THE NEW ZEALAND MATHEMATICAL SOCIETY (INC.)

NEWSLETTER

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PUBLISHER'S NOTICE

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Private Bag, Wellington, New Zealand.

However, correspondence should normally be sent directly to the Secretary:

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Department of Mathematics and Statistics,
Massey University, Palmerston North, New Zealand.

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Problems and Queries	Prof Graeme Wake and Dr Mike Hendy (Massey University)
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Prof D A Nield	Engineering Science (University of Auckland)
Dr J Rayner	Mathematics and Statistics (University of Otago)
Mr G J Tee	Mathematics and Statistics (University of Auckland)

LOCAL NEWS

UNIVERSITY OF AUCKLAND

Mathematics and Statistics

Jeff Hunter will leave us in January 1990, after 22 years in this department, to become Professor of Statistics at Massey University, as successor to Brian Hayman. We wish Jeff well in his new post. The 1989 Conference of the NZ Statistical Society was held in the Conference Centre of the University of Auckland from August 17th to 19th. The 85 people who attended found the conference to be a rewarding experience. Alan Lee has now taken over the post of Secretary of the NZSS. Alastair Scott has been elected to the board of directors of the American Statistical Association. He will visit Carleton University in December, and on 1990 February 1st he will commence his term as Head of this Department. A post as Senior Lecturer (or Lecturer) in Statistics in this department is currently being advertised.

Marston Conder attended the *Groups—St. Andrews 1989* meeting at St. Andrews in Scotland, from July 29th to August 12th. He was assisted by a Prince and Princess of Wales Science Award from the Royal Society of New Zealand. Peter Lorimer was an invited speaker at the *Third International Congress on the Theory of Groups and Related Topics*, held at Canberra from September 24th to 28th. Marston Conder also attended that Congress, and he and Peter Lorimer joined in the celebrations for Bernhard Neumann's 80th birthday. Peter and Marston have received a research grant of $20,000 from the Lotteries Board, plus $13,000 from the late (and much-lamented) UGC, to purchase equipment and software for their research in group theory and combinatorics.

Gaven Martin is going on leave to the Mittag-Leffler Institute at Stockholm, to be followed by visits to the University of Helsinki, Institute des Hautes Études Scientifique de Paris, and University of Michigan Ann Arbor. Cathy Macken has gone to Stanford for 2 years leave, as a Senior Research Scholar, to work with Samuel Karlin. Chris Wild has returned from his sabbatical leave at the University of Waterloo, in the Department of Statistics & Actuarial Science.

Shayle Searle, from Cornell University, will visit the Statistics Unit for Term 1 of 1990. Marcel Neuts, of the University of Arizona, will be a University of Auckland Foundation Visitor to the Statistics Unit in the latter part of Term 2. He will be a keynote speaker at ICOTS 3, at Dunedin.

Peter Dobcsanyi has now joined us as a programmer (part-time). He is a graduate of Szeged University, and he has done valuable work in implementing the stable full of SUN SPARC computer stations, with flexible networking facilities, which has been arranged by Paul Hafner. Dr. Günter Steinke, from Christian-Albrechts-Universität zu Kiel, is on a long-term visit to this department, to work on topological projective planes.

Malcolm Pullan, who had been a Junior Lecturer here, is now a graduate student at Cambridge University. Following on from the numerous prizes and scholarships which he had won, Malcolm has now gained an external research studentship at Trinity College, an overseas research student's award and a Rutherford research studentship.

Ren Potts's visit here as NZMS Lecturer proved to be a stimulating occasion.

Wayne Walker delivered a paper on almost-periodic functions, at the Aachen-York Colloquium on Fourier Analysis and Signal Theory, held at the Reinische Westfälische Technische Hochschüle in Aachen, in July and August. York University was represented there by two mathematicians, one being Maurice Dodson (*ex* Auckland). That Colloquium was the First Alcuin Seminar, arranged to honour the memory of Alcuin of York (c730-804), who was one of the most learned Europeans of his age. The Emperor Charlemagne engaged Alcuin to organise schools in the empire which he had created. Alcuin established at Liège a college of scholars, who produced the first Latin mathematical writings on the mainland of Europe. Those include a collections of puzzles *Propositions for Sharpening the Minds of Youth*, some of which are mathematical, including the perennially popular problem of transporting a sheep, a wolf and a cabbage (or a woman, her admirer and her jealous husband), across a river in a boat too small to carry everything together. One of the last musical compositions of Sir Arthur Bliss was his setting of some of Alcuin's puzzles, as "A Knot of Riddles".

Seminars

Dr. Peter L. Walker (Sultan Qaboos University, Muscat), "A representation of the zeta function", and "The iterated exponential function".

Dr. Ralph Kopperman (City College of New York), "Finite topological spaces, curves and cathode ray tubes". (Joint seminar with the Department of Computer Science.)

Professor Stavros Busenberg (Harvey Mudd College), "Minimal periods and total curvature bounds in normed spaces".

Dr. Colin Fox (University of Otago), "Reconstructing small conductance changes from boundary measurements"

Dr. Rachel W. Garden (CashLink), "Is quantum mechanics a realistic theory?".

Professor Ian F. Collins (Engineering Science, University of Auckland), "The function of an engineering mathematician in the computer age".

Garry J. Tee (University of Auckland), "Frederick William Frankland, the first NZ Government Actuary".

Dr. Gerhard Rosenberger (Universität Dortmund), "Generalizations of Fuchsian groups".

Dr. Günter Steinke (Christian-Albrechts-Universität zu Kiel), "Two-dimensional projective planes and circle geometries".

Professor Peng Tsu-Ann (National University of Singapore), "Finite groups with an Engel condition".

Dr. Marston Conder (University of Auckland), "Group actions on the infinite cubic tree", and "Möbius inversion on lattices, with applications".

Professor Douglas Bridges (University of Waikato), "Varieties of constructive mathematics".

Professor Willem Blok (University of Illinois), "An algebraic view of some notions of logic".

Dr. Gaven J. Martin (University of Auckland), "Discrete groups, conjugacy classes, Selberg zeta functions and other animals".

