Presidential Address: The image of the minerals industry

by R. D. Beck

SYNOPSIS
The minerals industry needs the support of all sections of the population if it is going to be able to supply the new materials required for future development. It will achieve this support only if its image is good.

Perceived images of the minerals industry are examined in respect of history, technology, environment, safety, education, and economics. Concern is expressed about the low technological image of the industry and the declining number of students enrolling in minerals-related disciplines.

It is concluded that it is the professionals, through institutes like The South African Institute of Mining and Metallurgy, who must take the lead in improving the image of the minerals industry. The Presidential Address gives data to support this thesis; data that, is hoped, can be used in efforts to educate people about the minerals industry.

SAMEVATTING
Die mineraalbedryf het die steun van alle seksies van die bevolking nodig om die nuwe materiale wat vir toekomstige ontwikkeling nodig is, te kan voorlaai, en hy sal hierdie steun net kry as sy beeld reg is.

Die huidige beeld van die mineraalbedryf word ondersoek uit die oogpunt van die geskiedenis, tegnologie, omgewing, veiligheid, opleiding en ekonomie, en daar word kommer uitgespreek oor die lae tegnologiese beeld van die industrie en die dalende getal studente wat vir mineraalverwerkende dissiplines inskryf.

Daar word tot die gevolgtrekking gekom dat dit die verantwoordelikheid van die professionele mense is om deur instellings soos Die Suid-Afrikaanse Instituut vir Mynbou en Metallurgie die leiding te neem met die verbetering van die mineraalbedryf se beeld. Die Presidentsrede verstre een data ter ondersteuning van hierdie standpunt, data wat hopelik gebruik kan word in pogings om mense oor die mineraalbedryf in te lig.

Introduction
I am sure that every previous President of the South African Institute of Mining and Metallurgy (SAIMM) has pondered lengthily on what topic to choose for his Presidential Address. It was no different for me. As I believe this address is a personal matter, I have chosen a subject that is not only of general interest, but one that has intrigued me since my student days.

As a vacation student in Cornwall, I used to talk to the Cornish miners in the local pub, and was disappointed to learn that the men did not want their sons and daughters to follow them into the minerals industry. Their image of the industry was all wrong.

Past presidents of the SAIMM have addressed similar issues in their Presidential Addresses. Many of the points were touched on by D.M. Jamieson in 1964 in his address Mining as a vocation. Professor A.N. Brown discussed the future supply of engineers for the mining industry in 1982.

In 1973, P.W.J. van Rensburg concluded his address Our mineral heritage by lamenting the fact that few men of ability take up mining, metallurgy, or geology as careers. He commented that a President of the Institute had made the same remark sixty years before, and the industry had not collapsed but had gone from strength to strength.

However, with the current pressure on the minerals industry as a result of low metal prices and increasing competition for the employment of engineers and scientists from industry in general, every effort must be made to uphold the image of the minerals industry.

How then does the general public perceive the mining industry?

The popular image is that it is a despoiler of the environment with a poor record of safety. This image has persisted for many centuries.

Book 1 of De re metallica by Georgius Agricola, published in 1556, starts:

‘Many persons hold the opinion that metal industries are fortuitous and that the occupation is one of sordid toil, and altogether a kind of business requiring not so much skill as labour’.

Further on he writes:

‘But besides this, the strongest argument of the detractors is that the fields are devastated by mining operations... Also they argue that the woods and groves are cut down, for there is need of endless amount of wood for timber, machines and the smelting of metals.

These images are still with the industry today. If the industry is going to be able to supply the raw materials required...
When the woods and groves are felled, then are exter-
minated, the beasts and birds...
'...when the ores are washed, the water which has been
used poisons the brooks and streams, and either
destroys the fish or drives them away. Therefore the
inhabitants of these regions, on account of the devastat-
ion of their fields, woods, groves, brooks and rivers,
find great difficulty in procuring the necessities of life,
and by reason of the destruction of the timber they are
forced to greater expense in erecting buildings.
'Thus it is said, it is clear to all that there is greater
detriment from mining than the value of the metals
which mining produces.'

These images are still with the industry today. If the
industry is to be able to supply the raw materials required
for future development, it needs the support of all sectors
of the population and will achieve this support only if its image
is good.

Let us first look at the perceived images of the minerals
industry.

Mining Industry Surveys

The Chamber of Mines of South Africa has monitored the
public attitude to the mining industry over the years. The
results of a survey carried out in 1980 are shown in Figure
1. A poor perception of the industry is noted.

The most recent survey (Figure 2) undertaken by the
Chamber of Mines produced findings that were much bet-
ter than expected and heartening for the industry.

