support the further growth on the local industry.
 - ➔ Optimum use of nickel laterite ores to produce Ni and Co units using hydro-pyro process flow sheet integration and smelting based on using intermediate products to support projects in sub-Saharan Africa to supply the growing battery and other markets.
 - ➔ Mega-scale iron and vanadium production in the Bushveld Complex to supply the large potential for vanadium storage batteries and iron units for integrated iron, steel, and stainless steel production as well as high-purity iron powder for added value products.
 - ➔ Growth of stainless steel to 3 Mt/a in South Africa through Fe, Cr, and Ni process integration and product optimization including improved production methods for lower cost and more effective ferritic grades.
 - ➔ Maximising cobalt recovery to over 90% with an optimum integrated sensing and sorting based mineral processing and more effective pyro-hydro and advanced smelting and hydro-based iron removal technologies, also for the growing battery markets.
- Finally, sub-Saharan Africa should strive to increase its production and be a more dominant producer of several of these critical materials in the table shown opposite and contribute more to those that can be found in the link to the reference below in the medium to longer term. Other elements such as chromium, manganese, and tin are close to meeting the criteria for this list too. The sourcing of the almost unlimited electrical power potential of the Congo river would in principle go a long way to addressing the current constraints in expanding the production of the ferroalloys from the world's most abundant resources of chromium and manganese as well as other important more advanced materials.
- Reference:** Study on the review of the list of Critical Raw Materials - Executive summary. Document date: 13/09/2017 - Created by GROW.DDG1.C.4 - Publication date: 13/09/2017 <http://ec.europa.eu/docsroom/documents/25421> *

The Minerals Education Trust Fund – A good news story

At a time when good news stories are few and far between, The Minerals Education Trust stands out. Over the nearly twenty years of its existence, it has had a significant positive impact on both the minerals and the education sectors. This article outlines the work and growth of the Fund since it reconstituted the Tertiary Education Fund run by the then Chamber of Mines in 2000.

The Minerals Education Trust Fund was constituted in 2000 by South African minerals and mining companies who were concerned about the ability of the minerals education departments at South African public universities to continue to produce graduates with much-needed high-level technical skills when the ranks of skilled and experienced lecturing staff were being depleted due to attractive offers from overseas institutions, as well as from local industry. There were few, if any, incentives for qualified engineers and scientists in disciplines such as mining and metallurgical engineering, as well as the geological sciences, to enter or remain in academia when they could secure more favourable remuneration packages and career prospects elsewhere.

The Fund therefore has as its objective to subvent the salaries of key lecturing staff in the abovementioned disciplines to the point where it becomes viable for qualified professionals to not only enter the world of academia but to make it their primary career choice.

The Fund receives contributions from its members, who represent the majority of the South African mining and minerals sector and have grown from 13 companies in 2000 to 38 in 2018. Their contributions are funding subventions for 238 academic staff members at nine Higher Education Institutions (2018 figures).

It is widely acknowledged by the universities that without this funding, they would not be able to attract and retain appropriately qualified academic staff in these disciplines. Vacancy levels in the funded departments are typically

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low, and when they do occur, it has been possible to make new appointments despite the scarcity of the required skills. Examples of this would be teaching skills in subjects such as mine ventilation, rock mechanics, mining geology, and extractive metallurgy to name but a few.

From time to time, the Fund has also been able to make grants for the purchase of capital items. These are normally selected to ensure that the undergraduate teaching meets the needs of the industry. An example of this would be mine design software currently used in industry being purchased with a capital grant to use in teaching undergraduate mining engineering students.

The Fund's work is carried out voluntarily by 90 individuals representing their member companies, who set aside time to visit the funded departments, build relationships, and gain the necessary insight into the status quo and needs of the departments before sitting with their colleagues on the Fund's various committees to make decisions around annual budgets and expenditure. This work has created close links between the minerals industry and the minerals education departments as well as an awareness of each other's requirements. This ensures the ongoing relevance of the teaching taking place.

The ultimate beneficiaries of this support are the 5625 undergraduate students registered in mining, metallurgical, and chemical engineering (with minerals processing) and the geological sciences in the nine funded institutions, 70% of whom are black African students and 36% of whom are female (2018 figures). We graduate more students in these disciplines than the rest of the English -speaking world. This is, however, not only a 'numbers' game – the industry also requires graduates equipped to deal with its technical and management challenges. In addressing both these requirements, the METF is key in ensuring a supply of high-level technical skills necessary for the transformation and viability of the South African minerals sector.

The Fund is extremely grateful for the contributions and participation of its members, on whom its sustainability depends.





President: 2000-2001

Larry Cramer reflects on the key role of education and learning

Larry Arthur Cramer

I believe the Institute has an important part to play assisting young students to complete their studies and become productive members of the industry.

I had the honour of being President of the Institute from August 2000 until July 2001. It is a year that I often remember quite fondly. When I reflect upon the Institute and its mission as well as the challenges facing South Africa now and in the coming years, I keep coming back to the important role of education and learning. Indeed, the thread that runs through the many SAIMM key functions is one of educating the professional in the mining and metallurgical industries of South Africa. The networking that one achieves through participating in the many activities of the SAIMM contributes to the sharing of talents, experience and ideas; after all, if you don't know the answer or how to approach a problem then perhaps you know someone who does. The many conferences, symposia, and technical papers presented and organized by the SAIMM Council make a huge contribution to the database of knowledge available to those active in the industry; there is a wealth of knowledge in past SAIMM Journals and the papers presented at SAIMM technical conferences. Many a new idea has grown into a commercial success from the small seeds shared at such SAIMM-organized events. In addition, the revenue raised by the SAIMM through technical conferences continues to fund the bulk of its activities and as such these are critical to it and its core function of educating the professionals in the industry.

The mining and metallurgical industry has contributed greatly to the wealth of Southern Africa and to the living standards of its people. It has provided incomes for hundreds of thousands of men and women for more than 100 years. The capital created from these industries has been reinvested in manufacturing and many others areas of the economy. Through the taxes the industry has paid there have been many schools, clinics, universities, and hospitals built to serve the population. Unfortunately, the commodities business is often cyclical, which leads to difficult lean years and only occasionally to very profitable years. This is difficult to manage but long-term success lies in good capital management and technical innovation to drive down production costs. This needed technical innovation only comes from well-educated professionals in the minerals field. Thus, a great deal of

the success of the industry relies upon the education, experience, and professionalism of its technical people; the SAIMM is intimately involved in producing such people and thus has a significant role to play in the success of South and Southern Africa.

I believe that an important part of that role is to assist young students to complete their studies and hence become productive members of the industry. To that I end I was pleased to be able to establish the SAIMM Scholarship Trust Fund during my term as President. The fund is a registered non-profit trust that enables the various university and technikon professors to provide key funding for students who need assistance in the years when it is difficult to obtain company bursaries. The funds remit is to focus on bridging the gap that many good students experience between their private funding and landing a bursary in their 3rd or 4th years. I still believe that this is a worthwhile cause and contributes to the success of many students that would otherwise be forced to drop out and seek less meaningful work. In the past 14 years of operation, the Fund has disbursed some R4.07 million to worthy students; this is not insignificant but there is the need for much more funding each year.

Sadly, the bulk of this funding over the years has come from the operating budget of the SAIMM. I am thankful for the Council's support in this worthwhile endeavour. I am, however, rather disappointed in the support received from professionals in the industry and individual members of the SAIMM. We could more than double our annual distributions to students in need if each member of the SAIMM was to give only R200 per year to the Fund. Given that this contribution is also tax deductible, that is surely not too much to ask of the Institute's members.

When one considers the importance of education and the minerals industry to the success of Southern Africa, I believe every member should be motivated to do their part and support the SAIMM Scholarship Fund every year. Our members are successful and employed in well-paid jobs in the industry; they should be helping the next generation of students to become contributing members of society as well. *

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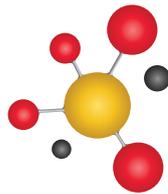
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President: 2005-2006

The more things change, the more they stay the same... 'Plus ça change, plus c'est la même chose'

Willem Hendrik van Niekerk

The World Bank has estimated that in 2015, 10 per cent of the world's population lived on less than US\$1.90 a day, down from nearly 36 percent in 1990. They also estimate that in 2015 there were still 736 million people living on less than \$1.90 a day. We need significantly more progress, and soon.

Big changes, in both number and impact, have happened over the last 25 years globally, as well as in South Africa – politically, socially, economically and technologically. I don't plan to discuss all of them, but rather highlight a few and how I personally experienced them.

From an economic point of view, let me start off by contrasting how much goods and services cost then *versus* now. I commenced my metallurgical studies at the University of Pretoria in 1978. In 1979, I received an Iscor (ArcelorMittal South Africa today) bursary of about R1 300 in cash that covered everything, including residence, tuition, and textbooks. Also included as part of the bursary were medical and pension contributions from Iscor. A doctor's visit cost less than R5, but I still had to make the 'large' co-payment of R0.50 – enough to fill the tank of my 50 cc motorbike with petrol. Before you think I am a geriatric – which I probably am – and therefore assume inflation can explain all of this, let me also remind you it was still the days of the mighty rand at about R0.85 for US\$ 1! Still, it remains a miniscule amount if you contrast it to what I pay today, even in real prices. I now live in the USA and work for Tronox, one of the leading global TiO₂ pigment and mineral companies. Annual tuition fees at a private university are currently about US\$35 000, and for public universities (only for students living in that state) they are about US\$10 000, and a visit to the doctor costs more than US\$200. You can make the calculations in rand terms – the exchange rate currently fluctuates between R14 and R15 for 1 US dollar.

These two examples clearly demonstrate the huge impact of inflation, and as a consequence, exchange rates, over time.

Politically, much bigger changes have taken place. In South Africa, for example, in 1978, due to the discriminatory apartheid regime, there were no black

students in my class. In fact, I think with the exception of a small number of postgraduate students, there were no black students at all at the university. Also, in those days, females were not encouraged to study engineering; the only female in our final year class photograph was the secretary of the department. Today, to the best of my knowledge, the majority of students at UP are black, and the number of female engineering students is significant.

If we look specifically at 1994, when the Institute was 100 years old (only 25 years ago), the world wide web (internet) was born, Yahoo and Amazon (market capitalization today of about \$1 trillion) were founded, and we watched movies on VHS (the now-outdated DVD wasn't even invented yet). For us South Africans, a much more significant change occurred: after three centuries of white rule, Nelson Mandela became South Africa's first black president on May 10, 1994.

Socially, big changes have also occurred. Consider, for instance, the world's biggest social challenge—poverty. If we look just at extreme poverty (people living at less than US\$1.90 per day on a 2011 PPP basis), the World Bank estimated that in 2015, 10 per cent of the world's population lived on less than US\$1.90 a day, down from nearly 36 per cent in 1990. That is huge progress, but they also estimate that in 2015 there were still 736 million people living on less than US\$1.90 a day. We need significantly more progress, and soon.

On a totally different topic, but very much part of our lives today, is the birth of social media, such as Facebook, Instagram, Twitter, during the last part of this era. I personally only use LinkedIn for professional purposes, but can fully see the benefits of social media.

Technologically, we have probably seen even bigger changes over the last 25 years, compared to those in the economic, political and social spheres. We are already talking of the 4th industrial revolution, which has brought

us concepts, such as 5G telecom networks, the Internet of Things, artificial Intelligence, big data, robotics and many more similar cyber-physical systems that are controlled through the application of computer-based algorithms. The digital revolution!

Buckminster Fuller, creator of the 'Knowledge Doubling Curve', observed that, until 1900, it took about a century for human knowledge to double, whereas today, human knowledge is doubling about every year. Furthermore, according to IBM, it will double every day in the not-too-distant future. Scary!