Ron Dettmers (University of Wisconsin), "Ron Dettmers's mathematics education experiences in New Zealand".

Professor Glen D. Anderson (Michigan State University), "Quasiconformal distortion", and "A lower bound for the capacity of the Grötzsch ring" .

Professor Sandy Koonce (Vassar College), "Immersions and algebraic topology".

Kathy Heinrich (Simon Fraser University), "Dudeney's round-table problem".

Brian Alspach (Simon Fraser University), "Hamilton cycles in vertex-transitive graphs".

Professor John Butcher (University of Auckland), "Differential equations and applied mathematics".

Dr. Alex McNabb (Massey University), "How long to boil an egg or freeze a chook?".

Professor R. B. Potts (University of Adelaide), NZ Mathematical Society Lecturer for 1989, Joint seminars with Department of Engineering Science, "Discrete calculus of variations", and "Impact problems".

Professor J. D. Cowan (University of Chicago), "Neural networks: a general review",

Professor Vernon Squire (University of Otago), "The wave reflection problem revisited: a continuing saga. Will it ever end?",

Dr. Greg Reid (University of British Columbia), "Symmetries of differential equations and their algorithmic determination".

G. J. Tee

Engineering Science

Dr Andrew Pullan has been appointed to a Lectureship.(See the profile elsewhere in this issue.) In August Andrew gave a seminar at the Lawrence Berkeley Laboratory (U.California), visited Cornell U. and presented a paper at the 11th International Conference on Boundary Element Methods in Engineering at Boston.

Mervyn Rosser, Andy Philpott and Julie Falkner and some of their students attended the N.Z. Operations Research Conference in August.

Professor Enok Palm, from the Mechanics Section, Institute of Mathematics, University of Oslo, has spent October and November working with Robert McKibbin.

Seminars

David Whitaker (Appl. Math. Div., DSIR) "A partitioned cutting stock problem applied in the meat industry".

Dr Tony Richardson (U. Bristol) "Generalised energy methods in electrohydrodynamic stability theory", and

"A hydraulic model of electrothermal convection".
Dr J.C. Rutherford (Water Quality Centre, DSIR) "Water quality modelling studies".
Rachel Clarke (Eng. Science) "Rostering staff using assignment algorithms".
Prof. Ren Potts (U. Adelaide) "Impact problems".
Dr A.J. Pullan (Eng. Science) "The boundary element method".
Prof. M.J.D. Powell (U. Cambridge) "A view of Karmarkar's algorithm for linear programming".
Prof. Enok Palm (U. Oslo) "Rayleigh convection, mass transport, and change in porosity in layers of sandstone", and "Propulsion of ships by water waves".

D A Nield

UNIVERSITY OF CANTERBURY

Electrical and Electronic Engineering

Oxford University Press has just issued a revised and up-dated reprinting, in paperback (at the more reasonable, although still high, price of £22, twenty-two pounds) of "Image Restoration and Reconstruction" by RHT Bates and MJ McDonnell (Clarendon Press, Oxford, 1989)

RHT Bates

Mathematics

Our latest visitor on the Erskine fellowship is Professor Mike Powell who will be with us until early December. Mike holds the John Humphrey Chair in Numerical Analysis at Cambridge University, and his interests include optimization, function approximation, solutions to non-linear equations and data-fitting. As usual with Erskine visitors, he has given a series of lectures suitable for undergraduates ("Multivariate approximation by radial basis functions" in this case), as well as the seminars mentioned below.

Our next Erskine visitor will be an old friend of the department, Professor Bob Kruse (from St. Mary's University, Halifax, Canada). Bob visited the department during the early 1970's and in fact supervised Kevin O'Meara's Ph.D. studies. He will be here from February until the end of April, and his main interests are data structures and the discrete mathematics associated with them, and automated typesetting (and related software). He has also written several papers on nilpotent rings and has collaborated with John Deely in some statistical research.

Murray Smith left for his sabbatical year during August. He will be spending the year at Purdue University.

Two of the department's students have received Australian honours recently. Richard Brookes (who left us during the year after completing his Ph.D.) was awarded the prize for the best student presentation at the CTAC-9 Conference in Brisbane in July. Ralph Loader, one of our Honours II students this year, has won an Australian National University Vacation Scholarship.

Finally, we wish a speedy recovery to two of our colleagues who have had heart operations recently. Brian Woods is recovering steadily from a by-pass operation in Dunedin, while David Robinson is now back at work after an angioplasty also done in Dunedin.

Seminars

Professor C C Lindner (Auburn University), "Graph decompositions and quasigroup identities."
Professor Stavros Busenberg (Harvey Mudd College), "A mathematical model for the transmission and persistence of AIDS in a heterogeneous population."
Professor Ren Potts (University of Adelaide), "Kangaroo, Koala, Kookaburra, Wombat: Which do you prefer?" and "Discrete calculus of variations."
Dr Alex McNabb (Massey University), "How long to boil an egg or freeze a chook."
Professor Mike Powell (Cambridge University), "A view of Karmakar's algorithm for linear programming," and "TOMLIN: A Fortran package for linearly constrained optimization."

J Hannah

MASSEY UNIVERSITY

Mathematics and Statistics

Our main news item this time is the appointment of Jeffrey Hunter from Auckland to the Chair of Statistics, left vacant by Brian Hayman's retirement at the end of 1988. Jeff will take up the position at the beginning of 1990, but he has already made several visits to Palmerston North to get to know the local scene (and to start adjusting to a more rigorous weather pattern?).

Greg Arnold spent a week in Adelaide during September (attending the 1989 Regional Meeting of the Biometric Society, and STATCOMP '89), and Graeme Wake visited Newcastle for a week in October. Apart from that it's been noses to the grindstone for the last few months—even seminars have been relatively thin on the ground:

Seminars

Mick Roberts (MAF) Wallaceville), "Modelling infectious diseases."
Hugh Morton, "Gambling, statistics and the law."
Stavros Busenberg (Harvey Mudd), "Minimal periods, total curvature and shortest complete paths."
Ren Potts (Adelaide), "A sheep shearing robot", "Impact problems", and "The marriage game."
Paul Bonnington, "A generalisation of a theorem of topology to 3-graphs."
Peter Milne (Philosophy Department), "The foundations of subjective probability."
Professor V K Srivastava (Lucknow), "Properties of Stien-Rule estimation procedure in linear regression models."

