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.

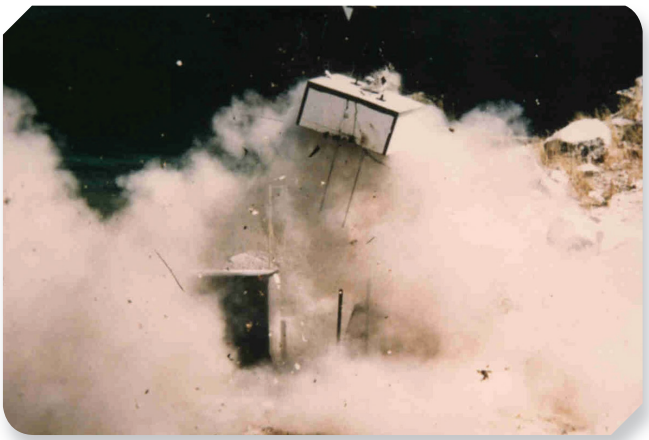
> **How is it possible that the mining industry would regard the research as too costly? And thus, how can rock engineering research capacity in South Africa have been allowed to dissipate completely from the research powerhouse that it once was?**

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,



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

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