<table>
<thead>
<tr>
<th>1980 CHAMBER OF MINES SURVEY</th>
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<tbody>
<tr>
<td>WHITE GENERAL PUBLIC:</td>
</tr>
<tr>
<td>1. Little familiarity with mining industry.</td>
</tr>
<tr>
<td>2. Mining contributes to the economy, especially gold.</td>
</tr>
<tr>
<td>3. Danger and health are negative perceptions.</td>
</tr>
<tr>
<td>WHITE OPINION LEADERS:</td>
</tr>
<tr>
<td>1. Know mining industry well.</td>
</tr>
<tr>
<td>2. Attitudes overwhelmingly favourable.</td>
</tr>
<tr>
<td>3. Minerals industry rate higher than general engineering industry as employer.</td>
</tr>
<tr>
<td>BLACK PUBLIC AND OPINION LEADERS:</td>
</tr>
<tr>
<td>1. Little familiarity with mining industry, with many unable to name a mining company.</td>
</tr>
<tr>
<td>2. Attitudes not favourable. Opinion leaders against the industry.</td>
</tr>
<tr>
<td>3. Serious poor image problems, low pay, exploitation, separation for the worker from his family.</td>
</tr>
<tr>
<td>EMPLOYEES:</td>
</tr>
<tr>
<td>1. Have good knowledge of the industry.</td>
</tr>
<tr>
<td>2. Good fringe benefits and security.</td>
</tr>
<tr>
<td>3. Danger and health hazards were negative perceptions.</td>
</tr>
<tr>
<td>4. Isolated communities.</td>
</tr>
<tr>
<td>POTENTIAL EMPLOYEES:</td>
</tr>
<tr>
<td>1. University students have a greater affinity for the engineering industry than the mining industry, claiming much greater levels of awareness.</td>
</tr>
<tr>
<td>2. Phoenix courses have resulted in a more positive viewpoint among career guidance officers.</td>
</tr>
<tr>
<td>3. University students have a more favourable opinion of the engineering industry than of the mining industry.</td>
</tr>
<tr>
<td>4. Both school leavers and university students were more likely to want to work for the engineering industry than for the mining industry. This is because mining is perceived as a dangerous occupation necessitating living in remote areas and it is seen as lacking in interesting job advancement.</td>
</tr>
</tbody>
</table>

A large proportion (75 per cent) of unskilled and semi-
skilled workers, and an even higher proportion (84 per
cent) of skilled employees, are proud to be mining men.

While danger and accidents are a recurring negative per-
ception, it is also recognized that the industry pays strict
attention to safety (85 to 92 per cent).

Among black technical students and scholars at university,
techikon, or school, mining is rated first or second as the
industry in which to pursue a chosen occupation.

The industry is poorly rated only by white scholars and
white university students.

The report concludes: 'it indicates that the image of the
mining industry is not entrenched as one of poorly paid min-
ers working underground under dangerous conditions, and
that it is possible to foster an image of providing well-paid jobs and varied career opportunities'.

It is interesting to compare these findings with those in
other mining countries.

A survey (June 1989) for the Mining Association of Canada shows that the top-of-mind image of the mining industry held by about one-half of Canadians is that of a sector which is an important part of the economy in terms of developing the country's resources and creating jobs.

However, occupations within the industry are perceived as being dangerous, and the industry as a whole is viewed as being disruptive to the environment. The other half of the population appears to be totally unaware of the industry's activities and has been unable to form any impression at all about its activities.

Figure 3 gives the major findings of that survey.

Let us consider some aspects of the image of an industry:

- History
- Technology
- Environment
- Safety
- Education
- Economics.

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### Figure 3: Canadian Mining Industry Survey

<table>
<thead>
<tr>
<th>RESPONSES</th>
<th>OUTSIDE MINING INDUSTRY</th>
<th>INSIDE MINING INDUSTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unable to name any achievement of the industry</td>
<td>57</td>
<td>39</td>
</tr>
<tr>
<td>Develop and market Canada’s natural resources</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Create jobs</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>Develop advanced technology</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Good for the economy</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>

The main criticisms were: harms the environment (20%) and has a poor safety record (10%).

Residents of mining communities were more concerned about: pollution (21%) and worker safety (6%).

The industry has not done enough to create markets for its products (6%).

Serious concern was expressed about the impact of mining activities on the environment. 67% agreed that the mining industry is a major source of pollution and environment contamination. However, a majority of Canadians (54%) feel the environmental record of the mining industry has improved over recent years.

### Mining and Metallurgy—One of the Oldest Professions

Gold and copper were the first metals ever used by early man to improve the primitive tools he had shaped from flint and bone. This metal had to be recovered and worked, thus creating the ancient profession of mining and metallurgy—a far cry from, yet a direct link with, the complex technological society of today.

The ease with which these metals can be beaten into useful or decorative shapes added greatly to their popularity. Vestiges of copper metallurgy, dating back to about 6300 BC, have been found in Turkey. The earliest recorded source of gold came from the first known culture, that of Sumeria, in the fifth millennium BC. Biblical references to gold abound.

The use of lead is just as old. Its extraction by roasting and smelting was known in 5000 BC. The abundant use of tools made from metals led archeologists to name periods of time after metals—the ‘Bronze Age’ (2500 to 1500 BC) and the ‘Iron Age’ (500 BC to 40 AD). The dates vary greatly in different parts of the world. Some archeologists believe that a ‘Copper Age’ even preceded the ‘Bronze Age’.

Initially, ore was collected from surface material and, in particular, alluvial deposits. Underground mining is recorded as early as the Fourth Dynasty of the Egyptians (about 2613 BC). Well-known mines of antiquity are the lead-silver mines of Laurion in Greece, which were worked from 1000 BC, and the Wadi Fawakar gold mine in Egypt, which operated during the Ptolemaic period (300 to 100 BC).