M R Carter

[I wish to apologize to Dr Ganesalingam, Dr Carter and other readers of this feature for omitting the word "Statistical" from the announcement in the previous issue that Ganes had been elected a Fellow of the Royal Statistical Society (London). Editor.]

OTAGO UNIVERSITY

Mathematics and Statistics

Professor Bryan Manly, the director of Otago University's Centre for Applications of Mathematics and Statistics (CASM), has been in the headlines recently. CASM was commissioned by the *Otago Daily Times* to conduct two opinion polls on the Dunedin mayoralty race. The results were front-page news, and fortunately, correctly predicted the final outcome.

During October Professor Vernon Squire visited the Jet Propulsion Laboratory at NASA to discuss future collaboration with their oceans remote sensing group. On the same trip, he spent a few days at his previous place of employment—the Scott Polar Research Institute, University of Cambridge—where he informally supervised ex research students and gave a seminar. From Cambridge Vernon went to Solstrand Fjord near Bergen in Norway to give a paper at the Workshop on Regional and Mesoscale Modelling of Ice-Covered Oceans. While there he also attended the annual meeting of the IAPSO (International Association for the Physical Sciences of the Ocean) Sea Ice Commission, a body which meets to discuss the future directions in polar oceanography and sea ice research, the support of conferences, workshops and summer schools, and the initiation and support of working groups in pertinent areas of current interest.

Vernon Squire leaves for Antarctica on November 10, where he will collaborate with the Physics and Engineering Laboratory and the Division of Information Technology, DSIR, in a project to study the rheology of sea ice and thereby devise an appropriate constitutive equation. This work represents the *in situ* experimental part of a larger programme of research involving theoretical studies and possibly laboratory work. Colin Fox will accompany Vernon.

Fred Lam and Laimonis Kavalieris have both recently become fathers of healthy baby boys. Felix Lam weighed 3.45 kg at birth, slightly less than Andis Kavalieris at 3.845kg.

We are working hard to put together the second circular for ICOTS 3, The International Conference on Teaching Statistics, which is to be held in Dunedin next August 19 to 24.

Seminars

Paul van Mulbregt (Wellesley College, Boston) "What is a zeta-function?" 31/7/89
E.V.Flynn (Cambridge University) "Curves of genus 2" 1/8/89.
Professor R.B. Potts (NZ Maths Society 1989 Lecturer) "Impact Problems" 17/8/89.
Dr Kath Hart (University of London) "Mathematics Education" 8/9/89.
Bryan Manly (Otago University) "Randomization and Monte-Carlo inference for some non-standard situations in biology" 14/9/89.
Dr Alex McNabb (Dept of Mathematics and Statistics, Massey University) "From wood preservation to black smokers on mid ocean ridges in 35 years at Applied Mathematics, DSIR" 21/9/89.
Prof L. S. Mayer (Erskine Fellow, University of Canterbury) "The impact of exploratory methods, robustness, and the bootstrap on real-time decision making" 3/10/89.
Prof M.J.D. Powell (Cambridge University, Erskine Fellow Canterbury) "A view of Karmarkar's algorithm for linear programming" 8/11/89.

John Rayner

VICTORIA UNIVERSITY

Mathematics and Statistics

Congratulations to Jim Ansell, a member of the Mathematics Department since 1970, who has been appointed to the vacant Chair of Geophysics. Also to Peter Donelan who has been appointed to a resulting half lectureship, thereby becoming a full-time Lecturer.

Rod Downey is a member of the Math. Sciences Research Center at Berkeley for November and December during their current special program in logic.

Stephen Glasby went to the 3rd International Conference on Group Theory in Canberra in September.

Leonid Lerner (formerly Borshevsky), a former MSc student in Mathematics here, has completed his Cambridge PhD on theoretical particle physics and returned to NZ, where he is working in the Meteorological Service on computing.

J F Harper

NEW COLLEAGUES

With this issue we continue a series of profiles of new mathematician appointees at New Zealand academic and other institutions. Local Correspondents at each institution have been invited to contribute material on new appointees, and what follows comprises all of the replies received since the previous issue. It is intended by this means to introduce new appointees to the NZMS membership.

Andrew Pullan

Dr Andrew Pullan has recently been appointed to a lectureship in the Engineering Science Department of the University of Auckland Engineering School. His research interests include porous media flow and various applications of the Boundary Element methods.

Andrew was born in 1963. He studied at the University of Auckland, where he graduated B.Sc. with

Honours (1st class) and a straight A+ record in 1985. After a summer working in the Applied Mathematics Division of the DSIR in Wellington he commenced a PhD in the Engineering Science Department and completed this in 1988. His thesis was titled "Quasilinearised infiltration and the boundary element method". Five papers on this work have been published or accepted for publication, and he has presented papers at conferences in New Zealand, Australia and the United States. After spending one year working in the Management Planning Department for Fletcher Challenge, Andrew returned to the Engineering Science Department where he has been employed as a temporary lecturer.

NOTICES

OzTeX
A Public Domain TeX, by Andrew Trevorrow, for the Mac

OzTeX 1.1 is a public domain version of TeX—the international standard in mathematics typesetting—for the Mac. It works, is free (except for the cost of the media: 10 disks or $50), and people who are used to using TeX on any other computer should feel very much at home with OzTeX. A detailed review of OzTeX and other TeX items appears in the Spring 1989 issue of "Wings for the Mind", the newsletter of the Apple University Consortium of Australasia.

Current distributors of OzTeX in New Zealand are as follows:

Russell Fulton, Auckland (ccco32u@aucc4341.aukuni.ac.nz)
Grant Keady, Hamilton (MATH3019@waikato.ac.nz)
Alex Heatley, Wellington (alex@rata.vuw.ac.nz)
Graeme NcKinstry, Dunedin (graeme@otago.ac.nz)

People interested in distributing OzTeX in other centres should contact Andrew Trevorrow, Kathleen Lumley College, North Adelaide, SA 5006. E-mail address: atrevorrow@g.ua.oz.au.