Strangely enough, however, given all these significant changes, to me it feels like not much has changed in our industry during my career. I am talking purely from a technological point of view as the economic, political, and social changes are clearly visible. I am not a mining expert so I will not comment on mining technology, but being a pyrometallurgist working mostly in the steel industry during the earlier part of my career, and now in the TiO₂ industry for the last 12 years, it is my view that very little has changed. Yes, we use state-of-the-art control systems, incorporating advanced process control algorithms, condition monitoring, building bigger and more efficient plants, and speeding up processes, to continuously drive down costs while improving output and quality. Simultaneously, we are developing new materials and alloys that are stronger, lighter, tougher, more heat resistant, and better equipped to work under extreme corrosive conditions, etc. So clearly, there are many advances in the metallurgical industry.

But, the main process route for steelmaking today is still that of the coke oven/blast furnace combined with oxygen steelmaking. The more modern scrap and DRI melting electric arc furnace route is also getting long in the tooth. The first equivalent of the blast furnace process, which was developed by the Chinese, dates back to centuries BC, and the first 'modern' blast furnaces in Europe were

already operating in the 13th century. The huge breakthrough of using oxygen (LD/BOF) rather than air (Bessemer) to make steel was developed in 1948, which is relatively recent, compared to the blast furnace. To the best of my knowledge, direct steelmaking – from iron ore to steel in one vessel – remains a commercial dream.

In the TiO₂ industry, changes are also happening quite slowly. There are two main process routes by which to make pigment – the chloride and sulphate processes. Each generates about 50 per cent of the global production. The original sulphate route was commercialized in the 1920s, and the newer chloride route in the 1950s. Many have tried, but there are still no alternative commercial processes operating successfully at scale today. In fact, China is only now adapting the chloride route. The most advanced new process is the Argex process being developed in Canada, but the jury is still out on that one.

I think that you will agree with me that change happens every day, at an ever-increasing pace. So fast, in fact, that it is difficult to keep up with all the new technologies, software, applications (apps) on smartphones, or stay abreast with the political changes, such as Brexit, global trade wars, nuclear treaties, etc. But on the other hand, many of the challenges we face seem to be the same challenges previous generations faced. In metallurgical processing, we have the exact same targets as when I finished university 40 years ago: we strive to make processes faster, at lower costs, with higher yields and recoveries. The objective is to be as efficient as possible.

Of course, we may use all the modern tools mentioned above, and yes, we have made big strides in achieving many of our goals, but it seems to me that the more things change, the more they stay the same. Or as Alphonse Karr, editor of *Le Figaro*, the person who coined this phrase originally, stated in 1849: 'plus ça change, plus c'est la même chose' *



There were no black students in my class. In fact, I think with the exception of a small number of postgraduate students, there were no black students at all at the university. Also, in those days, females were not encouraged to study engineering; the only female in our final year class photograph was the secretary of the department



President: 2010–2011

The transition to democracy and its impact on SAIMM and the mining and metallurgy industry

Gys Landman

The Institute has proved to be vibrant and dynamic and continues to maintain its relevancy by being open to change but staying true to its aims as required by its members who are the technical and economic professional bedrock on which the mining industry of Southern Africa stands.

I view myself most privileged to have been involved with the SAIMM since I graduated as a mining engineer in the mid-eighties. During this period many dramatic changes took place in both the South African mining environment as well as on the global mining stage. The most memorable being South Africa's transition to a constitutional democracy 25 years ago with a constitution which stated that South Africa belongs to all who live in it. I became President in August 2010 at a time when the once great South African mining industry had reached a tipping point and had entered a dramatic period of decline. My tenure began in the wake of the 2008 Global Financial Crisis when the consequences facing the global mining industry generally and the South African sector specifically, were only just manifesting themselves. It was to be a difficult year of office.

For those involved in South Africa's mining industry the transition to democracy implied that all the potential value contained in our mineral wealth should be utilized to the benefit of all citizens. Immediately after the change in government in 1994, the process of transforming the mining industry began, with all stakeholders entering into what became a seven-year consultative process to find common ground as to how this could happen. This resulted in the promulgation of the Minerals and Petroleum Resources Development Act (MPRDA) in 2002. The first Mining Charter was signed in 2004 between the three major constituencies of the industry, organized labour, industry, and government. The Charter was a collaborative, extra-statutory accord as to how the industry was to be managed into the future. However, the spirit of cooperation that followed was not to last and relationships between the key players in the industry started deteriorating rapidly.

Riding the commodities boom in 2002, the South

African mining industry showed encouraging signs, despite the contraction of the deep-level gold mining industry; however, resources and reserves were progressively depleted after sixty years of the most competent and adventurous mining the world had ever seen. The decline in the gold sector was initially offset by platinum as the new millennial metal substituting for gold and investment poured into the PGM sector. However, this new optimism and spirit in mining industry's growth was choked by the policy uncertainty that followed the questionable implementation of the MPRDA and Mining

Charter and new investment in the industry all but dried up. This led to hesitancy to invest in infrastructure development such as expanding harbour and rail capacity for exports, and water and electricity, which compounded the difficulties facing the industry. A new threat arose for the industry when the nationalization debate started in earnest. This was an entirely new challenge for a gutsy South African industry that had successfully overcome huge technical challenges and led the world in mining innovation. The nationalization challenge was an offshoot of a global problem facing the mining sector, the sentiment of resource nationalism sweeping through the emerging

economies as communities and governments demanded a greater share of what they saw as the fabulous fruits of mining after decades of exploitation.

As incoming President in 2010, I was tasked with navigating the Institute into an entirely new arena of battle for the mining industry. As a technical institute, we neither understood well nor had the appetite to get involved in such a contest, but nevertheless, it was one we could not ignore.

I co-opted Mike Solomon, a Fellow of the Institute who had been involved in the policy process since 1992 and gave him the lead in the creation of a new function

The Mineral Economics Division initiated by Gys Landman is still active and has followed up with this work through a new programme, Economy Beyond Mining, which is actively working with industry and government to develop innovative approaches to mining and its contribution to a sustainable economy.

for the SAIMM, the Minerals Economics Division. His brief was to monitor and work ranging from the new threat of community activism and demands, from the more radical elements in the ruling party clamouring for nationalization of the mines, to be able to inform and educate the members of the Institute on critical developments in these areas. While there was some reticence from many of the Council members, justifiably nervous of getting involved in the politics of the industry, a study into the demands being made by communities and an analysis of the threat was approved and commissioned by Council in 2010.

The study was funded by the Royal Bafokeng Nation and several mining companies. The 300-page report, a collaborative effort involving some of the country's leading academics, was initially released at the Mining Indaba in February 2012 during the presidency of Dr Nielen van der Merwe. It was withdrawn for amendment to include an analysis of the ANC State Intervention in Mining Strategy (SIMS), which was 'leaked' at the Indaba on the same day that the report was launched. The revised report was released on 22 July 2012 and signalled in its opening paragraphs the volatile sentiments building up in the platinum communities on the Western Limb. It warned that the situation had 'the propensity to explode'. It criticized the fact that while the symptoms of impending violent unrest were quite clear, there was a failure of the collective leadership in government, industry and labour to deal with the issues giving rise to the problem. Response was swift and retributive. The Minister angrily castigated Solomon for his 'irresponsibility' and demanded a written apology. The Marikana massacre hit on 12 August 2012, less than a month after the release of the report and its warnings and the Institute's critics were silenced.

The importance of the social dimension of mining will increase in future and it is to be hoped that these aspects will increasingly be reported through the SAIMM. The importance of the social impact of mining on communities and its effective management has been illustrated vividly, particularly at Marikana, in the years following my presidency. The Mineral Economics Division that I initiated is still active and has followed up with this work through a new programme, Economy Beyond Mining, which is actively working with industry and government to develop innovative approaches to mining and its contribution to a sustainable economy.

As a result of the unfavourable investment climate that has crippled the South African mining sector as a result of the poor implementation of policy, many South African mining entities have migrated elsewhere and are looking towards the rest of Africa, Australia, Latin America, and North America for expansion. Previous presidents wisely changed the focus of the institute to embrace all Southern African countries and their mining industries to extend our relevance and influence.

The SAIMM governance structure has always been of great value to me. The SAIMM Council provide long-term guidance and vision, the Office Bearers committee interpret strategy while the Secretariat implement and execute. Office Bearers allow a President to be part of the strategy and execution for three years before serving as President. This reduces the risk of one person derailing the will of the SAIMM members during his or her presidency. I can only say that if anything of lasting value was achieved during my

tenure, it was due to the collaborative thinking of those who surrounded me.

One of the main aims of the SAIMM then and today is the dissemination of new mining knowledge and know-how and, in the process, bringing leading technology innovators and thinkers together by establishing forums, colloquia, and conferences. Three concerns emerged during my time as President: Firstly, mining technology development in South Africa had been reduced by not only the demise of the Chamber of Mines Research Organization, but the mining technology development centres of big mining houses started moving to first world environments such as the USA and Australia. Secondly, the nature of mining technology itself was changing fast as the potential of the digital world became more apparent to mining. A third aspect is the management of the social impact of mining on communities and demands of host countries. As I have discussed above, the global trend at the time was resource nationalism, and the potential nationalization of mines in South Africa was being fiercely debated within the ANC and the broader mining community.

To sustain the relevance of the SAIMM at the time, it was realised that the three aspects of activity needed attention:

- >> Sourcing of new mining knowledge,
- >> Digitization and easy access to the SAIMM Journal papers; and the
- >> Establishment of a minerals economic section to encourage more papers on sociology of mining, mining policy, changing economics of mining and environmental aspects needed focus.

It was also important to make membership of the SAIMM more attractive, especially in the countries surrounding South Africa. A target of reaching a membership of more than five thousand was set. as the aim was to stimulate sustainability of mining not only from a strictly technical point of view, but also promoting mining as an essential human activity.

The strengthening of the new SAIMM branches in Southern Africa helped to secure more inputs for conferences and papers. Relations with all universities in Southern Africa with mining or related programmes were strengthened. Useful relationships with other mining and metallurgy institutes in the English-speaking world and elsewhere have been established. This activity I believe has broadened the net to obtain quality submissions for the conferences and publications of the SAIMM.

To improve accessibility to SAIMM papers and journal material, a programme of digitalization of journal content began. It was believed that this material should be freely available and for this reason these papers have become part of the global OneMine Database of technical papers. In addition, the user friendliness of accessing the SAIMM collection of papers improved.

My presidency of the SAIMM was a highlight of my career and it was a privilege to serve the professional mining, metallurgical, chemical, and other engineers serving the mining industry in Southern Africa. The Institute has proved to be vibrant and dynamic and continues to maintain its relevancy by being open to change but staying true to its aims as required by its members who are the technical and economic professional bedrock on which the mining industry of Southern Africa stands. *



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President: 2011-2012

There was a time

Nielen van der Merwe

Everything was here: the challenge, full support of the industry, funding, laboratories, full access to information, everything a researcher could wish for...

There was a time, more than 25 years ago, when South Africa was the undisputed leader in mining research. Only rightly so, the most challenging mining conditions in the world needed to be attacked by the best research in the world. The mining industry deserved the support of the best efforts of the best researchers in the world. And that support was there.

A hard-core researcher only needs a few things to be successful. Internally, that person has to be plagued by insatiable curiosity backed up by some measure of intelligence, a lot of patience and perhaps most importantly, perseverance. Albert Einstein said of himself 'I think and think for months and years. Ninety-nine times, the conclusion is false. The hundredth time I am right'.