Mineral processing and metallurgical techniques were recorded even earlier.

The early mining exploits of the Ancients and their descendants have been romanticized, and scientific truth has been diluted in myths and folklore. The Golden Fleece, which Jason and his Argonauts sought so assiduously, was no more than a sheepskin, commonly used in ancient times to trap fine specks of alluvial gold in the fast-flowing water of streams.

History shows that the recruitment of people into the minerals industry has always been difficult. German records from the 12th century show that men received shares, i.e. ‘Kuxe’, in the mining company as payment for their work.

Metal mines, in conjunction with the Sovereign, or Emperor, offered privileges to attract engineers, such as:

- free timber
- exemption from the payment of taxes
- exemption from military service
- permission to fish and hunt
- freedom of movement
- permission to carry weapons.

Those privileges were extended to coal miners only in 1767, when the economic importance of coal became obvious during the Industrial Revolution.

In 1770, the Government mining engineer of Saxonia, B. Rösslern, gave, in Speculum Metallurgiae Politissium, the following list of reasons why mines become unprofitable:

- cost of dewatering
- failure to provide tools for the workers
- unnecessary underground developments
- corruption
- over-mining of payable ground
- failure of directors and shareholders to agree on policy
- poor metal price (the Sovereign refused to pay more)
- no relief from the payment of taxes
- enforcement of unfavourable regulations by the Inspector of Mines
- poor wages
- effect of war and plagues
- unsafe procedures.

Matters have not changed much today.

### Technology

Unfortunately, mining is not seen to be closely associated with technology.

Although the use of large machines gives an impression of engineering, the popular perception of the mining and minerals industry would appear to be that the machinery used is of the Heath Robinson variety—a pastiche of picks, shovels, and explosives, with numerous pumps pushing sand–water mixtures hither and yon over odd-looking pieces of equipment at mineral-processing plants, while myriads of conveyor belts transport broken rock to just-visible tips, with spillage in abundance.

Nevertheless, the minerals industry has led technological development. For example, although pumps may seem to us to be very mundane pieces of equipment, the movement of water was critical to survival in historical times—as, indeed, it is now. The need for the mining industry to lift water from the mines led to the development of the first efficient pumps.

In 1556, Agricola described in great detail a pumping system at Scheunmütz in the Carpathian Mountains. That system included three levels of pumping, water being lifted 200 metres with three machines worked by 96 horses. Nowadays a modern mine may pump 15 megalitres per day from depths of 2000 metres.
The present century has seen the greatest advances in engineering and technology. In 1935, the bi-cylindro-conical winder at Simmer and Jack was the largest in the world. It had a diameter of 10.7 metres and was driven by two 1810 horse-power or 1440 kW motors capable of hoisting 51 000 tons per month at a speed of 15 metres per second in seven-ton skips from a depth of 2000 metres. This can be compared to the modern Blair multirope winder, which was installed at Leedooorn in 1987, and which is only 5.14 metres in diameter, although its two electronically controlled motors have nearly three times the power of the 1935 winder, viz 5140 kW. It raises skips of 20-ton capacity from depths of 2000 metres, and has an output of up to 200 000 tons per month.

On surface, computer technology for the control of large machines and complex processing plants has been introduced with great success. The first process-control computer was introduced at the Kloof Reduction Plant in 1968. This was followed by numerous advancements, one of which was the multivariable control strategy introduced for the optimization of milling.

Mining technology has not developed at the same pace. Except for longwall and mechanized mining, underground mining methods are essentially the same as they have been for centuries.

A recent study, funded by the US Bureau of Mines and prepared by the National Materials Advisory Board of the National Research Council, states that there is no adequate science base supporting the development of mining and processing technology. The mining industry is in a state of stagnation with respect to research and development (R and D), it says, most of the technologies currently in use having been developed at least 20 years ago. It concludes that mining research is not sufficiently imaginative.

The need for increased effort in the field of mining and extractive metallurgical research can be seen from a study of the US minerals industry.

Since 1985, a reshaping of the US minerals industry has taken place in the form of restructuring, rationalization, capacity reduction, and the introduction of some new technology. This has revitalized the industry after the disastrous first half of the decade.

However, there is a feeling that most of the benefits the industry has derived from non-technological measures such as plant closures, man-power reductions, and wage concessions, have probably been realized already6. It is argued that, unless greater emphasis is placed on technological advances, the industry’s success in competing internationally could prove to be transitory.

South Africa has contributed to technological advances in mining through the Chamber of Mines Research Organization (COMRO), which was established as the research laboratories of the Chamber of Mines of South Africa in 1952, and which was supported by research programmes at the Council for Scientific and Industrial Research (CSIR), Mintek, and the Bernard Price Institute, as well as at the major universities.

At mining depths below 2000 metres, rock stress and heat become major problems. It is expected that a number of South African gold mines will be mining at depths below 4000 metres by the end of the century. If we are to mine economically and safely in those environments, a great deal of research needs to be done. The foundations have been laid with research into backfill and hydropower.

Our slow progress in establishing backfill, and the slow acceptance of hydropower, indicate that we are slow to accept change. However, we must accept change if we are to create a high-technological industry. It is unfortunate that the financial state of the industry has necessitated recent cutbacks in research.