Grant Keady
University of Waikato

MATHEMATICIANS AND INDUSTRY
QPSC Report

In the last several years there has been a blossoming of programs that foster the interaction between academic and industrial applied mathematics. The highly successful Claremont Mathematics Clinics and the Oxford Study Groups have served as inspiration and sometimes as models for other such programs each with its own local flavor and innovations. Such programs are now flourishing in many settings (Duke, Waterloo, Kaiserslautern, Rensselaer Polytechnic Institute, to name some) and are all addressing the same basic issues: Anyone who has attempted to teach industrial and applied mathematics in a university setting has, no doubt, become acutely aware of the difficulty of bringing realism into the traditional course setting. The vast majority of industries have no internally-supported applied mathematics research staff, so that access to modern mathematical modelling and analysis expertise often seems impossibly remote. Nontraditional programs like the Mathematics Clinics and the Industry Study Groups help resolve these problems and provide a good setting for University-Industry interactions in applied mathematics, statistics, engineering, technology and computer science.

A program of this type has recently been launched at Massey University in New Zealand and it has had an auspicious start, partly because of the benefit it had from experiences with previous such efforts. One of us, Stavros Busenberg, has been with the Claremont Mathematics Clinic since it started with a project he directed in 1972 and had a short-term Fulbright Fellowship aimed at helping the initiation of the Massey program earlier this year. The other, Graeme Wake, was first involved with the Oxford Study Group when he was visiting that University in the early 1970's, and is heading the Mathematics and Statistics Department as well as the group of Massey staff who are supporting this project. The program has been named the "Quantitative Problem Solving Consultancy" (QPSC) and involves staff from the Departments of Mathematics and Statistics, Production Technology, Management Systems and the Computing Centre of the University.

On August 14-15 1989, the Consultancy organized the first of what promises to be an annual workshop which brought together at Massey over forty people from universities, industry, and various government departments. The two-day program of the workshop had two objectives. The first was to present convincing examples of successful Industrial Mathematics and Statistics projects in New Zealand and elsewhere, and the opening day was devoted to this. The second objective was to have industrial and government personnel present new problems which they felt needed mathematical, modelling or statistical expertise, to provide some preliminary analysis of these problems and to make initial contacts for starting collaborative projects. The second day of the workshop was devoted to this latter objective. Perhaps a measure of the timeliness of the workshop was the fact that instead of the six planned presentations by potential industrial or government clients, two of the industrial representatives, who initially came only as observers, requested time to present problems also. Sacrificing an hour of the lunch-time break was the only possible solution, and the full attendance at these impromptu presentations attested to the enthusiasm and feeling of accomplishment that permeated the two days of the workshop. We describe below in a little more detail the program of the workshop concentrating on two rather different problems that were presented during the second day.

The first day opened with a key-note talk by Stavros Busenberg describing various University-Industry collaborations in the United States as well as elsewhere and giving a synopsis of the aims of the consultancy and the workshop. A half-hour spirited discussion spilled over into the traditional Kiwi tea-break. This was followed by half-hour presentations of a variety of industrial mathematics projects that had been successfully completed at Massey and other places in New Zealand. The presentations included the description, led by Alex McNabb of Massey University, of a novel method of estimating the time for freezing irregularly shaped objects with applications to the food industry. John Burnell of the Applied Mathematics Division (AMD) of the Department of Scientific and Industrial Research in Wellington presented a description of the modelling and analysis of a novel fuel injection device, and gave a kaleidoscopic view of the work that was being done at the AMD, particularly in geothermal problems. Graeme Wake and Robert Sisson combined to present a case study of the analysis of the cause of fires due to spontaneous ignition. Paul Austin presented a case study involving the use of modern control theory methods in optimizing a biotechnology production plant. Two other case studies were given describing statistics, and scheduling problems.

The planned activities of the second day involved three presentations by industrial and government personnel in the morning followed by a break-up of the participants into three groups, each of which went to a separate room where they discussed intensely one of the problems for an hour or so. Two discussion leaders were designated at the start, and they had the responsibility of keeping the group on track and at a good clip. The attendance bell had to be rung repeatedly, and loudly, in order to get these groups to return to the other scheduled events. The afternoon session paralleled the morning with three more problems presented and discussed. The day ended as planned with brief presentations by each of the group discussion leaders of the preliminary views that emerged about the modelling of their particular problem. As mentioned above, two more presentations were squeezed into the lunch time, but time did not allow discussion groups to be formed for these. Perhaps the flavour of the workshop can best be conveyed by brief descriptions of two rather dissimilar problems which were presented and discussed.

One of the problems on the second day consisted of modelling the causes of corrosion of metal surfaces which are coated by water-based polymer paints. The problem was clearly presented in physical and chemical terms by Tony Van Dyk of Resene Paints Company, stressing the fact that the concern with pollutants is driving his industry to the predominant design and production of water-based paints. The discussion group focused on the primary cause of the corrosion which was determined to be the diffusion of atmospheric water to the metal surface. A model was proposed for this, based on the hypothesis that water diffuses through the paint film in an anomalous way with part of it becoming immobile and the rest being able to move. This type of model appears to reflect some of the observed phenomena and it was determined that it will be pursued further by Tony Van Dyk in collaboration with members of the QPSC at Massey. The second problem was presented by David Leathwick of the Ministry of Agriculture and Fisheries, and concerned the explosive population levels of rabbits in Otago, and of the need to control them because of the damage they cause to agriculture. The discussion group's attention centred on the possibility that predators are controlling the rabbit population in other parts of the country, however, in the harsher climate of Otago, they do not over-winter in large enough numbers to provide an effective control. A dynamical systems model was proposed which would enable the testing of this hypothesis, and the design of alternate means of population control other than the current rabbit poisoning methods. It was decided that this project could be handled by a student at the Master's level and will be pursued in that way.