Externally, there has to be a challenge, a laboratory, and funding. In South Africa, the challenge was certainly there. Serious research really started in reaction to the Coalbrook disaster, which was at least in part due to the lack of a formal design procedure for coal mine pillars. That was the initial challenge.

Suddenly, after the disaster, funding for research was available. Funding attracted bright young researchers, mainly from Europe, to come to South Africa. Everything was here: the challenge, full support of the industry, funding, laboratories, full access to information, everything a researcher could wish for.

The most important outcome of the initial drive was that the Chamber of Mines Research Organisation was born. The experienced researchers there taught the next generation and a magnificent upward spiral was set in motion. Bright young locals joined in. The whole mining world knew about COMRO, for decades the most respected brand name in mining research.

As a measure of the success and quality of work performed by COMRO, consider that South Africans (or at least people who worked here) won the Rocha Medal, awarded by the International Society for Rock Mechanics to the best rock engineering PhD thesis in the world, six times – more than any other country in the world. No small feat, considering that anything between five and seven hundred rock engineering PhDs are awarded annually.

When the Chamber of Mines Research Organisation was born, experienced researchers there taught the next generation and a magnificent upward spiral was set in motion. Bright young locals joined in. The whole mining world knew about COMRO, for decades the most respected brand name in mining research

Then, exactly twenty-five years ago this year, in a move that must have seemed sensible at the time, the Chamber of Mines transferred COMRO to the CSIR. In several respects this was an understandable move. Research is not the core business of the Chamber of Mines, while transferring the unit to the CSIR placed it in the heart of South Africa's national research entity.

What could not be foreseen was the impact of the loss of intimate contact between mining operations and research. Suddenly, the researchers were external, no longer part of the family. Such was the strength of COMRO that the momentum

carried the research effort for some time, but it could not be sustained. Some of the senior researchers had difficulty adapting to the new environment, finding it restrictive compared to the previous milieu. Many left the organization.

Gradually, it all slowed down. Numbers started decreasing. The mining research unit, known as Miningtek, lost its divisional status in the CSIR. Now it was even further removed from the heart of the industry. By 2013/14 it had all but disappeared.

Meanwhile there were attempts at recreating a national research entity but none were successful. They could not excite the industry and without enthusiastic industry support they were doomed to failure.

Research continued to be done but it was fragmented. Smaller and larger private consultants were awarded research contracts and the universities also continued. What was lost was the coherence of the efforts and, very importantly, the fundamental research upon which applied research depends.

The younger researchers no longer had the giants to lead and to coach them, to have tea with, to say good morning to in the passage. It had all come down to individual efforts of a few, scattered and working in isolation. Significant and solid results were still produced but it has to be remembered that consultancy is a commercial activity where the ratio of time spent on a project to the time allocated by the contract is of prime importance. There was no more room for Einstein's ninety-nine first attempts.

The mining industry as a whole is also not in the same good shape it was in 1993. Over the last twenty-five years output of almost all our minerals steadily declined, for a number of reasons. But the complexity of the problems to be dealt with - in the case of rock engineering it is mining-induced seismicity - is not correlated to the size of the industry.

Up to this point, we are not looking at a great twenty-five years that has gone by. The industry is in decline with the bottom not yet in sight and we have lost arguably the greatest mining research entity the world has ever seen.

So, is everything lost? The answer is a resounding no!

No matter which way we look at it, as long as there are people on this Earth there will be material things that they need and perhaps more importantly, things that they just want. Most of those things are minerals-based. There is only so much of any mineral in our Earth and we still have substantial reserves of that. It is still here beneath our feet.

Some point to political interference as one of the main reasons for the industry's decline. That may well play a part, but let us remember that the interplay with politics and society has always been part of mining. Just think back of Nicolaas Waterboer and what happened to his diamonds, look at the shape of the border between the Free State and the Northern Cape in the vicinity of Kimberley, consider the Anglo-Boer War. The industry always survived, at least in part due to the fact that only the brave and adventurous are attracted to mining in the first place.

Perhaps we are still in the melting pot with safety, general benefit of the people, and environmental concerns being more important than ever before. We have to mine in a different way, we have to become cheaper and safer and spread the profits wider. The fact that we can no longer mine in the same way we did twenty-five or fifty years ago does not mean that we can no longer mine, we just have to find new ways.

Where will those come from? Research, of course, followed by site-specific adaptation of generic results. But the adaptation cannot happen if the generic results are not in place. We simply need the fundamental work to be done if we are to survive and for that to be done efficiently, we need a national research organization of some description.

This year, the Rocha Medal was once again awarded to a South African. For the first time, not to a person engaged in full-time research but one who did his work while engaged in the industry at the forefront of operations. We still have the insight and the tenacity to produce excellent results. Just imagine what we can do if we had something like the old COMRO, but addressing today's needs in today's manner.

It may already exist. In 2016 the old Miningtek was revived in a different form, now with state support. They address different needs in a different way than before. Some of the senior researchers from the old Miningtek are back in research. Will this work? Are crystals beginning to form in the melting pot? Time will tell.

Yes, there was a time... and there will be a time... *

Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world.

Albert Einstein



President: 2016-2017

'I am confident that the SAIMM will survive and thrive in the next 100 years'

Cuthbert Musingwini

I am confident that the SAIMM will survive and thrive in the next 100 years and continue to be a great organisation.

It is always easy to reminisce about the past, but it can be quite a daunting challenge to envisage what is likely to happen in the future. The journey of the SAIMM started in 1894 but much has transpired since then. Past Presidents of the institute have come and gone, but the Institute has remained steadfast. If each President's tenure is plotted on the historical timeline of the Institute, each tenure would appear as a mere dot along that timeline. However, these dots connect in a special way. The connection is in the SAIMM's leadership strategy, which ensures continuity from one President to the next, and each President selflessly executes a collective strategy during his or her tenure. This is the DNA behind SAIMM being effective as a professional organization, which has ensured its existence for 125 years. It is this DNA which will ensure that the SAIMM will outlive the next century.

I had the privilege of serving the SAIMM as President during the 2016/2017 financial year when I succeeded Professor Rodney Jones. I had previously served the SAIMM as its first black Honorary Treasurer for the two financial years, 2014/2015 and 2015/2016. I can now reminisce about the past, despite my tenure being just a dot on the SAIMM's historical timeline.

My term of office was characterized by the continued economic challenges experienced by the global mining industry post the global financial crisis (GFC) of mid-2008. Due to continued depressed commodity prices that slumped on the onset of the GFC, the South African mining industry experienced job losses. The post-GFC period led to some mines either closing or put on care and maintenance. As with other kindred professional organizations within the minerals sector, the SAIMM also bore the brunt of the economic downturn as some of our members were sadly retrenched and consequently, could not afford to pay their membership fees nor

attend conferences organized by the SAIMM. As a caring organization, the SAIMM assisted its members in financial distress to retain their membership. Despite this challenge, we were able to surpass our target of reaching 5000 members by 2020, due to amongst other initiatives, our Membership Incentive Programme in which members receive a series of benefits. Our membership distribution remained at approximately 90% of members residing within the Southern African region.

Despite the economic downturn, we managed to turn around our fortunes during the 2016/2017 financial year. The deficit of *circa* R6 million reported for the 2015/2016 financial year was reduced greatly in the 2016/2017

financial year to around R63 thousand, mainly due to the austerity measures we implemented to keep the institute financially afloat and survive the short term in order to thrive in the long term.

Another highlight during my term pertains to the prestigious SAIMM Journal. The Journal's impact factor improved by about 26.5%, indicating that as an institute our strategy of publishing more papers of a higher quality was paying dividends. The

dual electronic and hard copy distribution of the Journal was continued with the hope of gradually phasing out hard copy distribution of the Journal in line with the institute's strategy of becoming totally digital in line with the 4th Industrial Revolution developments, and becoming open access with our technical publications.

The SAIMM continued with its support for the Young Professionals Council (YPC), which has been delivering positive outcomes. This ensures that the future of the SAIMM is secured by tapping into the generation of the younger professionals within SAIMM who will continue to build the on the SAIMM's legacy going forward. The SAIMM continued its support for regional branches to ensure growth of the SAIMM's footprint within the

I can now reminisce about the past, despite my tenure being just a dot on the SAIMM's historical timeline.

country and regionally within southern Africa.

Locally, the SAIMM maintained its interaction with kindred professional associations within the South African minerals industry. Internationally, the SAIMM maintained its participation in the Global Mineral Professionals Alliance (GMPA), which culminated in the strengthening of this international collaboration by the signing of a Memorandum of Understanding (MoU) in February 2017, at the GMPA annual general meeting hosted by the SAIMM in Cape Town. The GMPA comprises the Australasian Institute of Mining and Metallurgy (AusIMM), the Canadian Institute of Mining, Metallurgy and Petroleum (CIM), the Institute of Materials, Mining and Metallurgy (IOM³), the Southern African Institute of Mining and Metallurgy (SAIMM), the Society for Mining, Metallurgy and Exploration Inc. (SME), and the Instituto de Ingenieros de Minas del Peru (IIMP). The picture below is that of representatives of the GMPA member countries present at the MoU signing ceremony.

The Engineering Council of South Africa (ECSA) is the statutory body in South Africa mandated with registering engineering professionals, while Voluntary Associations (VAs) such as the SAIMM are there to serve the interests

of their members. ECSA and VAs have historically co-existed and enjoyed a symbiotic relationship. However, as it sometimes happens in history, relationships occasionally go through challenges, often coming out stronger. During my term of office, seven VAs, including the SAIMM with support from the SAIMM council, took ECSA to court to challenge the legitimacy of the new ECSA Council as there were alleged irregularities in the appointment of the Council in September 2016. At the time of writing this article the matter had not yet been concluded by the courts, but it is my desire that the relationship between ECSA and VAs (including the SAIMM) will be resolved amicably.

All I have said is in the past. So, what does the future hold for the SAIMM? It is a matter of crystal ball gazing. I am confident that the SAIMM will survive and thrive in the next 100 years and continue to be a great organization. This possibility is underpinned by initiatives that the SAIMM is pursuing. These include the YPC, Membership Incentive Programme, support of regional branches, digital transformation, and the more recent rebranding initiative. Only time will be the judge of my optimistic future perspective of the SAIMM. ✱

**GMPA (GLOBAL MINERAL PROFESSIONALS ALLIANCE), 3 FEBRUARY 2017,
SOMERSET WEST, SOUTH AFRICA**



Left to right: President, CIM, Michael Winship; President, SAIMM, Cuthbert Musingwini; President, IIMP, Antonio Samaniego; Manager, SAIMM, Samada Moolla; President, SME, Timothy Arnold; Chief Executive, AusIMM, Miriam Way; President, IOM³, Martin Cox; Executive Director, SME, Dave Kanagy; Past President, SAIMM, Rodney Jones



President: 2013-2014

Base metals production in Southern Africa provides the common thread between all the country branches in the SAIMM

Marek Dworzanowski

Because of the diversity and complexity of the South African mining industry, innovation has become a prerequisite to survival.

During my term as SAIMM President, 2013 to 2014, the South African mining industry witnessed the longest strike in its history, namely the 5-months strike in the platinum industry. It was thought that the strike would result in a substantial increase in the platinum price and cause a serious supply deficit. However, neither happened. The platinum price is now below US\$800 per ounce and more than half of the platinum operations are operating at a loss, threatening the survival of the industry.