Ore grades are declining, and the ore being mined is becoming more complex as the easier and higher-grade deposits become depleted. Current metallurgical techniques will be uneconomic for ores of the future. Nevertheless, there is no doubt that the laws of supply and demand will provide us with sufficient incentive to find methods to treat those difficult ores.

The complex ores of tomorrow will not be amenable to differential flotation for the production of clean concentrates. Pyrometallurgical processing, which tends to be energy-inefficient, environment-polluting, and costly to operate for the removal of unwanted byproducts, will have to be re-assessed. Total hydrometallurgical process routes, involving treatment of the orebody in situ (in situ mining), are considerations for the future.

Figure 4 suggests some possible research projects for the future.

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The Environment

Although minerals can be extracted from the earth in an environmentally sound manner, the record of the minerals industry in respect of the environment has been poor for centuries.

At present, the 'green revolutionaries' are a force to be reckoned with, and include mainly the young and better-educated members of society for whom environmental issues are of paramount importance.

It is difficult for us to see how these critics of the minerals industry can compare the effects of mining on the environment to the destruction of the rain forests, which will result in an imbalance in the carbon dioxide and oxygen levels of the earth’s atmosphere. This is arguably the greatest threat to mankind.
The Ontario Mining Association in the richest mineral-producing area in Canada quotes: 'The land paved by Highway 401 affects more land than all the mines in the province. Most of the land lost to the highway is prime farmland.'

The public accepts this, but not the need for mining. There has to be a balance. Society can no more do without mining than it can do without the environment.

The minerals industry is aware of its potential contaminant effect on the environment. This has resulted in the compilation of a comprehensive list of potential problem areas (Figure 5) and the promulgation of legislation to minimize the effects of industrial pollution in the environment.

### Figure 5

<table>
<thead>
<tr>
<th>POTENTIAL CONTAMINANTS OF THE ENVIRONMENT</th>
<th>POTENTIAL EFFECTS ON THE ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise and vibration produced by blasting, mine equipment, and processing plants</td>
<td>Effects of noise on human health. Damage to buildings due to vibration. Disturbance of habitat, of fauna. Land subsidence due to underground mining.</td>
</tr>
<tr>
<td>Excavation and deposition of large quantities of materials</td>
<td>Loss of habitat for fauna and flora. Land disturbance. Aesthetic values.</td>
</tr>
<tr>
<td>Air contaminants</td>
<td>Dust</td>
</tr>
<tr>
<td></td>
<td>Elements in suspension in the air are potentially of concern to human health. Fall-out of particles causes contamination of soils, vegetation, and water.</td>
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<tr>
<td></td>
<td>Gaseous</td>
</tr>
<tr>
<td></td>
<td>Liquid effluents</td>
</tr>
<tr>
<td></td>
<td>Acidity</td>
</tr>
<tr>
<td></td>
<td>Increased concentration of dissolved heavy metals.</td>
</tr>
<tr>
<td></td>
<td>Base metals</td>
</tr>
<tr>
<td></td>
<td>Many metals such as copper, zinc, are necessary to health in small concentrations, but are highly toxic when present in excess. Depending upon their concentrations, heavy metals can be lethal to fish, preventing reproduction, or enter the human chain by accumulating in fish tissue (cadmium, mercury). The toxicity of heavy metals in fresh water is not only dependent on metal concentration, but also on other factors such as pH, water hardness, and presence of other metals. Attention to aquatic flora.</td>
</tr>
<tr>
<td></td>
<td>Thiosulfates</td>
</tr>
<tr>
<td></td>
<td>Oxidation to acids. Toxic properties at low concentrations. Some take a long time to decompose.</td>
</tr>
<tr>
<td></td>
<td>Polynitrocyanides</td>
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<tr>
<td></td>
<td>Oils</td>
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<td></td>
<td>Suspended solids</td>
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</table>

Unfortunately, it has come too late to prevent unscrupulous operators from causing severe damage to the environment.

The South African minerals industry has reacted in a positive and pro-active manner. The Chamber of Mines of South Africa has published operational guidelines for its members. Many of these, such as *The Management of Tailings Deposits* and *The Management and Rehabilitation of Open-cast Coal Mines*, have been adopted by the authorities as practical guidelines for the application of the laws.

For many years, The Chamber of Mines of South Africa has also run an Environmental Management Services Unit to assist the mines with tailings-dams and general rehabilitation.

It is not generally realized that the minerals industry has adopted an approach of self-regulation in its response to both Government and public pressure on environmental conservation. The importance of a 'wholistic' or global approach to the environment is appreciated.

The Chamber of Mines of South Africa has requested its members to support a philosophy of appropriate environmental management. Environmental studies are assessed at every phase of mining from exploration to mine closure.

Few people realize that the minerals industry actually wins awards for environmental protection. In 1988, the Environmental Planning Professions Inter-disciplinary Committee (EPPIC) started an annual award for the engineering project that had made the greatest effort to protect the environment in the execution of the project.

The minerals industry won the second award in 1989 for the Tisands project, Richards Bay Minerals, and this year's award (1991) for New Vaal Colliery.

American Electric Power received an Environmental Achievement award in 1990 for the wetlands reclamation project and its Simco No. 4 Mine. The site was recently dedicated as the first urban wildlife sanctuary in Ohio. Numerous other examples abound.

