

PROCEEDINGS OF THE  
**MATHEMATICS IN INDUSTRY  
STUDY GROUP**

2005



## **Mathematics in Industry Study Group South Africa MISGSA 2005**

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## PREFACE

The Second Mathematics in Industry Study Group (MISG) Workshop in South Africa was held in the School of Computational and Applied Mathematics at the University of the Witwatersrand, Johannesburg, from Monday 24 January to Friday 28 January 2005.

There were approximately sixty-five participants at the MISG. Twenty University staff, three Postdoctoral Fellows, twenty five postgraduate students, nine Industry Representatives and seven invited overseas guests attended. The guests were:

Dr Chris Breward	University of Oxford
Prof Jon Chapman	University of Oxford
Professor Alistair Fitt	University of Southampton
Dr Neville Fowkes	University of Western Australia
Prof Andrew Lacey	Heriot-Watt University
Prof Kaisa Miettinen	University of Jyväskylä, Finland
Dr John Ockendon	University of Oxford

The South African Universities which were represented were the University of Cape Town, University of Johannesburg, University of Limpopo, North West University, University of Pretoria and University of the Witwatersrand .

The MISG Workshop was opened by Professor Belinda Bozzoli, the Deputy Vice-Chancellor for Research at the University of the Witwatersrand.

The MISG Workshop followed the established format for MISG meetings held in the United Kingdom, Australia, New Zealand, Canada, Asia and the United States. South African industry had been approached to submit problems during the second half of 2004. Thirteen problems were submitted. Eight of the problems were considered at the MISG and the choice was determined by the interests and experience of the participants. On Monday each Industry Representative made a twenty-five minute presentation in which he described the problem and outlined what he thought needed to be done. On Tuesday, Wednesday and Thursday the academics worked in small groups on problems which suited their interest and expertise. Each problem was managed by a moderator whose role was to co-ordinate the research on the problem during the week of the meeting and also to do preparatory work including literature searches before the MISG meeting. In 2005 the moderators were all from South Africa. Each moderator was in contact with the Industry Representative on Tuesday, Wednesday and Thursday. Several of the Industry Representatives stayed for the five days of the MISG. On Wednesday afternoon each moderator presented a five-minute progress report on their

problem. On Friday morning there was a full report back session to industry. Each moderator made a twenty-five minute presentation, summing up the progress made and the results that were obtained. Each Industry Representative then had five minutes in which to make comments on the progress and on the results which were reported. The MISG ended at lunch time on Friday.

Three invited lectures were given on Tuesday, Wednesday and Thursday evenings by applied mathematicians with experience at solving problems from industry. The aim of the lectures was to show how mathematics could be used to solve problems in industry.

Prof Alistair Fitt	<i>“How to solve industrial problems”</i>
Prof Jon Chapman	<i>“Asymptotics for ordinary differential equations”</i>
Prof Andrew Lacey	<i>“Modelling homeless populations and housing allocation”</i>

An informal after dinner talk was given on Thursday evening:

Dr John Ockendon	<i>“The globalization of Study Groups”</i> .
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The evening presentation was attended by the Vice Chancellor of the University of the Witwatersrand, Professor Nongxa, who is a mathematician.

The main contribution made during the week of the MISG was to expose the industrial problems to the mathematics community and to do modelling and simulations. Work continued on the problems after the meeting ended. In March 2005 an equation-free Executive Summary, not more than two pages in length, for each problem was given to each Industry Representative. The Executive Summary was designed to inform Management of the progress made at the MISG on their problem. In the Proceedings of the MISG the mathematical progress made on each problem up to December 2005 is presented and suggestions for further work are made. Moderators with the most active members of their group and the Industry Representative will be encouraged to publish their results in international journals.

A MISG brings together mathematicians to work on and solve research problems of industrial origin. Mathematical solutions will assist South African industry to become more efficient and competitive thereby creating jobs and contributing to the prosperity of South Africa. Mathematicians in turn see the challenges facing industry. By working in small groups with experienced industrial mathematicians academics receive training in solving problems from industry. New collaborations are established within South Africa and also internationally with the invited guests. Higher degree students are encouraged to participate in the small study groups and the work done could develop into suitable mathematics in industry topics for Masters dissertations and PhD theses. By demonstrating to companies that

mathematics can be used successfully to solve problems in industry, job opportunities will be created in industry for graduates in the mathematical sciences. Applied industrial problems can also lead to problems in basic research. Some of the problems should provide innovative teaching material since mathematical modelling plays a central role in the solution process.

**The sponsors of the MISG were:**

National Research Foundation (NFR), Pretoria, South Africa

University of the Witwatersrand Research Committee

Anglo American Chairman's Fund

The Royal Society of London

We thank the sponsors without whom the Mathematics in Industry Study Group meeting could not have taken place.

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## PROBLEMS

For each problem submitted by industry, the title of the problem, the industry presenting the problem, the industry representatives and the academic monitors are listed below.

### Problem 1.

**Title:** Analysis of lubricant behaviour and roll deformation during cold rolling of steel.

**Industry:** Cold Processes, Columbus Stainless Steel

**Industry Representative:** Johan Ackerman

**Moderator:** Tim Meyers

### Problem 2.

**Title:** Piston effect due to rock collapse

**Industry:** Mining

**Industry Representative:** Richard Stacey

**Moderators:** Eunice Mureithi and Astri Sjoberg

### Problem 3.

**Title:** Prediction of lime quality and carbon monoxide levels within in a lime kiln

**Industry:** Optin

**Industry Representative:** Tony Lange

**Moderator:** Peter Browne

### Problem 4.

**Title:** Optimal scheduling and loading of trucks for distribution of soft drinks

**Industry:** Amalgamated Beverage Industries

**Industry Representative:** Kevin Hingst

**Moderator:** Londwine Masinga

### Problem 5.

**Title:** Determining the source of moisture variation in produced paper

**Industry:** Sappi Forest Products, Ngodwana Mill

**Industry Representative:** Karel Boon and Corne De Jager

**Moderator:** Mark Jeffreys

**Problem 6.**

***Title:*** Support to rock excavations provided by thin adhesive liners

***Industry:*** Mining

***Industry Representative:*** Richard Stacey

***Moderator:*** David Mason

**Problem 7.**

***Title:*** Customer satisfaction under changes to a distribution network

***Industry:*** Amalgamated Beverage Industries

***Industry Representative:*** Kobus Fourie

***Moderator:*** Henri Laurie