At the same time the global mining industry was also experiencing uncertainty, with decreases in most commodity prices. However, despite all these negative factors, the SAIMM continued to grow in membership numbers and in many other areas. The relationship that the SAIMM had with its sister mining industry institutions continued, one of the best examples of this is the now well established MINESAFE conference on industry health and safety. The Global Minerals Professionals Alliance (GMPA) came into being during my term and I hosted the first GMPA meeting in Cape Town in February 2014. The GMPA consists of the SAIMM, the AusIMM (Australasian Institute of Mining and Metallurgy), the CIM (Canadian Institute of Mining, Metallurgy and Petroleum, and the SME (Society for Mining, Metallurgy and Exploration). This alliance has given the SAIMM a firm global footprint, thus allowing members of the SAIMM to have national and international benefits. The country branches of the SAIMM during my term were Zimbabwe, Zambia, DRC, and Namibia. These branches have grown in stature and now Botswana has been added. In terms of South African branches, the Northern Cape Branch was added during my term and all these branches continue to thrive.

Because of the diversity and complexity of the South African mining industry, innovation has become a prerequisite to survival. Certainly, over the last 25 years this has become more important than ever. The South African gold mining industry started with mines at relatively shallow depths and with high feed grades, making them highly profitable. Initially the mines were located in the Witwatersrand area but innovative geological exploration led to the discovery of the Carletonville, Klerksdorp, Free State, and Evander goldfields. It is hard to imagine now that back in 1970

South Africa's gold production was a staggering one thousand ton, about 35 million ounces.

As mining had to be deeper, again the development of new mining methods was instituted. We are now heading for depths in excess of 4 km, well beyond any other deep-level mining globally. With the decrease in gold feed grades, metallurgists also had to look at more cost-effective gold processing routes. This is where the carbon-in-pulp /carbon-in-leach (CIP / CIL) technology took over from the traditional leaching / filtration / clarification / cementation technology. Although the CIP / CIL technology was not pioneered in South Africa, the development of carbon elution, carbon regeneration, and gold electrowinning was mainly as a result of South African innovation. With the escalating costs that the gold mining industry faces, mining methods will need to be re-examined. The importance of tailings re-treatment has increased substantially over the last 25 years, given that the costs involved are significantly lower than deep-level mining.

The South African platinum mining industry started with the mining and processing of the Merensky Reef. Initially the UG2 Reef was not considered because of metallurgical challenges. However, as the Merensky Reef reserves started to dwindle, the mining and processing of UG2 Reef became a necessity. Again, South African metallurgists came to the party and developed innovative approaches to the concentration and smelting of UG2 Reef. More UG2 Reef is now processed than Merensky Reef but over the last 25 years the mining and processing of Platreef has become significant. The Anglo Platinum Mogalakwena Platreef operation is the only large-scale open pit mining operation in the platinum industry and is by far and away the lowest cost producer. The platinum industry is being forced to reduce costs substantially in order to survive. Innovation around mining and processing will be at the forefront.

When the global consumption of stainless steel and speciality steel increased significantly after the Second World War, the opportunity of producing ferroalloys in South Africa was identified. The design of submerged arc electric furnaces for the production of ferromanganese

and ferrochromium was developed in South Africa. During the last 25 years the application of DC arc electric furnaces for the treatment of fine chromite for the production of ferrochromium and then for the smelting of ilmenite to pig iron and titanium slag was pioneered in South Africa.

When it comes to hydrometallurgy there are also significant achievements to highlight. The Rand Refinery is the world's largest gold refinery and the technologies employed are efficient and innovative. In the platinum industry there are three precious metals refineries with capacities in excess of anything else globally. There have been significant technology changes over the years within these refineries, again mainly locally conceived.

The South African mining industry has mainly been associated with gold, which is understandable given that it was the gold mines of the late nineteenth century that were really the beginning of the South African mining industry as we know it. But base metals have never received any prominence even though they have been contributing for many decades. Copper, nickel, lead, and zinc are produced in South Africa. Palabora Mining Company produces copper, Nkomati Nickel produces nickel, and Black Mountain produces copper, zinc, and lead. In addition, copper, nickel, and cobalt are produced as by-products from the base metals refineries associated with the four main platinum producers.

If we broaden our view of base metals to Southern Africa then we have a global-scale industry when it comes to copper and cobalt. The Copperbelt that spans Zambia and the Democratic Republic of Congo (DRC) is world class. Although mined tonnage does not compare with the copper porphyries of North and South America, the higher copper grades mean that actual copper production is not that far behind. Zambia and the DRC are 5th in global copper production when their output is combined. Beneficiation of copper ores, sulphide and oxide, in Zambia and the DRC is well developed with most of the copper being produced as cathode metal via electrorefining or electrowinning. There is a significant diversity of copper concentrators, smelters, and refineries within Zambia and the DRC. When the Nchanga tailings leach complex in Zambia was originally built close to 40 years ago, it boasted the world's largest copper solvent extraction and electrowinning plant. At Ndola in Zambia is one of the world's few refineries processing copper refinery anode slimes, producing selenium, tellurium, silver, and gold by-products.

Within the Copperbelt we also have the world's largest deposit of cobalt. The cobalt is associated with the copper. There are a number of cobalt plants which beneficiate oxide and sulphide cobalt concentrates, produced from the copper / cobalt ores, into cathode metal via electrowinning. Zambia and the DRC produce about half the world's cobalt. This has become more significant now given the potential consumption of cobalt in new battery technologies. There are nickel mines in Botswana and Zimbabwe and there are zinc, lead, and copper mines in Namibia. This all highlights the extent of base metals production in Southern Africa and this provides the common thread between all the country branches in the SAIMM. This has been used to promote increased SAIMM membership in the country branches and the SAIMM biannual Base Metals Conference has grown in stature as a result of the contributions of the country branches. Along similar lines the Namibia country branch has established a focus for uranium mining and the Botswana country branch has established a focus for diamond mining.

The South African coal mining industry is very often

portrayed as a poor cousin to the gold and platinum sectors within the South African mining industry. And more often than not when coal is highlighted then it is around the supply of coal to Eskom. What is not appreciated is the true contribution of coal to the South African economy and the significant size of the industry. This has changed significantly over the last 25 years, with coal assuming a far greater importance.

The majority of coal mines are still based in Mpumalanga. These mines supply numerous Eskom power stations, Sasol's facilities in Secunda, and they produce a significant amount of export thermal coal. Limpopo has the very large Grootegeluk coal mine supplying the Matimba power station and also now the new Medupi power station. In the near future the centre of gravity of the South African coal industry will shift from Mpumalanga to Limpopo as the coal reserves are depleted in Mpumalanga. However, this shift will not be a simple case of more of the same, just a different location. The Limpopo coalfields are very different to those in Mpumalanga in terms of mining and in terms of coal washing. Whilst Grootegeluk is leading the way, new mining projects in Limpopo will require different approaches and future developments will need innovation and extended project execution. Coking coal required by the South African iron and steel industry is largely imported. Some coking coal is produced from the Limpopo coalfields but only on a limited scale. Development of coking coal resources in Limpopo is an important objective for reducing coking coal imports and adds further incentive to the more rapid development of the Limpopo coalfields.

Thermal coal produced in South Africa is of two types. The lower grade thermal coal is supplied to the Eskom power stations. The higher grade thermal coal is exported through Richards Bay to numerous global markets. The difference between these two types has sparked debate over the 'strategic' value of coal in South Africa over the last 25 years. There should be a secure supply of coal to the Eskom power stations but at the same time coal mining companies will obtain greater profits from export coal. Therefore, as the shift from Mpumalanga to Limpopo progresses, this aspect of Eskom supply versus export will become even more important to balance correctly in terms of the future sustainability of the South African coal mining industry.

The South African mining industry has changed significantly over the last 25 years. The size of the industry has reduced in terms of production and the size of the labour force. The industry operating costs have soared, particularly electricity and labour. Highveld Steel and Vanadium, the ferroalloy producers, and the aluminium smelters were all based on cheap electricity. With Eskom having had to increase the cost of electricity substantially, this has resulted in either complete closure and or a reduction in capacity. The gold and platinum mining sectors have relied heavily on cheap labour. With the increases in labour costs the size of the South African mining industry labour force has reduced by hundreds of thousands over the last 25 years. There is also the question of regulatory certainty, which has stalled meaningful capital investment into the South African Mining industry. To survive, the mining industry will have to adapt and be innovative. The advances in technology, IT, and communications have not been fully embraced and this will definitely be key to reducing operating costs. *



President: 2014-2015

125 Years? Only feels like 25!

Jim Porter

I was born 1 month and 1 day before Steve Jobs –
at least I beat him at something!

It has been a tough few years in mining, so my motivation for getting up in the morning has taken a bit of a hammering; but minds (and motivation) are wonderful things... and memories are so resilient and (luckily) quite selective. On first reading the letter from our Past President, inviting a contribution for this 125-year commemorative issue of the SAIMM Journal, I naturally consulted my memory. However, there was a quick and rude realisation that with age, retrieving memories was even harder than getting up in the morning. In addition, the introspection was potentially futile without a clear idea of a topic in terms of the invitation: It should be focused on my personal recollections of an industry over the last 25 years. I decided that only looking at my term as President was too narrow and my peers are much more able than I to recount more of the fundamental forces that have both driven and riven our industry over this period.

Selfishly, I am going to reflect on three experiences which are of interest to me (and from which I continue to learn) and I hope there is something in here of interest to the reader. But first a disclaimer: I am sure that like many others before me, one discovers that hindsight is a lens, which is, in fact, more like a kaleidoscope that both mixes and distorts personal perceptions of time, place, and the sequence of events. Those matters that I can recall about the industry are made, with humility, through this filter of 25 years.

Changing times

April 27th, 1994: You all know this date. I was the manager at what was then the East Mine of Western Deep Levels (now Tau Tona Mine). Election day was a great occasion and of global significance. I will never forget the atmosphere in the large, tented voting station that had been erected on the sports field of the hostel. The sense of occasion was palpable, a nervous tension. There were various visiting dignitaries, politicians, and executives – some of whom had worked at the mine in their youth. There was this unmistakable sense of expectation of what the future might hold – was this indeed the 'High Road'? (described by Clem Sunter,

Anglo-American Corporation, who was commissioned in the 1980's to prepare scenarios describing possible futures for the country.). Or, was this some other road to a very uncertain future?

Well, it was certainly not the future that had seemed likely during the vicious and violent days of unrest that prevailed on many mines for a while leading up to 1994. Instead, common sense had prevailed at a national and local level. I recall during this time and after the elections, that we were able to implement and achieve (amongst others) many small milestones of change.

- >> Adult Basic Education programmes
- >> AIDS awareness and community programs
- >> Removal of job reservation based on race
- >> Organisational and cultural change interventions
- >> Integration of mine sports and social programs
- >> Advancement of Black professionals in the technical disciplines

Looking back from today some seem almost naive in their simplicity, but at the time it was serious business. I for one felt good about being in an organization that was doing something to move forward on the 'High Road'. Where do we stand today 25 years on; is the job done? Clearly not. Our domestic mining industry has been a lightning rod for many historical ills, but the spotlight has moved on to new challenges. Not least of which is the contraction of our industry over the intervening years and the appalling toll that unemployment has taken on our youth and the foundation of civil society.

In 1994, my wife and I became South African citizens so that we could exercise our democratic rights in the country we had chosen to be the home for our growing family. We now observe with enormous pride how grandchildren from all sectors of our society interact at school, oblivious of what it was like 25 years go and naive of political machinations – for them, long may it be so. Now, 2019 presents another opportunity for voters to exercise their rights at the polling booth.

Miners can't type

May 6th, 1994: The Channel tunnel linking England and France officially opens. Fast forward 25 years and technology entrepreneur Elon Musk is challenging conventional norms with his Boring Company: Constructing tunnels with a finished cost of \$5000 per metre or less within their sights. Any shake-up to the mining 'norm' is welcomed because productivity in mechanized development has been on a slow disappointing decline globally over the past 25 years, despite huge advances in digital and material sciences.