It is essential that we minimize the impact of waste disposal on the environment and make the maximum use of all our resources, which means the effective recycling of waste materials. The minerals industry should take up the challenge and actively promote the recycling of waste.

Mining and minerals were not all bad news in 1556. Agricola comes to the defence of the minerals industry when he states 'as the mines dig almost exclusively in the mountains otherwise unproductive, and in valleys invested in gloom, they do either slight damage to the fields or none at all... where woods and glades are cut down, they may be sown with grain after they have been cleared from the roots of shrubs and trees. These new fields soon produce rich crops so that they repair the losses which inhabitants suffer from increased cost of timber. Moreover, with the metals which are melted from the ore, birds without number, edible beasts and fish can be purchased elsewhere and brought to these mountain regions.'

### Safety

Mining is a high-risk occupation. The industry is only too well aware of this, and efforts to prevent accidents are at the forefront of all endeavour.

All mining companies conduct expensive campaigns to make their employees aware of the need to work to standards. Improvements are noted, but go without remark,
except within the industry itself. Figure 6 shows fatality and injury rates for all mines of the Chamber of Mines of South Africa.

The fatality rates shown in Figure 6 should be compared to the 1,33 fatalities per 1000 at work for off-the-job deaths in 1988. This does not include deaths from natural causes.

The ‘Sword of Honour’ award, inaugurated in 1979, is possibly the world’s most prestigious safety award. It recognizes companies where dedication to the prevention of accidents is promoted at the Board-of-Directors level, and where advanced techniques are used to reduce the possibility of injury to personnel, and damage to plant and machinery.

The minerals industry has received recognition at this level, for Rössing Uranium won the award in 1988, 1989, and 1990. Little was heard this year when the Palabora Mining Company was awarded the ‘Sword of Honour’. Palabora is the first South African company to win this award.

Why does the mining industry hide its light—not merely under a bushel, but deep underground with the ores it endeavours to extract? Has not the time come for us, the mining industry, to beat our breasts of burnished gold? Our safety record is remarkable when compared with the daily slaughter on our roads, which elicits merely a shuddering of the shoulders.

Education

In order to run the industry, an adequate supply of qualified and trained man-power is essential.

Our champion, Agricola, ‘reflects’ on the knowledge and skill the miner must have to win metals from the earth. Beyond the recognized science related to mining, a man must know philosophy, medicine, astronomy, surveying, arithmetical science, architecture, drawing, and law.

A ‘knowledge of the divisions of the heavens’ from which he may ‘judge the direction of the veins’, may not be currently acceptable as a fundamental part of geology, but the other disciplines are still part of the knowledge required by the complete mining engineer.

This wide range of knowledge no doubt accounts for the popularity of the mining engineer in other fields of endeavour, and thus many mining men are led away to greener pastures.

Recruitment and training in the minerals industry were addressed at the conference of the Council of Mining and Metallurgical Institution (CMMI) held in Edinburgh in July 1990. Patrick McCulloch provides a useful summary of the outcome of the proceedings, and concludes that there was general consensus at the conference that the basic reasons for the decline in mining-related university enrolments are:

- the decline in the number of people of university-entrance age
- the decline in the number of high-school students taking maths and science
- the indifferent quality of most teaching of high-school science.

All this is evaluated against a backdrop of

- the negative image of the mining industry in general
- the negative view of mining companies as fairweather employees who lay many people off during cycles of low metal prices.

The decline in the number of university courses for mining-related subjects is alarming. In the USA, low enrolments have caused seven out of twenty-six undergraduate programmes to be closed down or curtailed. In England, three universities have closed all mining-related departments, and two more are expected to do so shortly. South Africa has always drawn engineers from overseas to supplement the graduates from our universities.

The decline in the teaching of mineral-related subjects is sad to see, not only from the point of view of the needs of the industry, but also because the mining schools that opened in the 18th century and early 19th century led to the formation of today’s universities and engineering schools.

In the closing years of the 18th century and the early 19th century, mining schools opened all over Europe. Hungary led the way in 1747, and France followed that example in 1767. High-level training began in Prague in 1761, in Schenmitz in 1763, and in Freiburg in 1765. A Royal Mining School, which was housed at the Hotel de la Monnaie (Paris Mint) until 1788, was founded in 1783. After being re-established in 1794 in the Ecole des Mines, it provided continuous instruction in Paris after 1815. In 1816 a school for mines opened in Saint Étienne, and immediately became a School for Engineers.

The Royal School of Mines resulted from the fusion, by the geologist, Henry de la Beche, of the Mining Records...
Office and the Museum of Economic Geology in 1841. The spirit engendered by those schools of mines is to be found in mining centres around the world. Alumni have dispersed to every corner of the globe in some form of mining diaspora, and carried their special spirit with them. Traditionally they meet every Friday in pubs around the world.

The training of mining engineers in South Africa originally started in 1894 at the South African College, the forerunner of the University of Cape Town. That training was followed by two years of practical instruction at the South African School of Mines, originally based at Kimberley, and subsequently transferred to Johannesburg. The school eventually split into the Witwatersrand Technical College (now the Technikon Witwatersrand) and the University of the Witwatersrand.

