

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

2006



Mathematics in Industry Study Group South Africa MISGSA 2006

The manuscripts for the Proceedings of the MISGSA were written by the problem moderators in consultation with the other members of the study group for that problem and the industry representative.

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PREFACE

The Third 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 23 January to Friday 27 January 2006.

There were fifty-two participants at the MISG. Nineteen University staff, four Postdoctoral Fellows, twenty-two postgraduate students, four Industry Representatives and three invited overseas guests attended. The guests were

Professor Sean Bohun:	Pennsylvania State University United States of America
Professor Linet Ozdamer:	Izmir Economy University Turkey
Professor Sanjeev Sabnis:	Indian Institute of Technology, Bombay India

There was a fourth overseas participant:

Dr Jens Gravesen:	Technical University of Denmark Denmark
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The South African Universities which were represented were:

University of Cape Town
University of Johannesburg
University of KwaZulu-Natal
University of Limpopo
North West University
University of Pretoria
University of Stellenbosch
University of the Western Cape
University of the Witwatersrand

The MISG Workshop was opened by Professor Ramesh Bharuthram, the Dean of the Faculty of Science 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 2005. Six problems were submitted. 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. The moderators were all from South Africa. Each moderator was in contact with the Industry Representative on Tuesday, Wednesday and Thursday. 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 results which were reported. The MISG ended at lunch time on Friday.

Four invited lectures were given, one each evening of the meeting, 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:

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|---------------------|--|
| Prof Tim Myers | <i>“Theory and applications of non-Newtonian thin film flow”</i> |
| Prof Sanjeev Sabnis | <i>“Case studies involving statistical applications in Indian industry”</i> |
| Prof Sean Bohun | <i>“Organising a successful Graduate Industrial Mathematical Modelling Camp”</i> |
| Dr Jens Gravesen | <i>“Highlights from the Danish Study Group”</i> |

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 2006 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 2006 is presented and suggestions for further work is 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 (NRF), Pretoria, South Africa
Anglo American Chairman's Fund
University of the Witwatersrand Research Committee

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 moderators are listed below.

Problem 1.

Title: Optimization of deliveries from distribution points

Industry: CaterPlus

Industry Representative: Martin Engelbrecht

Moderator: Montaz Ali

Problem 2.

Title: Analysis of the potential mechanisms of rockbursts

Industry: Mining

Industry Representative: Duncan Adams

Moderators: John Napier

Problem 3.

Title: HIV modelling in a labour force

Industry: Mining

Industry Representative: Two medical practitioners from the sector

Moderators: Londiwe Masinga and David Sherwell

Problem 4.

Title: Modelling temperature, moisture content and maturity in concrete dams

Industry: Cement and Concrete Institute

Industry Representative: Yunus Ballim

Moderator: Tim Myers

Problem 5.

Title: Polar plots of diamond surface energy

Industry: I.C. Consultants

Industry Representative: Joh Hansen

Moderator: Henri Laurie

Problem 6.

Title: Modelling airblasts in a long tunnel with surface roughness

Industry: Mining

Industry Representative: Richard Stacey

Moderators: David Mason and Eunice Mureithi