To say that the technology change has been dramatic is an understatement.

Personal digital technology hardly existed 25 years ago — a niche, nerdy add-on to the lives of people and the operations of companies. Today, it stands at the core of many people's lives and most companies' businesses. Back then, you could still do OK without a computer. Today, you'd never think of being without a smartphone. And we're entering the era of even more ubiquitous computing with sensors on and in our homes and offices, machines, and bodies. I could not type 25 years ago!

The effects have been profound, both for good and bad. Nearly everyone you know, or need to know, is only a few clicks away. The world's news, information, and entertainment are at your disposal, interactive, on demand, in text, audio, and video. So much of what we know of the world, so much of what young people take for granted, didn't exist just 25 years ago. Moreover, literally billions of people who are alive today—45 per cent of the world's population, were not yet born 25 years ago.

The World Wide Web began to really take-off in 1994, with the release of the first successful mass-market browser (Netscape), but access is now almost considered a Universal Human Right. During this period, I invested my personal time in trying to understand how computers worked. I built my own, repaired other peoples' and learnt that DOS was not something you did at the miner's box. As a result of this new (non-mining) knowledge and in the latter part of the 1990s, I was fortunate enough to be offered the opportunity

to start a new company (GMSI – now MineRP) that played a significant role in the invention and implementation of digital technology in mining – this was before anyone had thought of 'Mining 4.0'.

As shown in Figure 1, by the late 1990s the gold industry was facing a crisis of a gold price in freefall. This created the pressure and motivation for many survival strategies. The broad re-structuring of the gold sector, delayering of management overheads, massive cuts in discretionary spending are examples. To this day these changes have impacted the operations of the SAIMM as the same process has run through the platinum sector.

One specific area of rationalization was technical services (geology, survey, sampling, planning and reporting functions). Someone that happened to be working on these issues was our current SAIMM President, Alastair Macfarlane. He identified inefficient silos of work and that this should be streamlined through greater multi-tasking and by removing the silos. However, to do this in practice was not about changing what people did, it was fundamentally about changing how people thought about doing their work. Something subtle also happened as a result of these interventions. There was the realization that mining was not a series of discrete activities or events but was, in fact, a process that lent itself to process analysis, design, and performance improvement. Technical services were about managing data – so bring in the computers.

In truth, big number-crunching computers had been used in mining for some time already, certainly from the late 1970s in finance, payroll, management accounts, *etc.* and in early geostatistics and 3D mine design and scheduling.

Eventually, the concept of Mineral Resource Management became the way to manage and report a company's mineral assets. However, the drawback was that many mines' technical data was on paper (in South Africa that is), very little was digital. Before any computer system could really be used to facilitate a change in how people worked, the whole process of data collection, storage, and manipulation had to be automated (digitalized).

In the space of five years the bulk of South Africa's gold

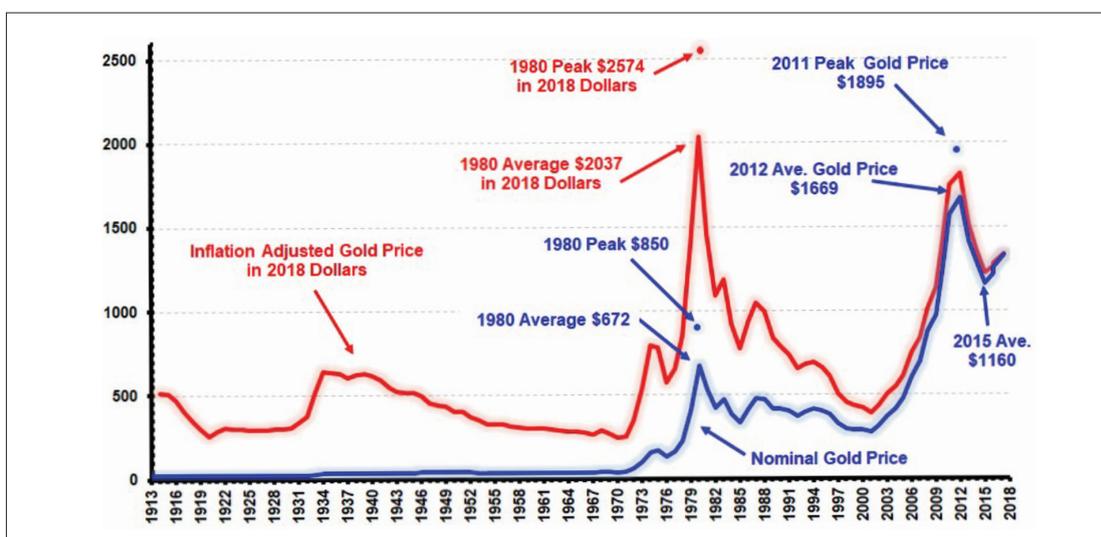


Figure 1—Gold Price

and platinum technical mining systems were digitalized and computerized. Multiple iterations of life of mine plans were now possible in weeks as opposed to one over the course of months. And I had learnt to type.

What is the stuff of the mining industry?

I am sure that other people contributing to this publication, like me, have lived through boom and bust cycles in the mining industry. They can be seen in the gold sector example of Figure 1, above.

For me, the resource industries (all 'stuff' comes from either the oceans, in the Earth or off the land) are only really driven by one thing. It is by far the most significant contributor over the past 25 years and certainly over my lifetime and career. It is population growth that drives many (if not all) of the factors that impact our daily lives. From overcrowding to climate change. Couple this with the cultural and social norm that creates the expectation that our children will always have more than the preceding generation. It is the definition of this 'have more' that, coupled with the population multiplier, drives consumption. Very often the mining industry must explain itself in terms of sustainability. I think this misses the point entirely. Somehow people must come to terms with the fact that to 'have more stuff' is ultimately not sustainable.

To fully grasp the impact, look no further than the following Figure 2, published by the United Nations. In merely one short lifetime (mine) the global population has surged from 2.77 billion (1955) to about 7.71 billion (2019), 2.8 times increase (178%) which is also set to grow a further 2.0 billion by 2050 - and that is the conservative estimate. In the past 25 years our South African population has ballooned by 16.9 million from 41.2 million in 1994.

So, the point I am trying make here is that over the last 25 years we see that:

- The growth of the world's population almost guarantees

that mining will continue to be a viable industry despite the changing legal, economic and social licenses to operate

- Sustained periods of economic stability since The Great Wars has created an expectation that more 'stuff' is available for successive generations
- Over the same period, there has been a significant number of people move out of poverty in to an economic space where they become consumers of 'stuff' (Ref: South Korea, Indonesia, Brazil, China, India)
- To date, the mining industry has always found ways to meet demand

In my mind there is a growing realization that the times must change, there is a need for a new type of miner and that the global population must accommodate new metrics and a new definition of 'enough stuff'.

In conclusion, I guess you are expecting me to declare myself a Malthusian? Not so. Little attention is paid to societal evolution and with it the maturity to handle the implications of a disconnected but networked society. Despite the current rise of nationalism and isolationist policies, I believe that the next 25 years of the SAIMM's long and distinguished existence will be marked not by how well the mining industry responds to yet more challenges, but how well we as people are able to respond to the growing realisation that health and happiness are not determined by how much 'stuff' we are able to consume. Social and individual happiness is NOT reflected in negative and destructive social media feeds nor by the rantings of political leaders with scant regards to the example they set for their electorate, but by how much 'stuff' we are able to save and re-use. A portion of what defines mental happiness, for me anyway, is knowing that what I do and what I can achieve - in whatever small way - does lead to the greater good. ✨

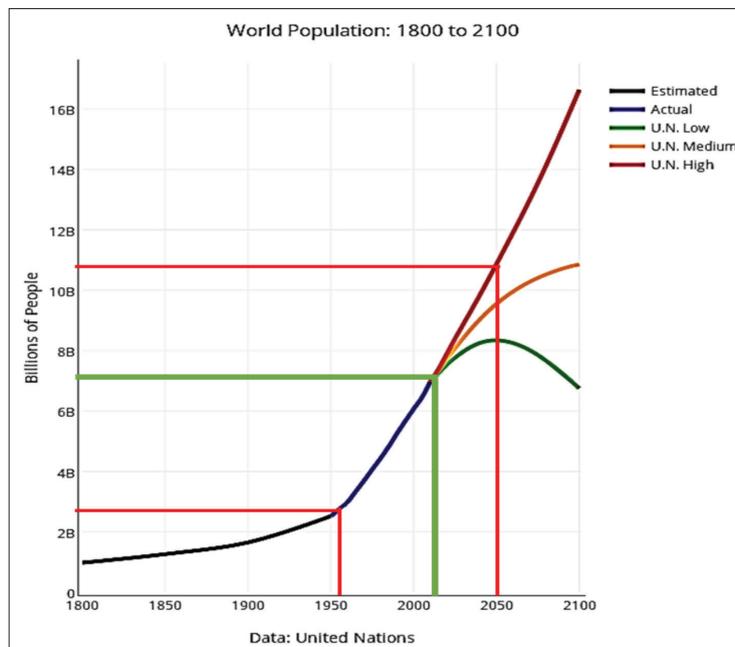


Figure 2—United Nation population projections



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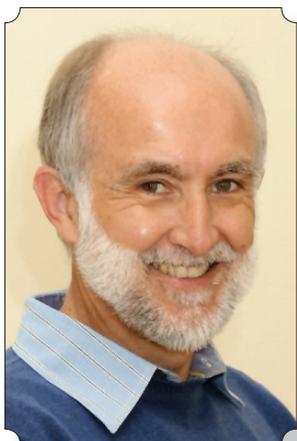
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President: 2015-2016

Continuity and change

Rodney Trevor Jones

Having our current and historical papers available on the SAIMM website has greatly increased how much they have been read.

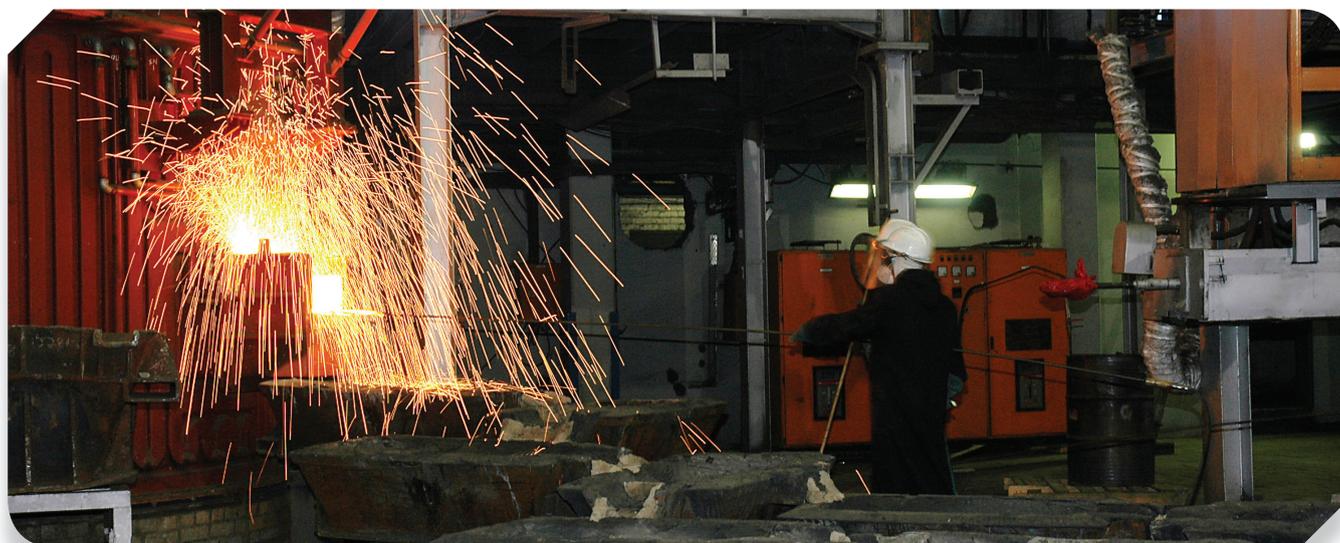
It is not like to think that if one of the founding members of the SAIMM were to visit one of our present-day meetings, they might bemoan the lack of bowler hats and neckties, but would recognise what was happening, and take part enthusiastically in discussing the technical issues of the day. Just as mountain streams have to change course in response to their environment, and forests lose some trees and grow new ones, yet visibly remain the same rivers and forests, so organizations need to change yet keep their essence the same. Continuity and change are both vital, and neither should dominate at the expense of the other.