For many years tertiary education was the main focus of support for the minerals industry. A proposal to put minerals-related subjects into a single school of mines in South Africa was mooted some years ago, but fell through because of the individual interests of the parties concerned.

Over and above the economic and teaching rationalization that would lead to higher standards, such a scheme would, I believe, have engendered that special mining-school spirit.

A major key to the image of the minerals industry is education aimed at
• the provision of an adequate supply of competent young people to staff the mines, and
• the education of the future general public on matters related to the mining industry so that informed comment can be made on mining-related issues.

It was to provide knowledge of the minerals industry that the Phoenix programme was devised.

The Phoenix Programme

The programme is jointly administered by the Chamber of Mines of South Africa and the SAIMM. Its main goals are:
• to develop, design, test, and evaluate, in schools, curricula material that relates school science to the mining and mineral-processing industry in the form of optional science topics;
• to implement the inclusion of minerals-industry material in the new school science syllabi, and at black colleges of education where primary and secondary teachers take diploma courses in science teaching;
• to conduct courses for science teachers in schools and science lecturers at colleges of education and equip them with knowledge and skills so that they can relate the theory they teach to its practical applications in the minerals industry.

It is absolutely essential that interest in, and enthusiasm for, science and technology should be instilled at an early age.

The contribution by South African mining houses of more than 5 per cent of their gross salary bill to the development of resources, including training, bursaries, and corporate social development, has received little publicity.

Growing concern is being expressed world wide at trends in education that will continue to produce people ill-suited to mining and, indeed, to society's needs in general. Regrettably, science graduates do not enter the teaching profession, preferring to choose more-lucrative employment in industry.

South Africa is not unique in its lack of students entering the 'hard' disciplines of science and engineering.

The lack of students has reached crisis proportions, largely due to the failure and inability of the country's divided education system to provide sufficient school leavers with the necessary academic background and work skills to meet the country's man-power requirements. The situation looks bleak when one considers the numbers for the number of science and engineering degrees conferred in South Africa (Figure 7).

![Figure 7](image-url)

**DISTRIBUTION OF DEGREES CONFERRED IN SOUTH AFRICA DURING 1986**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>7%</td>
</tr>
<tr>
<td>Engineering</td>
<td>5%</td>
</tr>
<tr>
<td>Natural Science</td>
<td>10%</td>
</tr>
<tr>
<td>Other subjects</td>
<td>78%</td>
</tr>
</tbody>
</table>

Only 500 out of 25,000 black students who gained university exemptions in 1989 had taken mathematics as a subject.

The South African mining and minerals industry is taking an active role in the restructuring of education. During the early part of 1990, the Education Advisory Committee of the Chamber of Mines of South Africa, which includes education specialists drawn from the individual mining groups, examined the country's education system and formulated an overall mining-industry education policy.

Figure 8 compares the paucity of engineering graduates in South Africa with the number in developed countries. Even with an assumed economically active population of 10 million for South Africa, the number of graduate engineers being produced is between one-half and one-fifth of those produced by developed nations.

![Figure 8](image-url)

**GRADUATING ENGINEERS**

<table>
<thead>
<tr>
<th>Country</th>
<th>POPULATION (Millions)</th>
<th>GRADUATING ENGINEERS per million of population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>120</td>
<td>500</td>
</tr>
<tr>
<td>USA</td>
<td>240</td>
<td>370</td>
</tr>
<tr>
<td>West Germany</td>
<td>61</td>
<td>340</td>
</tr>
<tr>
<td>France</td>
<td>55</td>
<td>270</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>56</td>
<td>250</td>
</tr>
<tr>
<td>Australia</td>
<td>18</td>
<td>220</td>
</tr>
<tr>
<td>South Africa</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

Figure 9 shows the actual number of graduates in mining and metallurgical engineering produced by the Universities of the Witwatersrand and Pretoria. Since the encouraging increase in numbers in the early '80s, a decline is being experienced.
These alarming statistics lead one to speculate on whether the mining engineer is possibly becoming a candidate for the Panda Paw—an endangered species. It is necessary to preserve the species for the exploitation of future mineral resources.

Although we may be experiencing a crisis in the industry, with mines closing and what appears to be a bleak future for mining engineers, there is, nevertheless, very good reason for us to redouble our efforts to change the image of the industry.

Education is a pipeline process. If people do not take up mineral-related disciplines now, there will be a shortage in four years' time when, it is hoped, a boom will again occur.

The low enrolments and closure of mining-related subjects indicate that there will be a severe worldwide shortage of mining engineers in the future. However, new technology will require more engineers. The previously mentioned research and development required by the industry will require engineers of an even higher quality.

But when there is no choice, quality will suffer. Research activities within a university department rank fairly high when students determine their choice of a specific engineering faculty. Unfortunately, the mining industry is not well known for its support of university research.

**Economics**

The minerals industry is important to the economy of most countries. Figure 10 tables the contribution that mining makes to the GDP of various countries. The overriding importance of the minerals industry in Southern Africa can be clearly seen.

South Africa possesses more than half of the world's known reserves of gold, almost half its vanadium and platinum, nearly one-third of its chromium, and one-quarter of its uranium and manganese. In addition, it has the fourth-largest known recoverable coal reserves.