Five of the eight problems that were presented led to the beginning of collaborative arrangements for further work. The QPSC at Massey has developed a flexible array of methods for accommodating collaborations with industry. These range from the funding of Master's and Ph D students to short-term contract work involving lecturing staff and other staff members. The success of this first workshop has led to plans for repeating it next year.

Stavros Busenberg
Harvey Mudd College
Claremont
USA

Graeme Wake
Department of Mathematics and Statistics
Massey University
Palmerston North

AUSTRALIAN MATHEMATICAL SOCIETY
34th Annual Meeting, 2-6 July 1990.

The 34th Annual Meeting of the Society will be held at the James Cook University of North Queensland in Townsville, 2-6 July 1990. The 365 hectare Townsville campus is nestled in the foothills of Mt Stuart, and its attractive park-like grounds are surrounded by Australian bush. JCU was Australia's first University in the tropics, and it has an excellent "winter" climate (daytime temperature approximately 25° C). There is ready access to Magnetic Island and the Great Barrier Reef, to tropical rain forest, and to places of historical interest (eg Charters Towers and Ravenswood).

Townsville is the administrative centre of North Queensland. Nearby scientific institutions include the CSIRO Tropical Pastures Laboratory, the Australian Institute of Marine Science, the Great Barrier Reef Marine Park Authority, and the Queensland Department of Primary Industry's Veterinary Laboratory.

Accommodation is available in single rooms on campus at John Flynn College (anticipated cost approximately $50 per day, including all meals). Off-campus accommodation is readily available if booked well in advance, although there is only one motel close to the University. The cheapest accommodation available is at a backpackers hostel (around $10 a night, bed only).

Airfare concessions are being negotiated for travel within Australia and region.

The opening session on the morning of Monday 2 July will include the presentation of the Australian Mathematical Society Medal, and a brief talk by its recipient. There will be invited contributions from overseas and Australian mathematicians, supplemented by contributions from participants as usual, throughout the week.

A welcome party on the Monday evening, a choice of excursions on the Wednesday afternoon, and the Annual Dinner on the Thursday evening, are the main social occasions planned. Participants will have access to University facilities, including the Library, University Club, and sporting facilities.

The Organizing Committee is

Director:	Professor Roger Hosking
Secretary:	Mr Lachlan Marsh
Treasurer:	Dr Bill Newman

The Programme Committee is

Dr Robert Anderssen
Professor Annette Dobson
Professor John Loxton
Professor Neil Trudinger

If you wish to be included on the mailing list, please forward your request to the Secretary, Mr L M Marsh, Department of Mathematics, The James Cook University of North Queensland, Townsville Q 4811, Australia.

HENRY GEORGE FORDER, 1889-1981
Centenary of his birth

The centenary of the birth of Henry George Forder occurred on 1989 September 27.

He was born at Shotesham All Saints, near Norwich, and he studied at Cambridge from 1907 to 1910. He was a schoolmaster in England until 1934, when he became Professor of Mathematics at Auckland University College. He had much influence upon the development of mathematics in New Zealand, with his enthusiastic teaching, enhanced by his dry wit. He built up a major mathematics collection in the Library at Auckland University College, and enriched it with his generous gifts of books and journals.

He was one of the leading modern geometers—his monograph on *The Foundations of Euclidean Geometry* (CUP, 1927) was translated into Rumanian in 1970, his large treatise on *The Calculus of Extension* (CUP, 1941) gained him the Hector Medal of the Royal Society of New Zealand, and his popular exposition *Geometry* (Hutchinson, 1950) was translated into Turkish in 1968. After his retirement in 1956, he continued to give regular courses in mathematics for 15 years.

In December 1969, *The New Zealand Mathematics Magazine*, Volume 6, No.3, was a Special Forder

Issue, dedicated to Professor Forder for his 80th birthday; and in December 1979 his photograph was published on the cover of Volume 16, No.3, for his 90th birthday. The first issue of *Mathematical Chronicle* (Volume 1, No.1, November 1969) was dedicated to him for his 80th birthday, and Volume 9 (February 1980) was the H. G. Forder 90th birthday Volume, publishing articles dedicated to him. A *festschrift* volume of Essays presented to H. G. Forder was edited by John C. Butcher and published as *A Spectrum of Mathematics*, Auckland University Press & Oxford University Press, in 1971 When the NZMS was founded in 1974, the Council elected Professor Forder and Profesor J Campbell as Lefe Members. In December 1980, Peter Lorimer's Centrefold article on him (the second Centrefold article) was published in *The NZMS Newsletter* **19.**

Professor Forder spent his final years at Selwyn Village, a retirement home in Auckland, where he died on 1981 September 21, a few days before his 92nd birthday. An obituary article by Peter Lorimer was published in *The NZMS Newsletter* **22** (December 1981), supplemented by a cartoon depicting "Heaven with Henry"; and an obituary article by John Butcher was published in the *Bulletin of the London Mathematical Society* **17** (1985), 162-167.

Professor Forder left a large bequest to the London Mathematical Society, which uses the income to send distinguished mathematicians from the U. K. to New Zealand as Forder Lecturers, commencing with Christopher Zeeman (in 1987) and Sir Michael Atiyah (in 1989).

G. J. Tee

UNIVERSITY OF AUCKLAND
Lectureship/Senior Lectureship in the Statistics Unit of the Department of Mathematics and Statistics

Applicants should have a proven track record in teaching, research and consulting in any area of Applied Statistics or in stochastic aspects of Operations Research.

The Department of Mathematics and Statistics teaches a full range of undergraduate and postgraduate courses. The Statistics Unit, which operates with a certain amount of autonomy within the department, has strong links with other statisticians throughout the University, Medical School and the DSIR. As a member of the Unit, the appointee will be expected to be available for consulting in his or her area of expertise.

Commencing salary will be determined in accordance with qualifications and experience within the scale for Lecturers/Senior Lecturers. Conditions of Appointment and Method of Application are available from the Assistant Registrar, Academic Appointments, University of Auckland, Private Bag, Auckland, N.Z.. Further information may be obtained from the Head of the Statistics Unit, Professor G. A. F. Seber. Applications should be forwarded by 21 December, 1989.