Stability is fostered in the SAIMM by its progressive leadership structure where, every year, incoming people move from one role to another of increasing responsibility. The five-year period of office (from junior vice president, to senior Vice President, to President Elect, to President, to immediate Past President) encourages the sense of participating in a team structure that allows the delivery of long-term strategies. Previous

office-bearers are encouraged to remain active Council members.

One of the Council decisions I am proud to have played a part in was to make all of our journal and conference papers freely available via open access. Having our current and historical papers available on the SAIMM website has greatly increased how much they have been read.

The way in which the Journal of the SAIMM is distributed to members illustrates how we have embraced change while simultaneously retaining continuity. A monthly contents page (with hyperlinks to each individual paper) was e-mailed to members, starting in 2009, and has been a greatly appreciated service. In 2016, the full Journal was, for the first time, e-mailed to those who preferred to receive it electronically, while retaining the printed version for those members who preferred reading a paper copy. By the end of 2018, just over a third of SAIMM's members had responded to a questionnaire about their journal preferences, and of



those about a third have chosen to receive their journals electronically, thereby incurring significant savings for the Institute in terms of printing and postage costs. This was done without sacrificing our circulation figures which are important for the prominence of our journal, as well as being significant for our advertisers. In fact, we have been able to increase our circulation by including student members in the distribution list, because of the much lower cost of electronic distribution.

Another change, whose intention was announced in 2015, has taken a little longer to deliver, yet the first set of SAIMM talks to be streamed via live video took place in 2018.

SAIMM maintains strong links with similar societies in other countries through what is known as the Global Mineral Professionals Alliance (GMPA). In November 2011, an inaugural meeting was held in London between several leading international mining and metallurgical societies - AusIMM (Australasian Institute of Mining and Metallurgy), CIM (Canadian Institute of Mining, Metallurgy and Petroleum), IOM3 (Institute of Materials, Minerals and Mining), SAIMM, and SME (Society for Mining, Metallurgy and Exploration). The meeting was intended to foster cooperation between the various organizations, to discuss opportunities for improving and sharing benefits to members, and to benchmark the institutions against each other. Further meetings between these societies were held in September 2012 in Las Vegas (SME), in February 2013 in Denver (SME), in February 2014 in Cape Town (SAIMM), in October 2014 in Vancouver (CIM), in March 2015 in Hong Kong (AusIMM), in February 2016 in Phoenix (SME), and in February 2017 in Somerset West (SAIMM). Discussions were held about the state of the mining industry in the various countries, as well as the structure and strategies of the societies represented. There was broad agreement that the societies would offer services to each other's members at member rates. Calendars of events are circulated between the organizations to coordinate major events and minimize clashes.

The flagship project of the GMPA is OneMine.org, a database of over 100 000 technical papers that is freely available to the members of GMPA societies. Support of this project - both financially and by sharing technical papers - is a necessary precondition for a society to belong to the GMPA.

In *A Tale of Two Cities*, Charles Dickens wrote that 'it was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness'. The period 2015-2016 certainly had elements of both prosperity and struggle. South Africa was at a very low point economically and politically. The country set something of a record in having three finance ministers within a period of four days. Governance was poor, and corruption was rife. In 2015, for the first time on record, South Africans began investing more abroad than foreigners were investing in South Africa. The mining industry was struggling against high electricity and labour costs. In some sectors, demand and metal

prices were low. For example, 2015 saw the worst market conditions for TiO_2 , with market prices at their lowest point in at least the preceding 28 years. However, the mining industry remains a significant contributor to the economy of South Africa, and contributes 7% to the GDP of the country.

The dominant role of the platinum group metals in the South African economy was strongly affected by developments elsewhere in the world, especially in the international automotive industry. In September 2015, allegations surfaced that Volkswagen had been involved in worldwide rigging of diesel emissions tests, affecting an estimated 11 million vehicles globally. This resulted in a strongly negative sentiment towards diesel vehicles, and a decrease in the platinum price as a consequence of the expected lower demand for platinum-based diesel autocatalysts. However, on the positive side, it has long been argued that wider usage of fuel cells would increase the demand for platinum. In 2015, Minerals Council South Africa unveiled a 100 kW platinum-using fuel cell to power its central Johannesburg headquarters, and in 2016 Impala Platinum unveiled a fuel cell forklift and hydrogen refuelling station at its refinery in Springs. Whichever way things develop, there is no doubt that the catalytic use of platinum group metals will continue to make an enormous contribution to cleaning up the world environment.

Towards the end of that year, the 2015 United Nations Climate Change Conference - the 21st yearly session of the Conference of the Parties (COP 21) to the 1992 United Nations Framework Convention on Climate Change (UNFCCC), and the 11th session of the Meeting of the Parties (CMP) to the 1997 Kyoto Protocol - was held in Paris, with the intention of establishing a binding and universal agreement on climate, from all the nations of the world. The European Union and 195 nations were the participating parties, and the conference was attended by leaders from 147 nations. A global climate change pact was agreed at the COP 21 summit, committing all countries to reduce carbon emissions for the first time. This initiative will have a significant impact on what gets mined, and how metallurgical processes are carried out in the future - with the intention of improving our custodianship of the planet on which we all live.

It was at the end of 2015 that Klaus Schwab, founder of the World Economic Forum, first published his ideas around the 'Fourth Industrial Revolution' - the convergence of physical, digital, and biological aspects of our lives. The rapid pace of change in the technological world will undoubtedly have a great influence on how we live our lives in the future. I agree with him that 'We need to shape a future that works for all of us by putting people first and empowering them' by using these technologies wisely. We should not allow the always-connected way of life to deprive us of 'the time to pause, reflect, and engage in meaningful conversation'. *

“ The rapid pace of change in the technological world will undoubtedly have a great influence on how we live our lives in the future. We need to shape a future that works for all us by of putting people first and empowering them by using these technologies wisely. ”



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President: 2003-2004

What happened to rock engineering research in South Africa?

Thomas Richard Stacey

In the 21 March 2014 edition of *Mining Weekly*, an opinion piece that I authored was published, entitled 'Does rock engineering's demise spell the end of South African mining?' A summary of this opinion is included here since it is relevant to the other content of this article.

Rock engineering research in South Africa began significantly in the 1950s, initially at the CSIR. The mining industry subsequently established the Chamber of Mines Research Organisation (COMRO) which, over a period of about 20 years, grew to a major research facility unparalleled in the rest of the world. Opinions on numbers of rock engineering researchers in South Africa during this period vary, but is estimated to have been in the range of 600 to 800. The international stature of these research organizations is illustrated by the following: South Africa has provided a President of the International Society for Rock Mechanics and Rock Engineering (ISRM, now more than 8 000 members) and more than 10 Vice Presidents, since the society was formed in 1966. Two members from the CSIR/COMRO research environment have received the Leopold Muller Award, the ISRM's most prestigious award, and a further individual was nominated. This is out of a total of just seven such awards to date. Two South Africans have been awarded the status of Fellow of the ISRM, out of just 15 in the world at that time. And no fewer than six researchers from South Africa have been ISRM Rocha Medal recipients, and one a runner-up, for the best rock mechanics PhD in the world in a particular year. This is a better record than any other country.

Four people who developed their rock engineering skills in South Africa have become household names in the rock engineering field: Hoek, Bieniawski, Cook, and Salamon. This illustrates the major contributions made - and the prestigious status achieved internationally - by the South African rock mechanics and rock engineering fraternity.

But, what happened to this research powerhouse? In the 1980', individuals within the mining companies were of the opinion that the research facility was costing the

industry too much, and not delivering sufficiently. The result of this was that, several years later, the facility was effectively 'given away' to the CSIR. In itself, this at least preserved the research capability as a new Mining Technology Division within an established research organization. This Division continued to carry out good research for several years. However, the CSIR was apparently not focused towards the mining industry, and it appears that there was no mining/rock engineering

research strategy. The consequence was a significant draining away of researchers over a period of little more than 10 years. Most of the old COMRO properties and infrastructure were disposed of, equipment was scrapped, and the Division became dysfunctional, eventually closing.

How could the mining industry not recognize the benefits provided by a competent research capability? Properly managed research can lead to substantial benefits, which can be quantified. The following are brief descriptions of some rock engineering research projects carried out by students under my supervision during the past 15 years, which resulted in significant safety

benefits, as well as substantial financial contributions to the mining companies, and to South Africa.

>> Research into preconditioning to prevent or reduce the occurrence of stope face bursts in the gold mines proved that preconditioning improved safety considerably. In addition to the safety benefits, however, it was found that, with preconditioning, the drilling penetration rate for blast holes was increased; the face advance per blast increased by up to 50%; the condition and stability of the hangingwall was improved; and fragmentation was finer, resulting in more efficient material handling. The research proved that preconditioning contributes to improved productivity and profit,

How is it possible that the mining industry would regard the research as too costly? And thus, how can rock engineering research capacity in South Africa have been allowed to dissipate completely from the research powerhouse that it once was?



Dynamic rock support research

resulting in the creation of value running to hundreds of millions of rands during the life of a gold mine.

- >> Research into the quality of blasting for an open pit mine defined the fragmentation distributions required in ore and waste rock. This research resulted in optimum blast designs to achieve the required fragmentation. Extended research into the use of electronic delay detonators proved that they were able to deliver uniform fragmentation consistently and at lower cost. As a result of this research, substantial improvements in loading, hauling, and milling rates were achieved. The financial benefit associated with milling alone amounted to some 30 million rand per month, and there was an improvement in loading and hauling in excess of 15%. Additional research into open pit slope design included geotechnical database development and management, and development of a slope design model. As a result of this research the final walls were optimized by three degrees, resulting in a revenue increase for the mine in excess of 900 million rand.
- >> In deep-level tabular reef mining, rockfalls have been a major safety hazard. Research was focused on prediction of the probability of occurrence of rockfalls in the tabular mining geometry, based on the statistical parameters of the jointing, as well as a generic methodology to quantify the cost of the losses associated with rockfalls, including the costs of accidents. This research showed that the probability of failure of blocks greater than a certain size can be predicted very satisfactorily, and that the probable locations of rockfalls can also be determined. This allows the probability of occurrence of an accident to be calculated, as well as the total costs of the consequences of rockfalls and collapses - consequential costs include direct and indirect costs associated with accidents, rehabilitation, damage to equipment, loss of production, loss of reserves, reassignment of the workforce, dilution of ore, etc. Regarding the creation of value, it was shown that the use of a higher cost support system would limit collapses and could create substantial value for a mine, as well as providing better safety.
- >> In an open stoping operation, it was found that dilution could be in excess of 10%, falls of ground being a major contributor to the problem. Dilution caused a

significant reduction in the recovered grade, which resulted in a substantial loss of income. In addition, the costs of damage to mining equipment were substantial. Over a 10 year period, losses due to these causes were estimated to have been nearly 1 billion rand. Rock engineering research into the stope instability resulted in the development of a new design criterion, which proved to be very successful. After its implementation, major reductions in dilution and equipment damage resulted, creating value for the mine estimated at 3 billion rand.