The importance of the industry to South Africa's neighbours is even greater. Botswana, which had little or no mining 20 years ago, now boasts a boom economy, primarily as a result of its rise to the position of being the world's third-largest diamond producer.

The minerals industry is largely responsible for Southern Africa's extensive transport network. The railway lines linking the Transvaal with the Cape, Natal, and Mozambique were developed to service the gold-mining industry on the Witwatersrand.

More recently, two major rail lines were built and, with them, the two biggest deep-water harbours to have been constructed anywhere in the world in recent decades. These are the rail lines linking the Transvaal coalfields to Richards Bay harbour on the Natal coast and the Sishen–Saldanha line transporting iron ore from the north-western Cape to the west coast.
Public Image

In a recent editorial on Mineral Resources Engineering, Professor C.T. Shaw tells the old joke about the city child who did not know that milk comes from a cow, but thought it came straight from the bottle. He suggests that, rather than laugh at this ignorance, we should ask where the bottle came from. A surprisingly large number of people would not be able to take it further back than 'a bottle factory'.

When the material is more esoteric than glass, confidence in the knowledge of the ultimate source is even less likely. As Shaw says, very few people buy things direct from a mine.

The word *exploitation* is often used in connection with minerals when the work of the industry is being summarized. Although correctly used to mean 'to work' or 'turn to account', the word has an unfavourable semantic connotation meaning 'utilize for one's own ends, take advantage of'. *Beneficiation* is a much better word, and surely no finer example of beneficiation can be given than gold or diamond mining.

In the former, the gold won to pure metal forms 5 to 10 parts per million of the ore and, in diamond mining, the figure is around 1 part per million.

People believe that, because individual mineral deposits are non-renewable resources, this term is a correct reflection of the industry. In the minds of some, therefore, the mining of a resource is seen as a depletion of that resource by the current generation to the detriment of future generations.

Deposits do run out and mines do close, but metal prices and new technologies can alter cut-off points, and greatly affect the life of the resource. Sustainable development is possible.

The mining industry is capable of constant self-renewal under the right circumstances. Exploration to find new resources is funded by an average of 7 per cent of pre-tax earnings by South African mining houses.

The world will not run out of resources; price and technology will ensure that there are sufficient resources to meet the needs.

The world is continually developing. For example, the race to develop the peaceful use of atomic energy stimulated the development of new materials required by the modern electronic industry. The new technologies themselves have generated a demand for the less common elements (uranium, thorium, zirconium, and beryllium) and stimulated the demand for some generally unwanted and inconvenient impurities, such as antimony and arsenic.

The platinum industry is driven by the need for platinum, palladium, and rhodium in exhaust catalysts to clean motor-vehicle exhausts. Paradoxically, this 17-year-old need is driven by a concern for the environment, the same environment people want to protect by banning mining.

Those who speak out against the minerals industry say that one ton of coal per second is mined to feed Sasol 1, 2, and 3 Plants. This may seem a plundering of resources, but if one considers the wide range of products that are derived from coal, and the use that is made of them, the work is justified.

More than this: if one considers the effort that is required to win and process this coal to the end-product, surely the challenges and technology involved form the basis of a most exciting industry?

During the Industrial Revolution, the social and economic status of man gradually evolved from farming and hunting to industry and latterly to a clean, high-technological industry. The mining industry, however, is still largely shackled to its image during the Industrial Revolution, when boardings schools and a rough image were all the vogue.

At present, society has a more-sophisticated veneer, and social mores have changed. Because mining is a rough industry, it has difficulty in attracting 'outside' people, although second- and third-generation mining families are well known in mining communities.

Mines are in remote localities and necessitate a hard lifestyle to the detriment of family life. The former statement is correct, but 'a lifestyle to the detriment of a family life' certainly is not for the professional man. Mining villages are extremely attractive on the whole, providing every comfort, and catering particularly for sports lovers.

The pressure and danger of large-city life are absent and, with speedy modern transport, no location is really remote any longer. Experience shows that the family that believes it will suffer the most on being transferred to a remote mine is usually the one that does not want to leave at a later date.

Mining men tend to be independent. They are used to making decisions in remote locations and therefore resist outside interference and regulation.

The minerals industry provides job satisfaction to a broad spectrum of people because of its diversified requirements in all disciplines of engineering and science. One of the excitements of the industry is to be a part of that team.

The Role of the Institute

The SAIMM, like any institute or institution representing the minerals industry, has a key role to play in presenting the image of the industry.

It is to these professionals that industry and the general public must look for assistance. They have to ensure the maintenance of the highest technical standards. Furthermore, an institute provides a forum for the communication of specialized knowledge, and looks after the technical interests of its members. A well-respected journal of technical content is essential, as stated by John Ralph, in an address to the Australasian Institute of Mining and Metallurgy (AusIMM) last year.

'Members of the Institute are the more informed and influential people, who should be willing to enter into the public arena to educate people about mining and to influence public policy formation as it affects industry. It has become increasingly important that informed voices are prepared to speak out and redress some of the excesses in the debate which are having detrimental effects on the industry.'

If we in the industry cannot see the benefits of being part of the industry, then there is a problem that requires addressing. It is to the sons and daughters of our middle-
management team that we must appeal for our future technologists. They know the life of the industry. In short: the mining spirit needs to be regenerated.

