

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

2004



Mathematics in Industry Study Group South Africa MISGSA 2004

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PREFACE

The First 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 19 January to Friday 23 January 2004.

There were approximately fifty participants at the MISG. Twenty-five University staff, fifteen postgraduate students, ten Industry Representatives and two overseas invited guests attended. The guests were Professor Alistair Fitt of the University of Southampton in the United Kingdom and Dr Neville Fowkes of the University of Western Australia in Perth, Australia. Professor Gazanfer Unal of the Istanbul Technical University who was visiting North West University also attended. The South African Universities which were represented were the University of the Witwatersrand, University of Cape Town, University of Limpopo, North West University, University of Pretoria and Tshwane University of Technology.

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 2003. Ten 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. 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 results which were reported. The MISG ended at lunch time on Friday.

Four invited talks illustrating the application of mathematics to industry were given by experienced industrial mathematicians. These presentations were designed to assist participants many of whom were attending a MISG for the first time. The following three talks were given on the afternoons of Tuesday, Wednesday and Thursday:

| | |
|-------------------------|--|
| Professor Alistair Fitt | <i>"The mathematics of the human eye"</i> |
| Dr Neville Fowkes | <i>"MISG downunder"</i> |
| Professor Tim Myer | <i>"Industrial applications of thin film flow"</i> |

The fourth talk was given after dinner on Wednesday evening:

| | |
|-------------------------|--|
| Professor Alistair Fitt | <i>"The craziest industrial problems ever"</i> |
|-------------------------|--|

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 2004 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 July 2004 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

University of the Witwatersrand Research Committee

Anglo American Chairman's Fund

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

LIST OF DELEGATES

Because of Higher Education mergers the names of several Universities and Technikons in South Africa changed during 2004. The new names for the Universities and Technikons have been used when compiling the list of delegates.

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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: Fault slip in a mining context

Industry: Division of Mining Technology, CSIR

Industry representative: John Napier

Monitor: Neville Fowkes

Problem 2

Title: Transportation of a water based slurry in an open furrow, launder or stream

Industry: Lynx Geosystems South Africa

Industry representatives: Pierre de Hill and Pieter Breed

Monitor: Jean Charpin

Problem 3

Title: Fracturing rock with ultra high pressure water

Industry: Mining Industry

Industry representatives: Edward Moss and Jian Cheng

Monitor: Alistair Fitt

Problem 4

Title: Modelling surface heat exchanges from a concrete block into the environment.

Industry: Cement and Concrete Institute

Industry representatives: Yunus Ballim and Anthony Patini

Monitor: Tim Myers

Problem 5

Title: Maturity effects in concrete dams

Industry: Cement and Concrete Institute

Industry representatives: Yunus Ballim and Anthony Patini

Monitor: Neville Fowkes

Problem 6

Title: Piped water cooling of concrete dams

Industry: Cement and Concrete Institute

Industry representatives: Yunus Ballim and Anthony Patini

Monitor: Neville Fowkes and Tim Myers

Problem 7

Title: Discrimination and identification of UXO using airborne magnetic gradients

Industry: Image Processing Company

Industry representative: Neil Pendock

Monitor: Mark Jeffreys