ZONTA SCIENCE AWARD

Zonta International has established a National Science Award open to women graduates with tertiary qualifications in the fields of pure and applied sciences. It is intended that the Award will be given every biennium, starting in 1990. The objectives of the Award are:

- To recognise and pay tribute to the valuable contribution of women scientists both to their disciplines and the community at large.
- To encourage young women to enter the field of science, thus making their special talents available to society.

Contributions to science have to be identified with New Zealand. The intent of the Award is to enable the recipient to continue further study, research, or to assist in their returning to the science arena.

The recipient will be chosen by a selection panel made up of Zontians, industry heads, public figures and academics in the appropriate fields. The finalist will be approved by a Nationally chosen panel of Zontians.

Eligibility. Women graduates with tertiary qualifications including degrees and diplomas; teachers of science; those involved in research; and women wishing to return to the workforce. Consideration will be given to the excellence of the contributions made to science and to New Zealand society in general. Recipients will be asked to give media interviews and supply photographs where appropriate.

Award. The recipient will receive the Zonta Science Medal, $5000 cash, and return air travel to Europe, U.K. or U.S.A. courtesy of British Airways for a conference or meeting overseas, of the recipient's choice. Air travel has to be taken within the first year of the biennium.

Applications. Application forms are available from all University Registrars and major educational institutions throughout New Zealand, or from:

Zonta Science Award
PO Box 10-274
Wellington

Closing date is 31st March 1990, with presentation of the Award in May 1990.

MATHEMATICS EDUCATION CENTRE, AUCKLAND

MECA is being established by representatives of education groups ranging from preschool to tertiary levels to support all aspects of mathematics education with particular relevance to research, teacher development and resource development. This centre will act as a focus both for mathematical education and for the users of mathematics within industry, commerce and the community.

MECA has already contributed to research projects sponsored by NZCER, initiated research into the present use and effectiveness of apparatus to enhance children's conceptual development, and initiated the publication, adaptation and distribution of resources.

Early in the new year, MECA is coordinating a national network of workshops to be run by Afzal Ahmed and Honor Williams of the Mathematics Centre, West Sussex Institute of Higher Education. Afzal was a member of the group responsible for the Cockroft report on mathematics teaching in schools and has subsequently worked in the area of professional development of mathematics educators to implement many of the recommendations in that report. Afzal Ahmed and Honor Williams are director and assistant director of two very successful projects aimed at raising children's achievement in mathematics. This visit is seen as an opportunity to support the excellent work already being done by teachers and to give further direction to mathematics teaching in New Zealand. Workshops, seminars, lectures, public addresses and a teleconference are being organised in eleven different centres.

MECA is also well on the way to setting up a curriculum development research project for 1990. The project will be launched in Auckland during the visit of Afzal Ahmed, and it aims to promote good practice in mathematics teaching across the age and ability range and will provide a focus for the professional growth of teachers by enabling them to examine and revise their own practices. The project will follow a participatory model and involve two teachers from each of four secondary schools and their contributing intermediate schools. The project will be documented so that the process can be fully understood by teachers and thus provide a model for ongoing professional development.

MECA is seeking both individual and institutional membership and is establishing credibility as an active centre and focus for mathematics education. Financial support is anticipated from a variety of community and commercial organisations thus ensuring its growth and continuity.

[At the most recent NZMS Council meeting, the minutes of which appear in this issue, NZMS agreed to give $1000 to MECA towards supporting the visit of Afzal Ahmed and Honor Williams. Ed.]

Jill Ellis
Auckland College of Education

BOOK REVIEWS

Undergraduate Algebra, by Serge Lang. Undergraduate Texts in Mathematics, Springer-Verlag, Berlin- Heidelberg-New York, 1987, ix + 251pp, DM 84. ISBN 3-540-96404-5.

With this book Lang has set about writing a text addressed to a year course in algebra subsequent to one in linear algebra. Thus in New Zealand it would correspond to a third year (or so) course in "groups, rings and fields", and this book would certainly cover much of what would be regarded as standard for such a course.

Lang begins with some basic elementary number theory such as GCD and unique factorization and then

in the next 35 pages works from the definition of a group through permutation groups to the structure of finite abelian groups. In the next section we meet rings, ideals and quotients and then topics related to the factorizations of polynomials over rings.

In the next section Lang discusses (in 27pp) vector spaces and modules. (The author remarks that he's essentially assuming that the reader has already completed a course in linear algebra and the vector space material is only included for completeness.)

The next short section is rather unusual in that it treats matrix groups and the structure of $GL_2(F)$ and $SL_2(F)$. Lang then turns to field theory , giving some Galois theory which includes a brief discussion of infinite extensions. He then gives a section on finite fields, Galois theory over finite fields and algebraic closures.

Section 9 deals with some material that might often be found in an analysis course: the construction of the reals and the complex numbers. In particular, the fact that $\mathbb{C}$ is algebraically closed is proven. Finally in the last section some naive set theory is given, and in particular we meet Zorn's lemma and the well-ordering principle, as well as a discussion of some basic facts on cardinalities.

In terms of the scope of the text I feel that the material would constitute an adequate third year text. Compared to a standard curriculum the amount of group theory discussed would seem a little thin and the decisions such as examining the structure of $GL_2(F)$ instead of (for example) proving the Sylow theorems seems a little idiosyncratic.

From this lecturer's point of view a rather more important consideration is the style of the text since this is often our main consideration for adoption. I think it is fair to say that this book is similar in style to Lang's many other texts. The presentation is quite terse. Also many elementary (yet important) facts are relegated to the exercises. These were mostly good but also would seem a little thin on the ground. To comprehend the section on group theory, for example, it would be essential for a student to attempt most (if not all) the exercises - rather along the lines of Rotman's book on group theory. There are not a lot of examples and I found the presentation rather "linear" in the sense that I did not feel motivated either by seeing applications or by being given goals throughout the text. I feel that in many ways it is a course of algebra presented as a module "out of context".

Nevertheless, to balance the previous paragraph, all of the comments above may reflect my personal vision of what is appropriate for a text. Many would see the text as economical rather than terse and see this as a plus rater than a minus. As with a set of lecture notes, a student would probably find studying from this (in a reading course, say) rather easier than with a long wordy text where it is often difficult to discern the key points.