What Can be Done

The following remedial actions can be taken by the mining and minerals industry.

Education of the Public

The Chamber of Mines South Africa is doing this via schools and through its Phoenix programme. The American Mining Congress (AMC) recently published a booklet What Mining means to Americans. The Australian Mining Industrial Council (AMIC) is producing a series of advertisements entitled Mining: life's essential element.

Assistance with School Education

Engineers associated with the local mining industry are probably the best-qualified people in a variety of disciplines to assist with the teaching of science and maths.

Adoption of a School

There is no way in which the mining industry can affect school education over a broad front. Individual mines and the Chamber of Mines can influence selected schools in mining areas through mine visits, talks at these schools on subjects like conservation, and support of the school in numerous ways. This method will ensure a supply of people to the industry from these schools.

Pro-active and more aggressive Public Relations

The minerals industry should develop positive relationships with the media, citizens, and the communities in which it operates.

Encouragement of the Entrepreneurial Spirit

Mining is a risky business. We are only too aware of that in the current circumstances of low gold and base-metal prices. However, an entrepreneurial spirit is essential.

Increased Encouragement of Academic Performance in Science Subjects at High Schools, Technikons, and Universities

Good examples of this type of encouragement are the prestigious Gold Fields Engineering Awards and the Mintek Science competitions.

Summer schools should be arranged for scholars in Standards 8 and 9 at which they can observe, and preferably participate in, engineering work.

Professional Stature and Recognition

The minerals industry as a whole should make every effort to ensure that engineers are accorded the professional stature and recognition they deserve. This perception must also extend to the non-mining world.

Conclusions

- The minerals industry has shaped civilization throughout history.
- Minerals are essential in our every-day lives.
- There is good engineering and technology within the industry, but increased research and development is needed if we are to keep pace with the demand for minerals.
- Minerals can be extracted from the earth in an environmentally safe manner, and the industry can lead in areas of environmental control. The rejection of economic growth as a means to save the environment must be seen to be a false concept.
- Recycling must be encouraged to conserve resources.
- The minerals industry has a need for the best engineers.
- The minerals industry is an industry of which we can be proud, but unless a concentrated effort is made to improve the industry's image, its detractors will grow in numbers and strength.
- It is our duty, as professionals in the industry, to provide the lead in improving this image.

Agricola gave his conclusions thus.

If we remove metals from the service of man, all methods of protecting and sustaining health and more carefully preserving the course of life are done away with. If there were no metals, man would pass a horrible and wretched existence in the midst of wild beasts, they would return to the acorns, fruits and berries of the forest. They would feed upon the herbs and roots which they plucked up with their nails.

They would dig out caves in which to lie down at night and by day they would move in the woods and plains at random like beasts and in as much as this condition is utterly unworthy of humanity, with its splendid and glorious endowment, will anyone be so foolish and obstinate as not to allow that metals are necessary for food and clothing and they tend to preserve life?

Acknowledgments

I am indebted to a number of my colleagues, representing different disciplines in the minerals industry, who read this paper and gave me their valued comments. My thanks are also due to Horst Wagner and Fritz Volk for the loan of reference material on the historical aspects of European mining. Particular thanks must go to Eris Malan for her assistance with editing and layout.

References


Simon-Robertson Group Prize

Student members of The Institution of Mining and Metallurgy (IMM)—both in the United Kingdom and elsewhere—are invited to submit short reports on their 1991 summer-vacation work.

- Students' submissions will be reviewed, and selected reports will be published in the IMM Journal Minerals Industry International.
- The Simon-Robertson Group Prize (which will consist of a certificate and a cheque for one hundred pounds) will be awarded to the author of the best report, as selected by the Younger Members Committee.

Reports that are likely to be considered suitable for publication will cover an area or areas of interest to a high proportion of the IMM readership. Some suggestions are given below.

- A topic of special technical interest encountered at any place of work—for example, a mine, exploration programme, industrial operation, or research establishment
- Experiences of employment in an unusual location
- Experiences and recommendations in obtaining vacation employment, and achieving the maximum benefit from it.

Reports should be between 1000 and 2000 words in length, typed double-sided on A4 paper. The inclusion of line and photographic illustrations is encouraged. The deadline for the submission of reports is 30th November, 1991, and the prize will be awarded at the Annual General Meeting of the Institution of Mining and Metallurgy in May 1992. The reports should be sent to:

The Secretary
The Institution of Mining and Metallurgy
44 Portland Place
London WIN 4BR
United Kingdom.

Metals and Steels Opportunities

A conference on 'Southern African Metals and Steel: Opportunities for the '90s is to be held in Harare from 17th to 19th November, 1991. The conference is being organized by Metal Bulletin PLC.

The changing pattern in world politics and the growth of new markets are set to significantly alter the face of Southern Africa's metals industry, creating exciting opportunities for traders and investors in one of the world's richest sources of metals and minerals.

The programme is currently being finalized and includes papers on mining and investment opportunities in Zimbabwe; the future of PGM mines and markets in Southern Africa; power, labour, and transport; prospects for iron and steel exports; stainless steel; ferro-alloy produc-

This Conference will be of special interest to the producers of metals and steel in the region, local and international trading houses, international investors and analysts, and anyone who is seeking new business opportunities for the next decade.

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