projects and mine exploitation; these have become an integral part of the engineering requirements.

In the economic domain, the various elements required to establish the economic feasibility and profitability of a mining project are reviewed, and assessment steps and procedures are proposed (Chapter 10). The final (bankable) feasibility study and the decision it supports must be based on appropriate quantitive estimates of all the aspects involved, so that the profitability of the investments required for mine development is ensured (Chapter 11). At that stage, proper evaluation of all the risk factors that cannot be quantified is essential to ensure proper returns on these investments. Chapter 12 suggests norms for the presentation of professional reports dealing with reserve estimation, feasibility studies, and mine financing.

Part 2, *Classification of Reserves and Resources*, first presents the various systems for ore, reserve, and resource classifications that have been used since the start of the century (Chapter 13). The main problems encountered, especially in the use of the terms *ore, reserves, and possible reserves,* are reviewed critically in Chapter 14. Mineral inventory and reserve classification are proposed to integrate the significant features of the existing systems (Chapter 15).

The key elements of the proposed classification system follow current trends. The term *reserve* should be used only when the geological, engineering, and economic knowledge and information ensure that the mining project is feasible. *Reserves* are by definition mining reserves. At earlier stages of deposit development, when quantitive knowledge is mainly geological, the terms *delimited mineralized resource* or *delimited mineral deposit* should be used. Proven and probable reserves can each be subdivided into two classes that better express the many steps of mineral evaluation; similar divisions are used for delimited mineralization. The *possible reserves* category should be replaced by that of *inferred mineralization* (or *resources*); this solution conforms to the U.S. Securities and Exchange regulations and to the recommendations of the Australasian Code. Use of the margin of error of the estimates at a confidence level of 90 per cent is proposed as an objective; implementation would establish the precision of the estimates, and would assist in distinguishing the deposit categories and classes.

LETTER

Safety factors

Mr Janisch's comment* in the August issue on Dick Stacey's remarks about safety factors indeed requires wider debate. The example he quoted to illustrate the successful application of the safety factor concept in coal mining, namely the Salamon formula, is to my knowledge the only recognized application of that concept. Not only that, but that particular formula should be used only for what it was intended, namely to prevent major disasters. It was never intended to indicate long-term pillar stability, and it should not be used for that.

In coal-pillar design, we progressed from the pre-Coalbrook gutfeel method to one of rational design. Extension of the basic method to cover squat pillars and to derive area-specific strength parameters are mere refinements of a basically proven method.

The next quantum leap would be to design for stability over time. We must aim at developing a method that will enable us to quote pillar stability in terms of weeks, years, decades, millennia, whatever—not just a ratio of what we tend to think are constants but are, in fact, variables.

This is not development for the sake of science. Worldwide, pillars that have been stable for anything from a decade to a century are now failing, in certain instances at tremendous cost to the surface infrastructure. To cater for the accelerated trend towards urbanization in South Africa, we will want to develop more and more areas that are standing on coal pillars. Who can really tell how safe that is?

We often hear the silly argument that there is no reason for pillars to fail now if they have been stable for fifty years. Please. If we apply the same argument to our own lives, it implies that we die on the day when our probability of living reaches its maximum.

We need to address the time-related decay of pillar strength scientifically. We now have data that Salamon would only have dreamed about. Computational facilities are mind boggling when compared with what was available in the sixties. We still have trained people. I believe we can do it. I believe we have to do it.

With regard to the general issue of applying safety factors in rock engineering, its absence is more than disturbing. Surely, if we really *design* layouts, support, pillars, whatever, we logically need to know two things: the demands that will be placed on the thing, and to what extent the capability of the thing exceeds the demand. Comparison of these two basic parameters yields a measure of predicted success, whether we express it as a safety factor, failure probability, or whatever.

The fact that we never see such a figure is to my mind an indication that we do not apply rational design procedures. We follow standard guidelines and recipes that have been shown to work. This is not design; it is copying.

It is true that seismicity overshadows the rock-engineering scene. Dick Stacey has also correctly pointed out that we do not know enough about this phenomenon to apply rational design procedures. But surely there is more to rock engineering than seismicity? What about tunnel support in non-seismically active areas? Or coal-mine roof support? Longwall shields?

I believe that there are several aspects that are sufficiently well understood to allow the application of rational design procedures. By knowing the extent to which we are either over-supporting or under-supporting, we can improve either the economics or the safety of mining. We can bring about the improvements only by doing real design. It is time we started doing just that.

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