Journal Comment

The increasing role of computers in engineering

When I first read the abstracts of the six papers appearing in the *Journal* this month, I thought that I would have to comment on each paper individually and in depth, as there did not seem to be a common theme linking them in any way. What do you think: CFD modelling of ventilation patterns in mines, sublevel stope optimization, the indexing of mining risk, controlling fires in coal mines, process for treating vanadium titano-magnetites, and erosion of the freeze lining in submerged-arc furnaces?

However, on shifting my grey-matter brain cells into turbo mode with subsequent readings, I noticed that only two papers highlighted experimental results, their interpretation, and implications. In terms rarely used today, they closely followed the 'Scientific Method', consisting of 'systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses' (source: Wikipedia). All the other papers employed a far broader version of the Scientific Method by focusing on some aspect of computer-based modelling coupled with verification of the output using either simulated or actual experimental data. For a traditional experimentalist, the fact that a computer model can be verified using simulated data is the realm of the heretic – how times have changed!

Even as recently as 20 years ago almost all the papers in the *Journal* would have reported on experimental results, with computers being used for only for extremely complex numerical calculations such as multivariable linear and nonlinear regression to find a 'best fit' to the data. However, at least early versions of Excel were available with add-ons to do the background programming for you. If you go back 40 years, computer literacy meant having to learn Fortran IV, possessing an in-depth knowledge of matrix algebra, and punching your own cards. Hullo, hullo – does anyone remember those days?

I learnt to program in Fortran IV in the late 1960s at the Durban campus of what is now the University of KZN. The university had an IBM 1130 mainframe computer that occupied the floor space of an entire room: 128 kB of random access memory and a 20 MB hard disk that required two persons to lift. I swear – it's the truth! Ask anyone who studied in the Chemical Engineering department at that time. I remember running in pouring rain to the Electrical Engineering department where the computer was housed, slipping on the wet walkway, and dropping a box of cards that had taken two full days to punch the source code into a huge puddle. Or surreptitiously exchanging the order of two cards in the box of the massive programme of your best friend so that the computer printout (note: there were no computer screens in those days) the next day read: 'Compilation terminated - Format error'. What can I say, but – 'Happy Days'.

Seriously, to revert to the present time, the impact of cheap, readily accessible, off-the-shelf, computational software such as Excel and Matlab, and techniques such as computational fluid dynamics, finite element analysis, Monte Carlo simulation, and many other others is immense. The research published in the Journal this month would have been unthinkable to the average engineer when we were all queuing up for the first democratic elections in South Africa a mere 20 years ago. There's an Afrikaans expression, 'Kyk hoe lyk dit nou', that loses some of its meaning when translated into English, 'See how it looks like now', that captures the incredible advances that computer-based modelling has made into the engineering space that used to be occupied almost exclusively by the experimentalist.

The computer modellers have plenty to read in this month's *Journal*. Dirker *et al.* at the University of Pretoria use computational fluid dynamics to find ventilation solutions to control the high concentrations of coal dust and methane gas in underground coal mines. Bai *et al*. at the Polytechnique University, Canada, present a mining stope optimizer to show that multiple raises reduces dilution compared to a single raise stope, and provide significantly larger profits. Abdellaha *et al.* at McGill University, Canada, use a finite difference model to estimate the risk index for a mine development intersection situated 1.5 km underground. Hu Dong *et al*. at the University of Science and Technology, China, use the boundary element method to develop a heat conduction model to determine the erosion of freeze linings in a ferronickel submerged arc furnace. All great examples of computer modelling.

For the experimentalists, Chen *et al*. at the Northeastern University, China, report on the results obtained after subjecting vanadium titano-magnetite samples to metallization reduction and magnetic separation in order to attempt separation of iron, vanadium, and titanium. I assume that the samples originated from a mineral deposit in China, but they might well have come from the Bushveld Complex in South Africa. Those who regularly read a local weekly mining newsletter will have noticed, I am sure, that the Bushveld Complex has been receiving considerable press recently, and is described as 'a veritable Aladdin's Cave of mineral treasure'. A bit over the top for my liking, but there is no doubt that mining companies are looking with increasing interest at the mining and processing of these multi-element complex orebodies. Finally, Sahay *et al*. at the Central Institute of Mining and Fuel Research, India, derive a methodology from experimental results on open fires in underground coal mines that will facilitate rapid control of such fires by the application of modified ventilation control techniques.

We are now so dependent upon computers, not only in the technical realm, but also in our social lives, that it difficult to believe that technology leaders of their time made statements such as:

Journal Comment (continued)

'I think there is a world market for maybe five computers' - Thomas Watson, Chairman of IBM, 1943.

'Computers in the future may weigh no more than one-and-a-half tonnes' - Popular Mechanics, 1949.

'There is no reason anyone in the right state of mind will want a computer in their home' - Ken Olson, President of Digital Equipment Corp, 1977 (quotations sourced from the internet).

To end, for those who are forced to comply with the IT policies of their companies (e,g. can't send e-mails with attachments bigger than 5 MB), or to wait for some 20-year old to fix the bugs introduced into your crashed computer when they upgraded software remotely without telling you, enjoy the following:

'How many hardware engineers does it take to change a light bulb? None: We'll fix it in software.'

'How many software engineers does it take to change a light bulb? None: We'll document it in the manual.'

'How many Microsoft engineers does it take to change a light bulb? None: Let's define darkness as the industry standard.' (Original source unknown – just google 'computer light bulb jokes').

Just kidding – I love computers and all computer engineers!

R. Paul

The Danie Krige Memorial Lecture

The first Memorial Lecture was presented by Dr Winfred Assibey-Bonsu at the WITS Professional Development Hub on 15th May. The event was organized by Prof Dick Minnitt and the attendance of 82 people included Ansie Krige and a number of Krige family members.

The Lecture can be accessed from the SAIMM website: www.saimm.co.za