The financial contribution to mining companies, and indirectly to the country, of these few rock engineering research projects totals about 10 billion rand. Many of the research projects carried out by COMRO over many years will similarly have made significant contributions to the value of mining operations. With knowledge of such benefits, how is it possible that the mining industry would regard the research as too costly? And thus, how can rock engineering research capacity in South Africa have been allowed to dissipate completely from the research powerhouse that it once was? South Africa's minerals are of major value to the country, and the government is the custodian of these minerals. How can it be that there was no strategy conceived by the CSIR to preserve and focus the tremendous research capability that existed for the long-term benefit of the country, all its residents and the mining companies?

South Africa's mines are getting deeper, hotter, and more highly stressed. New techniques must be developed to mine safely and efficiently under these 'extreme' environmental conditions, and this requires long-term research. What is necessary is a long-term strategy to define the problems and the research that is required for their solution. There is some hope on the horizon, however. A government/industry initiative was established recently, with well-defined research aims: the South African Mining Extraction Research, Development Innovation Strategy (SAMERDI). Research numbers in this initiative are now up to about 50.

Acknowledgements

The research projects described briefly above were carried out by Dr Z. Tooper, Dr A. Bye, Dr M. Cole (*nee* Little), Dr J. le Roux, L. Rwodzi, and E. Nezomba. The new research initiative is described in the Presidential address by the 2018-2019 President of the SAIMM, Alastair Macfarlane. Dave Ortlepp was responsible for the support research shown in the photographs *



Dynamic stope support research



Brigadier Stokes Memorial
Award Winner—2010

SAMMRI: Working towards the sustainability of the South African mineral processing industry

Cyril O'Connor (co-authors – V. Ross and J.R. Mann)

A 2009 survey of the South African mining industry indicated that major challenges facing the industry were a shortage of skilled people in the industry and in SA universities in the area of mineral processing to enable the sustained development of a strong technological base.

On the basis of these findings, the South African Minerals to Metals Research Institute (SAMMRI) was established as a national initiative to promote sustainable development of the SA mineral processing industry through the development of globally competitive technology, driven by people with world-class skills. This Institute is funded jointly by the industry and the Department of Science and Technology (DST).

South Africa features prominently in terms of the world's reserves and producers of many mineral commodities. A recent report stated that South Africa is the world's richest country in terms of its mineral reserves, which are estimated to be worth US\$2.5 trillion. As in the case of most countries endowed with abundant natural resources, South Africa has relied immensely on its primary minerals sector as a source of wealth and economic growth in the past and continues to do so today. According to the Minerals Council South Africa's annual reports the mining sector employs almost 500 000 people and contributes about 8% to South Africa's GDP - about 18% if the multiplier effect is taken into account.

On the basis of concerns at the time that most of the South African mining industry's investment in research was being directed offshore, a study was carried out in 2009 by SAMMRI, funded by the DST, to identify the reasons and to propose a strategy to address this challenge. The major weaknesses and threats were identified as a shortage of skilled people both in the industry and at SA universities as well as inefficiencies of many of the existing processes.

Recent economic pressures have led to a reduction by local companies of investment in longer-term research and development, both internally and through external investments in universities. If these technical challenges are to be addressed the country needs to ensure ongoing significant investment in research and development. To address this situation, in 2009 five mining companies -

Anglo American, Impala, Lonmin, Exxaro, and AngloGold Ashanti - collaborated to establish a national initiative to promote mineral processing research investment and this gave birth to SAMMRI, a virtual institute intended to involve all of the higher education institutions. This was to be achieved through the development and support of research capacity at South African universities, through developing researchers and students with world-class skills that would create a platform from which globally competitive technology would emanate.

The SAMMRI model

In the context of R&D being carried out by industry and supplier laboratories, including organizations such as Mintek and the CSIR, SAMMRI identified its role to be to one of expanding research capacity by involving universities in a national programme aimed at developing human capital in the form of an increased number of highly skilled people with postgraduate degrees to take up employment in industry and academia. At the same time, it is focused on developing a strong cohort of younger researchers at universities capable of driving this programme, thus promoting sustainable development of the South African minerals processing industry through globally competitive, innovative technology. This would be achieved by supporting emerging academics and researchers at South African universities by funding industry approved research projects. After its establishment, the DST approached SAMMRI with a view to entering into a joint venture and this led to an injection of funds from DST to complement industry's contributions. Since 2015, SAMMRI has become the beneficiary of more significant funding from the government through the Sector Specific Innovation Fund (SSIF).

From the outset SAMMRI has defined its scope as all aspects of the processing and extraction of minerals from the point of delivery of the mined ore to the production

of the final refined and saleable metal or mineral product. Currently it exists as an association of member companies whose representatives constitute a Board. Assessor members, who are appointed on the basis of their influence and strategic roles as key players in the industry, include DST, DTI, Mintek, the Council for GeoScience, and Coaltech. In order to minimize administrative costs, the management and administration of SAMMRI has since the outset been entrusted to the University of Cape Town which is a public institution subject to all the usual financial regulations governing any such institution. The CEO is appointed by the Board and reports directly to the Chair of the Board.

Roadmap

From the outset, SAMMRI established a template against which it could measure its long-term success and inform the SAMMRI Board in its decisions on which projects to fund. To this end a roadmap for the South African minerals processing industry was developed, defining the main drivers that would shape the future of the industry. Based on extensive input of senior technical staff from industry stakeholders, government departments, research institutions, and other similar roadmaps these factors were distilled into four strategic focus areas:

- >> Economic value added
- >> Environmental impact
- >> Mineral and metal resources
- >> Sustainable development

The roadmap is generic in nature, identifying gaps and defining initiatives specific to key strategic / economic commodities. The development of human capital is the key focus of SAMMRI activities and therefore was not included as a separate driver. The scope of the SAMMRI technology roadmap was hence to:

- >> Cover the value chain from mined ore to refined metal
- >> Focus primarily on the operation (third) phase of the project life cycle
- >> Influence and drive the development of the SAMMRI technical project portfolio
- >> Focus on identifying 'generic' R&D priorities for the industry
- >> Reflect industry challenges and needs with a 'direct' technology research and innovation base only
- >> Focus on the development of (world-leading) R&D competence in specific areas
- >> Endeavour to create an environment for innovation.

Outputs

Since its inception in 2011 (which was a 2-year pilot programme to develop appropriate processes to manage this Institute) SAMMRI has co-funded 66 projects at seven Universities viz. North West, Stellenbosch, Cape Town, Limpopo, Pretoria, Witwatersrand, and KwaZulu Natal. These projects have addressed major technical challenges (decided upon by the industry sponsors) in 11 different

DELEGATES AT A SAMMRI WORKSHOP



technology themes of critical importance to the minerals industry. These interventions have led to 22 Masters and 8 PhD completed degrees, with 21 and 15, respectively, in progress at the time of writing. In terms of demographics, more than 63% of the students have been black and 28% women. A total of almost 80 publications have been produced to date. At the same time, 28 young research supervisors have been groomed at these universities, of whom 12 are women and 9 black. These are the future research leaders of the academic departments where they are located. Of importance is the spin-off which the outcomes of these projects have had either directly or indirectly on the local minerals industry, and these are elaborated on below.

The projects SAMMRI supports are typically in the development of fundamental science and knowledge, protocols, and procedures, rather than fully implementable processes and process technologies, *i.e.* knowledge products that can be transferred into the industry *via* their use by SAMMRI members. Using this approach, and together with the additional industry funding procured by the principal investigators (PIs), SAMMRI has facilitated the development of several sustainable Centres of Technical Competence. A number of them are now internationally acknowledged and are research partners in bilateral and multilateral research consortia and collaborative platforms.

There is now significant local capability and capacity to conduct research and development at South African HEIs to address most of the sector's mineral processing technology development and efficiency improvement needs. This includes inter alia research in the fields of:

- >> PGM - Base metal hydrometallurgy
- >> Data-based process modelling and control
- >> Process mineralogy and geometallurgy
- >> Comminution and Classification
- >> Flotation
- >> Molecular modelling
- >> Computational modelling of pyrometallurgical equipment
- >> Waste recycling

Project-specific mentorship is provided by appointing Board members to the students and PIs for each allocated project. This is to meet the SAMMRI aspiration of developing world-class researchers, who through mentorship are assisted in not only producing research outputs that are of scientific and academic value but knowledge products that can be transferred into value-added usage within the industry. This intervention has arguably been considered by the PIs as the most valuable contributions by SAMMRI to their research development.

One of the major challenges which SAMMRI has faced has been to ensure that there is appropriate transfer of the research outputs to industry. This is self-evidently greatly facilitated by the close working collaboration between the industry sponsors and the PIs and their students through

the industry mentoring programme. Hence there are now many examples of research which appeared at face value to be fundamental in nature but being transferred with great success into company operations. Examples of these include the following

- >> Bench-scale test procedures developed during the research being used by industry to optimize their process performance, leading to real benefit in financial returns. There are also now case studies that demonstrate the progress from project conceptualization through fundamental research, piloting, demonstration, techno-economic assessment, construction and commissioning, to full-scale implementation. One example is the development of the use of reflux classifiers for chromite recovery. Similarly, the development of a strong area of expertise in geometallurgy using technologies such as XCT microtomography has the potential to have a major positive impact in the industry.
- >> Knowledge transfer impact occurring *via* involvement of final-year students carrying out projects associated with the sponsored projects.
- >> Industry members using the universities to deliver curriculum-specific training in these knowledge products for their graduate engineer employees.
- >> The establishing of Centres of Technical Competence which now deliver key research and consulting services to the industry to help improve production performance. Examples include applications in flotation, fault detection through process monitoring, and assessing the impact of process water quality on the efficiency of flotation.

In the above regard it is worth noting that SAMMRI is endeavouring to move its focus into more applied areas of technology (e.g. TRL_≥ 4). There is abundant literature on this topic, much of it emphasizing that the best way to achieve this is for university-based research to partner with industry rather than to try to mimic what industry does so much better. Besides, the cost ramifications of moving into TRL_≥ 4 areas significantly greater than that to which SAMMRI has access. SAMMRI's view therefore continues to be that its primary role is to strengthen the availability of highly skilled engineers and scientists to the industry so that the challenges can be addressed in the best manner.

Conclusions

The intervention by SAMMRI has enjoyed considerable international attention and is seen to be unique in terms of the close collaboration between industry, the higher education sector and the state in promoting the development of the minerals processing industry. The programme clearly requires a long-term commitment by both the industry and the government if it is to ultimately achieve its objective of ensuring South Africa is a global leader in terms of the high quality of its technology and its human capital, and so enable the minerals industry to play an ever-greater role in the economic growth of the country. ✱



President: 1999–2000

We said farewell to both the old year and century and welcomed in the new year and century

Michael Howard Rogers

Recognizing the need to adapt to the changing operational environment and circumstances in the new dispensation, current practices and traditions of the Institute were reviewed.

Halfway through my year as President, we said farewell to both the old year and century and welcomed in the new year and century.

Recognizing the need to adapt to the changing operational environment and circumstances in the new dispensation, current practices and traditions of the Institute were reviewed.

