Stoping systems and technology

by R. Pickering*

Introduction

The purpose of this paper is to explore the application of technology to stoping systems. *Technology*, because for the past 100 years the South African narrow reef mining industry has battled to control working costs in a labour-intensive industry. *Stoping systems*, because it is the stoping method and methodology which is at the heart of the mining system. Introduce a more efficient stoping system and the mining system will look after itself. The technology applied to stoping over the past 100 years can be categorized as follows:

- The introduction of pneumatic rockdrills early this century, the cumbersome rig mounted units being replaced by smaller, lighter hand-held units which were then made easier to use with the addition of an air leg
- Scraper winches to replace gravity and shovels to move rock both in the face and the gullies were first introduced in the late 1920s
- Hydraulic props as a support method arrived in the 1960s
- Some people argue that tungsten carbide inserts were equally important.

There have been a number of attempts to introduce different technologies into stoping, the most recent being trackless equipment. Where the stoping layout suits the technology it has been successful. There have been too many instances where a technology has been installed because it is fashionable.

At the end of the day the outcome from change in the stoping systems has to be safer and more profitable mining systems. It is the contention of the author that change is only likely to be effective if it is supported by the introduction and application of appropriate technology.

Other industries

It is interesting to see how other mining industries have changed in the last 50 years. The British coal mining industry is a good example. Table I gives an overview of the statistics between 1947 and 1994. Fatalities per thousand employees improved by a factor of three and productivity measured in tons per man shift improved by a factor of thirteen. Over the corresponding period the SA gold mines experienced a 25% reduction in fatalities per thousand employees and productivity measured in ounces of gold per employee doubled (see Table II).

The author of the paper which contained the coal mining statistics went on to say. 'These improvements have been made by the application of advanced technology. From the early stages of mechanization in the 1950s through to the rapid development of the 1970s and 1980s and on to the heavy duty mechanization in more recent years'.

Table I

British coal 1947/1994

		1947	1994
Number of Mines		980	16
Production (million tons)	Deep mines	180	29
	Open cast	8	14
Employees		697 000	7 400
Tons per man shift		1.03	13
Fatalities		543	2

Table II

South African gold mines (Chamber members) 1947/1993

		1947	1993
Production	(million tons rock)	49	122
	(tons gold)	332	617
Grade (grams/ton)		6.8	5.6
Gold value (R/oz)		17.3	1 176
Employees		334 696	366 248
Fatalities		482	390

Selection of appropriate technology

The author has recently been involved in the development of stoping systems for a number of mines. The process usually involves mine employees and suppliers of technology. It is important that the team includes people who have the ability to think broadly and who, preferably, have had experience in the development of novel stoping systems. The basic requirement of any new stoping system is *safe production*, that is, safer and more profitable mining. It is achieved by ensuring that *competent people* carry out *safe working practices on fit-for-purpose equipment*. Like risk assessment, the process used for the development of these systems requires proactive and participatory behaviour from the team.

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The various steps in the process can be defined as follows.

Define the untouchables

These are factors which are inviolate and cannot be contravened. They are almost always safety related and in the various debates have included the following:

- no employees to work under unsupported hanging,
- the spacing between pillars not to exceed ??????
- the ground must be destressed before mining
- the stope width not to exceed ??????
- the maximum spacing between face and backfill is not to exceed ??????.

These factors are defined at the beginning of the session and each suggestion or stoping system proposal is tested to ensure that it conforms to the untouchables.

Proposed stoping layout

To the best knowledge of the team the proposed layout must be practical. (If use is to be made of long hole drilling then what is a practical limit for straight holes?) The equipment must not be expected to perform outside its normal operating parameters. It is still only a stoping layout and the major issues are usually 'will the equipment be able to practically operate in the defined environment' (what is the maximum incline for trackless equipment); and how the layout will cope with variations in geology, grade and rock structure. At all times the various proposals are tested to ensure that they do not contravene the untouchables. At this stage a preliminary suite of equipment is identified.

Equipment selection

The appropriate equipment is now selected. The focus is not on a particular manufacturer but rather on the functional specification for the equipment and how it impacts on the proposed stoping layout. The equipment is now fitted into the stope excavations i.e. the stope excavations are sized to accommodate the equipment.

Definition of mining district

Based on the expected performance of the individual pieces of equipment an equipment fleet is identified. Every effort is made to optimize the production from the fleet. Rock handling capability is matched to rock breaking rate. Support is integrated into the mining cycle. It is at this stage that the stoping system and technology requirements are defined.

Costing

The capital and operating costs of the equipment are now determined based on experience and historical data from similar environments. Dilution and manning levels are often major issues at this stage. These cost and performance figures are compared to conventional mining costs. *The new system has got to be more cost effective than the old system*.

Application of new technology

It is recognized that the application of new technology in the mining industry is a difficult process and has often been unsuccessful, however, it is also important that we are able to learn from our previous experiences to ensure that the installation of new technology is more successful in future. It is well known that safe production can only be achieved with a combination of the right equipment, trained people, and appropriate operating procedures. The purpose of any technology implementation, plant, or technology transfer process is to ensure that these objectives are achieved. At a workshop attended by senior people in the mining industry it was determined that the most important issues which govern the successful transfer of technology were as follows:

Recognizing needs

- People at all levels in an organization must see the benefits of the technology for themselves.
- The need addressed by the innovation may have to be described differently to the various levels in the mine or organization.
- Mine staff should be involved in the need definition process at an early stage to ensure that real needs are recognized and appropriately described.

Mining people

- People in the mining industry rely heavily on word-of-mouth to gauge the effectiveness or otherwise of equipment trials.
- The training of people in the application of new technology requires a professional approach.
- People must be educated in the concepts on which the new technology is based.
- Unanticipated consequences during the introduction of new technologies can lead to failure of the technology transfer process.
- Technology suppliers should under-promise and over-deliver.

Champions

- Champions are essential at all levels in the mining hierarchy, they must be identified early and adequately supported by their superiors and the staff involved in the technology transfer.
- Championship is a managed process, and champions should be created at all the stages of the transfer process. The 'flame of championship' must be spread.
- Good champions are innovative, successful, and leaders with credibility and integrity.
- Champions are more objective than passionate about the technology they are promoting; they put success of the technology above personal ambition.

Appropriateness of the technology

- A new technology must be appropriate to the skills of mine production and maintenance staff, and it must be sufficiently robust to withstand the underground environment.
- It must address real and current needs.
- Sophisticated technology must be 'invisible' to the end user.

Management of the technology transfer process

- The introduction of new technology, although a complex social process, can and must be carefully planned and managed.

- Technology transfer plans must be compiled early and reviewed regularly, to ensure that the need and the solution remain relevant.
- It is easier to transfer incremental change than it is to transfer technologies which result in significant changes in work practices.
- The technology transfer process must be managed to minimize the risk of all concerned.

Partnerships

How does a company like Sandvik Tamrock fit into this equation? We supply equipment to mine operators and contractors on a world-wide basis. It is in our own interest to ensure that mechanized mining is successful and this can only be achieved if the right equipment is selected for the right job. We have an employment policy of recruiting people who are experienced in mine mechanization. We will bring our experience to the party and help you plan your new mining operation—we hope you will select our equipment—then we will maintain it for you. Finally, you can help us to identify where we should be going in the development of new equipment. We all need to work together to achieve safe production.

Conclusion

Technology is the only way to substantially increase the safety and productivity of the mines. We tend to think we have tried it all before. However, times have changed and technology has developed. Today the need is even more pressing than it was in the past. There are processes and methodologies that we can follow to ensure that we have a more than reasonable chance of success.

Let's just do it. ◆

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