In summary, I will certainly find this a useful addition to my library as a reference for the backbone of a course in third year abstract algebra. Although I don't agree with the stylistic philosophy I can see that many would see this as a very good text for such a course. If you have liked Lang's other texts, or are dissatisfied with your current text, I would suggest Lang's book as well worth an examination.

Rod Downey
Victoria University of Wellington

Riemannian Geometry, by S. Gallot, D. Hulin and J. Lafontaine. Universitext, Springer-Verlag, Berlin-Heidelberg-New York, 1987, xi + 248pp, DM 48. ISBN 3-540-17923-2.

This book is an outgrowth of graduate lectures given in Paris. It is written for readers who already have some knowledge of differential manifolds. The book begins directly with abstract manifolds and illustrates its point of view by a series of examples each time a new definition or theorem occurs. As a consequence the reader meets a detailed recurrent study of spheres, tori, real and complex projective spaces and compact Lie groups equipped with bi-invariant matrices. The first chapter gives a quick introduction to differential manifolds.

Chapters two and three deal with basic Riemannian geometry of manifolds finishing with global results (Cartan-Hadamard, Myers and Milnor's theorems) concentrating on relations between curvature and topology. An overview of recent research results is also given in these sections.

Chapter four gives an introductory treatment of analysis on manifolds with an emphasis on the Weitzenboch formula and some aspects of spectral theory. The central role played by the Ricci curvature is a feature of this chapter.

Finally in chapter five classical topics on Riemannian submanifolds are covered. The book has exercises at the end of each chapter with worked answers at the end of the book. It is written in a clear style which enables many of the current global aspects of differential geometry to be readily understood.

E. G. Kalnins
University of Waikato

SPRINGER-VERLAG PUBLICATIONS

Information has been received about the following publications. Anyone interested in reviewing any of these books should contact

David Alcorn
Department of Mathematics and Statistics
University of Auckland

Algorithms and Combinatorics

8	Halász G, Sós VT (eds)	Irregularities of partitions. 165pp.

Applied Mathematical Sciences

78	Dacorogna B	Direct methods in the calculus of variations. 308pp.

Encyclopaedia of Mathematical Sciences

9	Khenkin GM (ed)	Several complex variables III. 261pp.

Ergebnisse der Mathematik und ihrer Grenzgebiete

18	Brouwer AE (et al)	Distance regular graphs. 495pp.

Lecture Notes in Mathematics

1368	Hübl R	Traces of differential forms and Hochschild-homology. 111pp.
1369	Hou Z (et al)	Differential geometry and topology. 366pp.
1374	Kirby R	The topology of 4-manifolds. 108pp.
1377	Pierce JF	Singularity theory, rod theory and symmetry-breaking loads. 177pp.
1378	Rumley RS	Capacity theory on algebraic curves. 437pp.

Mathematical Sciences Research Institute Publications

14	Goodman FM (et al)	Coxeter graphs and towers of algebras. 290pp.

Universitext

	Zaanen AC	Continuity, integration and Fourier theory, 251pp.

Miscellaneous

	Grimmett G	Percolation. 296pp.
	Kantor IL (et al)	Hypercomplex numbers. 169pp.
	Kiang T	The theory of fixed point classes. 174pp.
	Krasnosel'skii MA (et al)	Systems with hysteresis. 410pp.

PYTHAGOREAN TRIPLES—A NEW SOLUTION AFTER 2500 YEARS

A.G. Schaake and J.C. Turner

Bless us, divine number,
who generatest gods and men .

Prayer of the Pythagorean Brotherhood. (circa 500 B.C.)

Who has not heard of Pythagoras' equation? Hardly any educated person in the world! For thousands of years all schoolchildren have learned the theorem about the sides a, b and c of a right-angled triangle. As

you read these words, it is highly probable that somewhere in the world a teacher will be writing the famous equation $a^2 + b^2 = c^2$ on a blackboard.

Apart from learning the geometrical facts about the squares on the sides of the triangle, the children may be studying the problem of finding triples of whole numbers for (a,b,c) which satisfy the equation. For example, (3,4,5) does since $3^2 + 4^2 = 9 + 16 = 5^2$. Other examples are (5,12,13), (7,24,25) and (8,15,17).

Discovery and study of Pythagorean triples, as these whole-number solutions are called, has occupied the minds of many of the finest mathematicians that the world has ever known. A short list of those who have made major contributions to the theory of this and similar equations is the following: Pythagoras (c. 500 B.C.), Euclid (c.300 B.C.), Diophantus (100? A.D.), Fermat (1601-65), Euler (1707-1783), Lagrange (1736-1813) and Gauss (1777-1855); all truly great names in the history of mathematics. Further, we know from tablets found in archaeological digs that back in Babylonian times, over one thousand years before Pythagoras, solutions for the triples were known. Unfortunately records of the methods that were used to find them have not come to light.

Given the astonishing weight of history, and the mental effort that has been expended on studying the triples problem since ancient times, we are pleased to offer what we believe to be an entirely new method for solving $a^2 + b^2 = c^2$ in whole numbers.

For the understanding of nonmathematicians, we emphasise that finding a new method of solution does not mean that earlier work is wrong. Not at all! Euclid's method, as discussed in Book X of his famous mathematical treatise *Elements*, appears in essentially the same form in all number theory texts today. It is an elegant exercise in elementary algebra, which will remain taught and true until the end of time. Our method, which we consider to be powerful and beautiful, uses operations on simple continued fractions to exhibit the whole set of Pythagorean triples in an integrated way. By contrast, solutions by Euclid's method occur in apparently random fashion. New light thrown on old problems, even those hitherto considered fully solved in antiquity, can cause re-examination of old techniques to be made and point the way to entirely new research work in a variety of areas of mathematics. Contrary to popular supposition, mathematics does not develop along straight paths, from past to present to future. Its theories and methods form a vast interconnected network of ideas; any new idea, injected at some point, can cause a ripple through the network and open up new channels and growth points.