More importantly:

- >> The composition of membership, of Council and of Committees in terms of the demographics of South Africa. It is interesting to note that Rams Ramakgopa, who served as Junior Vice President, later became the first black person to lead the Institute. We welcomed Dr Lesley Cornish and Professor Rosemary Falcon as members of Council. The efficient Secretariat led by Ms Samada Moodley was an all women one apart from a single male accountant.
- >> The Institute was under financial stress at the time and this became a focus area. The Secretariat relocated from Cape Towers to the vacant 5th floor of the Chamber of Mines building. Not having to pay rent for the offices certainly assisted our financial position. An emphasis on the timeous collection of debts led to cash in the bank of R638 000 at the end of the year compared to a negative R179 000 the previous year.
- >> Finally, we focused on the service provided to members and our relationship with sister institutes, associations, and societies. Having had an incident-free Y2K transition into the new century we were able to upgrade our communications with members by the installation of an ADSL line. The SAMREC Code was resurrected in conjunction with the CMMI and published during the year. The Brigadier Stokes Memorial Award was presented to a sprightly 83-year-old Mr Alex Mokken in recognition of his

work in the recovery of gold and, in particular in the field of comminution of gold-bearing ores. Council made an award of a Special Certificate to a doyen of the Institute, Professor Robbie Robinson, in recognition of his meritorious service, renamed the Book Fund in his honour, and dedicated a special edition of the Journal to him. *



Mike delivering his Presidential speech in August 1999 at the AGM



President: 2018-2019

Reflecting on 25 years of democracy and the mining industry

Alastair Stuart Macfarlane

During 2015 a landmark event occurred in our industry, which was the Mining Phakisa. This multi-stakeholder event focused on reviving the contribution of mining to gross domestic product, by focusing on key workstreams. This was a milestone event more in terms of process than outcome, as it created genuine dialogue on very difficult issues.

As President of the Southern African Institute of Mining and Metallurgy, reflecting on 25 years in the mining industry since our transition to democracy in 1994 is an honour, and it is also a reality that this is but an exciting part of the SAIMM journey, which began in 1894. This year the Institute celebrates 125 years, having started life as the Chemical and Metallurgical Society of South Africa, which was formed after 14 chemists and metallurgists met on 24th March 1894 in Johannesburg to form a society and elect a council.

After the dark days of apartheid, and before liberation, it became increasingly clear from the late 1980s that something exciting was about to happen. It was clear from the speech by FW de Klerk that a monumental shift in direction was on the horizon. This, and then the subsequent euphoria after the democratic elections, created great hope for the country, as well as for the industry.

However, translation of democratization into the industry proved to be difficult, due to many legacy issues in terms of work structure, work practices, migrant labour, and legislation, coupled with an industrial relations environment that was driven by politicization.

This created the need for major structural changes, and led to the unbundling of large corporate institutions, and the development of a new Minerals Policy, and the enactment of the Minerals and Petroleum Development Act.

Subsequently, the Mine Health and Safety Act and the establishment of the tripartite organizations such as the Mining Qualifications Authority and the Mine Health and Safety Council created the atmosphere for dialogue, and this undoubtedly was instrumental in the remarkable improvements that we have seen in mine health and safety since 1994.

These improvements were also supported by significant research work that was done into rock engineering design, especially the development of seismic monitoring systems and sequential grid mining

for deep-level gold mines, which has resulted in a significant improvement in terms of the effects on mine seismicity.

However, it has not all been all plain sailing. Rapidly escalating costs and declining productivity have had a devastating effect on our production output, as mines became more marginal in the gold sector in particular. This was also impacted by sluggish prices in gold and platinum in the 1980s, until economic respite for the mining industry when the 'super cycle' kicked in during 2009, and lasted through to 2014.

The super cycle did little for productivity improvement generally, unless a bottom line metric is used (influenced by metal price and exchange rate).

This meant that after the cycle ended, difficult days appeared, with a sudden increase in mine closures and retrenchments, and the devastating impact of the 5-month long platinum industry strike in 2014. The Marikana massacre on 16 August 2012 represented one of the darkest days of the industry, and the wounds have still not healed.

During these times, the industry also felt the effects of State capture, and relationships between certain parties in the industry reached an all-time low. We all feel betrayed and at the same time full of bewilderment that such manipulation and destruction could happen on our collective watch.

So where do we find ourselves now? During 2015 a landmark event occurred in our industry, which was the Mining Phakisa. This multi-stakeholder event focused on reviving the contribution of mining to gross domestic product, by focussing on key workstreams. This was a milestone event more in terms of process than outcome, as it created genuine dialogue on very difficult issues.

Since the election of our current President, President Cyril Ramaphosa, and a new Minister in the Department of Mineral Resources, a 'new dawn' has emerged which is epitomized by dialogue and transparency, and a collective desire to make the industry work.

It is estimated that South Africa still possesses mineral resources worth US\$2.5 trillion, with 16 commodities ranked in the top 10 internationally. Despite this, local gold production has decreased from 605 ton in 1994 to 133 ton in 2014, with a loss of 273 152 jobs over the twenty-year period. This apparent dichotomy is explained by the economic reality that much of what we have left in the ground is deep, low grade, and/or expensive to extract. Additionally, much still has to be explored, and all these effects require us to leverage our collective will and collaborative efforts to find solutions, through research and development, to open margins and attract investment for the sustainability of our great industry.

Our mining industry has also, over the last 25 years, had to move from a purely profit-based, internal and shareholder focus to become a more engaged and complete corporate citizen, in terms of community engagement and environmental protection, involving an ever-widening group of stakeholders. This the industry continues to do, as it moves voluntarily beyond mere compliance. Our Institute has had to change to be able to provide platforms for dialogue on issues such as these, and to concentrate increasingly on issues that are more of a socio-economic nature than a purely technical one.

Internally, our Institute has constantly had to conduct self-examination to ensure transformation, inclusion, and diversity to reflect the demographics of the country and to celebrate this transition. Despite having made significant progress in these areas, there is still much to be done.

Supporting this work, and in addressing the issues of career and professional development of our members, the Young Professionals Council was formed, which has contributed significantly to the needs and expectations of our younger members. Our Scholarship Trust Fund has so far helped needy students to the extent of some R3 million in the support of their studies.

A significant change to the Institute occurred in 2006, when it became the 'Southern African Institute of Mining and Metallurgy', reflecting the reach to branches in Botswana, Namibia, the Democratic Republic of Congo, Zambia, and Zimbabwe, making it a truly international Institute.

Meanwhile, challenges continue to unfold, but those such as the current electricity and energy crisis will only be solved through collaboration and transparency, and a desire to solve these problems together, and the Institute will continue to play a constructive role in creating the platform for dialogue that will find solutions to these challenges.

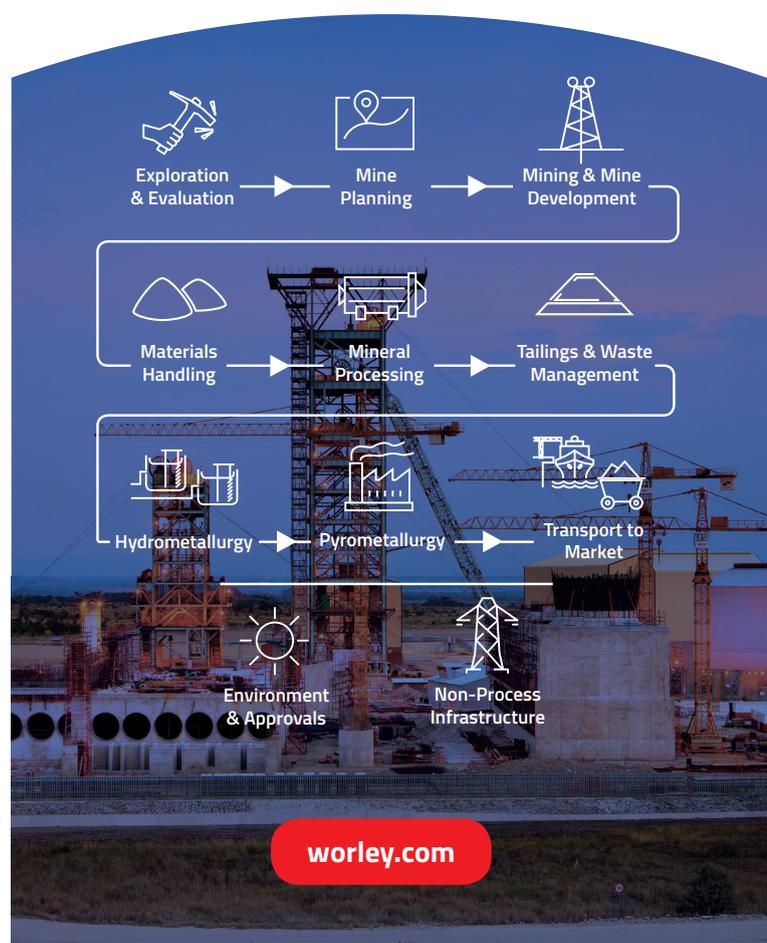
These have been an exciting 25 years, and we can all be proud of our individual, corporate, and institutional efforts that have brought us to where we are, despite the challenges along the way, and to create a bright future for the next 25 years.

The Southern African Institute of Mining and Metallurgy is proud of its contribution in these 25 years, as well as the preceding 100 years, and will continue to support our industry and our members, not only in South Africa, but across the Southern African region. *

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YOUR WORLD

SAIMM continually fosters linkages, contacts, and cooperation worldwide with institutes that share our vision and are working towards the same goals.

This ensures that SAIMM is part of a prestigious network of professional peers that ensure the promotion of local best practice in mineral resources.

Our contribution to high-profile forums such as the Global Mineral Professionals Alliance (GMPA) cements the reputation of SAIMM as a global roleplayer in the sector.

YOUR CONTINENT

In 2006, SAIMM articulated its commitment to mineral resource development in the subcontinent and the rest of Africa by changing its name to the Southern African Institute of Mining and Metallurgy.

With branches in Namibia, Zambia and Zimbabwe and regular conferences, SAIMM has ensured a strong presence as a proponent of innovation, sustainability, and transparency in the region and the African continent.

YOUR NATION

SAIMM fosters communication to multistakeholder audiences in the interests of development and innovation of the sector in Southern Africa.

In the broader regulatory and industrial landscape, SAIMM represents its members on statutory bodies such as the Engineering Council of South Africa (ECSA) and the South African Council for Natural Scientific Professions (SACNASP).

Through cooperation with other professional associations, we are able to speak with a single voice to government and mineral industry forums.

The prestigious SAIMM Journal was ranked a 'premier journal' by the International Society of Mining Professors (SOMP) in 2014. SAIMM Journal and conference papers are hosted on the OneMine.org database, which gives our authors an even wider audience.

PROFESSIONALS FOR THE MINE OF THE FUTURE

SAIMM's Scholarship Trust Fund, set up in 2002, and the Young Professionals Council (YPC), established in 2014 for members 35 and younger, further support the local sector by securing a supply of competent and dedicated minerals sector professionals.

The aim of YPC's three working groups – Education, Career Guidance, and Enterprise Development – is to further the mission of the SAIMM across schools, universities, business, professional bodies, and the broader enterprise spectrum.

YOUR COMMUNITY

Our members are the foundation of our dynamic community of professionals and academics, united by a vision for a prosperous and principled mineral resources sector.

As a local collaborative platform for development of the sector, our primary role is to identify, represent, and promote the needs and concerns of our members.

Another vital function is to share scientific and technical knowledge and promote continuing education.

Our student members benefit from opportunities for career development.

BUILDING A COMMUNITY

BUILDING A NATION



SAIMM
THE SOUTHERN AFRICAN INSTITUTE
OF MINING AND METALLURGY

