

# SMI Knowledge Transfer

## Statistics



### The Problem

Minerals engineers are often required to do experiments and to analyse the results from those experiments. They may range from simple laboratory tests to major plant trials lasting several months and costing hundreds of thousands of dollars. Examples include:

- Laboratory tests of a new flocculant
- Laboratory grinding and flotation tests of new ores
- Pilot plant tests for flow sheet design
- Plant trials of a new flotation reagent
- Plant trials of a new circuit configuration or item of equipment

In each case, data are collected to allow some decision(s) to be made. It is important to arrive at the right decision in the shortest possible time and at the lowest possible cost. This is often difficult to achieve because mineral processing data are usually imprecise and, especially in the case of plant data, subject to uncontrolled trends, cycles and variations, which make comparisons difficult. The figure below shows the daily gold recovery from a copper-gold concentrator. An improvement of 1% in recovery would be well worthwhile, but very difficult to detect against a daily variation of over 25%, unless the data are collected and analysed in the correct way.

### The Solution

A 3-day course and a 2-day workshop are offered, to equip the student with the statistical tools necessary to make wise decisions in the face of uncertainty in the mineral processing environment.

A full set of notes is provided for each, plus Excel spreadsheets for many of the methods discussed. A wide range of numerical examples taken from real mineral processing case studies is used to illustrate the methods described. Excel-based examples allow students to develop and refine their analytical skills. Tutorials and answers provide a library of additional case studies for future reference. Topics covered include:

- The nature and measurement of error. Where does error come from?
- Uncertainties and confidence limits; the propagation of error.
- Comparing quantities using the t-test, F-test and chi-square test.
- The number of tests required.
- Experimental designs, including the randomised block and the factorial experiment.
- Modelling with regression; comparison of two regression lines.
- The practice of conducting and analysing plant trials.
- Time series modelling and cumulative sum charts for analysing plant trials.
- Selecting the best statistical method.
- A protocol for conducting mineral processing experiments

SMI Knowledge Transfer, a business unit of JKTech, is a unique professional development initiative, offering professional development and life-of-mine training courses and workshops to the global resources sector.



## Statistics

The courses are intended for metallurgists, chemists and other mine site professionals. Technical staff and students concerned with the planning and analysis of laboratory experiments, assay data and plant trials in industry or for research will find the course a valuable and relevant addition to their skills. Some knowledge of elementary statistics is useful but not essential. Much more important is a sense of enquiry and a real desire to run better, more decisive and more cost-effective experiments and to analyse data correctly. A sense of humour always helps.

## Courses Available

A 3-day course in Comparative Statistics and Experimental Design for Mineral Engineers. This covers the statistical principles and methods needed to conduct and analyse effective laboratory experiments and plant trials. A comprehensive 133-page manual is provided for use in the course and for later reference. Participants use the Excel statistical toolbox to analyse a large number of examples of the methods discussed in the course.

A 2-day workshop in Designing and Analysing Laboratory Experiments and Plant Trials. This concentrates on mineral processing plant trials. One day is spent learning the basics through instruction and practice with the Excel statistical toolbox, and a second day is devoted exclusively to the analysis of data from several actual plant trials, working in small groups and discussing the results in plenary sessions so that experience can be shared and good experimental practice encouraged. The workshop is supported by a 40 page manual.

Participants are encouraged to bring along case studies and problems for discussion. Specific case studies can be submitted for the workshop if sufficient notice is given (at least one month). Participants should bring a laptop PC with Excel installed, including the Analysis ToolPak Add-In.

## The Course Leader

Professor Tim Napier-Munn has been making sense of mineral processing data for 40 years. He has extensive experience in mineral industry statistics and experimental design, both as a practitioner and as a teacher. He has been giving statistics courses for over 30 years to practicing engineers and to undergraduate and postgraduate students on five continents. He also consults to mining companies and vendors in the design and analysis of plant trials, and has published a number of papers on the topic.

Tim Napier-Munn is a mineral engineer with bachelors and PhD degrees from Imperial College, London, and a Masters degree from the University of the Witwatersrand, Johannesburg. He worked for De Beers in South Africa for many years, latterly as Manager of the Diamond Research Laboratory Mines Division. He lectured at Imperial College in London, and in 1985 joined the Julius Kruttschnitt Mineral Research Centre at the University of Queensland, from where he retired as Director of JKMRC and Managing Director of JKTech Pty Ltd in 2004. He now works part-time for the JKMRC and consults through JKTech. He is a Fellow of the Australasian Institute of Mining and Metallurgy.

### JKTech Services

- Consulting (comminution, flotation, mineralogy, mining & geometallurgy)
- Process Mineralogy and In-House Instrument Analysis
- Specialist Software (JKSimMet, JKSimFloat, JKMultiBal, JKSimBlast)
- Specialist Equipment (ore breakage characterisation, flotation characterisation)
- Metallurgical Laboratory Services
- SMI Knowledge Transfer

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