To show how our method works, it is necessary to explain how simple continued fractions are written and computed. Only elementary arithmetic is involved. Any string of positive whole numbers can signify a continued fraction, as the following examples show.

string	continued fraction	→	worked out fraction
1,3	$\cfrac{1}{1+\cfrac{1}{3}}$	→	$\frac{3}{4}$
2,4	$\cfrac{1}{2+\cfrac{1}{4}}$	→	$\frac{4}{9}$
1,2,4	$\cfrac{1}{1+\cfrac{1}{2+\cfrac{1}{4}}}$	→	$\frac{9}{13}$
1,2,4,1	$\cfrac{1}{1+\cfrac{1}{2+\cfrac{1}{4+\cfrac{1}{1}}}}$	→	$\frac{11}{16}$

Interested readers should take a pencil and paper, and try their hands at computing a few of these fractions. Check that the last string in the above table really does give the fraction 11/16. Then try working out the following four:

$$2 \to \frac{1}{2}$$

$$2,1 \to \frac{1}{3}$$

$$2,1,3 \to \frac{4}{11}$$

$$2,1,3,2 \to \frac{9}{25}$$

Once this simple procedure has been grasped, the computation of Pythagorean triples will be found to be truly elementary. And like magic! Here are the basic steps of our method.

(1) Take a string like 2,1,3,2.

(2) Work out the *last two fractions* as above:

$$2,1,3 \to \frac{4}{11} \quad \text{and} \quad 2,1,3,2 \to \frac{9}{25}.$$

(3) Use the two fractions as follows:

$$\left(\frac{4}{11}, \frac{9}{25}\right) \to \begin{cases} a = 25 - 4 = 21 \\ b = 9 + 11 = 20 \\ c = 25 + 4 = 29 \end{cases}$$

Voila!, as the conjuror would say: the triple (21,20,29) satisfies Pythagoras' triangle equation. Try it:

$$\begin{aligned} 21^2 + 20^2 &= 441 + 400 \\ &= 841 \\ &= 29^2 \end{aligned}$$

After waiting a few moments, to take his applause, the conjuror might do the trick again, using another string of whole numbers. Then again with a third string; and so on, until the applause fades, the audience becomes bored. The following table shows four more turns of the trick.

string	last two fractions	Pythagorean triples
1,3	$\frac{1}{1}, \frac{3}{4}$	(3,4,5)
1,1,3,1	$\frac{4}{7}, \frac{5}{9}$	(5,12,13)
3,1,3,3	$\frac{4}{15}, \frac{13}{49}$	(45,28,53)
1,2,1,3,2,1	$\frac{25}{34}, \frac{36}{49}$	(24,70,74)

Readers should check out the triples in the above table, and experience the pleasure of finding that they really do satisfy $a^2 + b^2 = c^2$. Without knowing the tricks of the mathematician's trade, it is not a simple matter to find solutions to the problem: pleasure is a natural consequence of learning 'how to do' tricks. A few more strings to work with are:

$$7,5 \; ; \; 4,6 \; ; \; 1,1,2,2 \; ; \; 1,3,1,1.$$

Can you spot any patterns in the strings, or rules that might tell you how to change one to another and generate a new Pythagorean triple ? Try working with the following strings:

1,3 ; 3,5 ; 5,7 ; 7,9 ; 9,11 .

Now can you make some conjectures about strings and triples to investigate?

Is this all there is to it? Is this really mathematics research? The answers to these questions are respectively 'No' and 'Yes'. There is a great deal more to it than can be written in a popular article. Many questions about the procedure should have occurred to the reader, after working through the simple examples given above. Does the method work for every string of numbers? If not, which strings make it work? How can it be proved that it works, when it does work? What is the connection between a string of whole numbers and Pythagoras' equation?

The questions come thick and fast. Answers are slower to arrive. The reader is challenged to find an answer to any of those questions asked above. In mathematics, discovering or creating some beautiful relationship between numbers is often an extraordinarily long and difficult task. And, even if the relationship appears to be quite a simple one, it might be found even more difficult, perhaps impossible, to prove important general facts about the relationship.

We discovered our results, which give a complete analysis of the solution of $a^2 + b^2 = c^2$ in a circuitous way. For several years we have been studying the mathematics needed to describe how knots and braids are tied. The methods we invented to do this led us to study simple continued fractions; and one day, quite recently, we realised how we could connect up these studies with solutions in whole numbers of quadratic equations. One thing that excites us is that the methods we have evolved for $a^2 + b^2 = c^2$ can be used to solve many other equations which involve squared terms. An example is the famous Pell's equation, which may be written as $x^2 - Dy^2 = 1$. This too was an equation studied in antiquity; thousands of articles have been written on its properties; but until Lagrange (1736-1813) developed his methods for solving it, general answers about the problem were not known. To give an idea of the difficulty of dealing with such problems in number theory, Lagrange's own remarks on solving Pell's equation may be quoted. He said that proving the existence of a solution for any given value of D in the Pell equation had taken him many attempts, and that these had cost him more thought than many of his other great successes, perhaps more than the result was worth.

We attack the equation in a different way, and come up with many different types of results about it, both general and particular. Our approach is not to solve for a specific value of D. Instead, we find families of solutions of Pell's equation in the form (x,y,D) for which the D can be expressed in functional form. This gives an entirely new perspective to the problem.

Lagrange used methods which went well beyond elementary arithmetic to effect his general solutions. The Crown Prince of mathematicians, Karl Friedrich Gauss (1777-1855) was the next in history to devise new methods for solving equations of this type. To do so, however, he had to invent a new kind of higher arithmetic, which involved so-called complex integers, numbers of the form $c + d\sqrt{-1}$. However, our method remains in the domain of elementary arithmetic, although admittedly we rely on techniques involving directed graphs, and lengthy parity arguments about rational numbers.

The American poet, Edna St. Vincent Millay, wrote as the first line of a much-quoted sonnet: 'Euclid alone has looked on beauty bare.' That surely is not true! Many other mathematicians have glimpsed it too. Legend has it that when Pythagoras discovered his proof of the theorem about sides of a right-angled triangle, he was so elated that he sacrificed 100 oxen in the temple of his gods. He had been singled out by the gods, he thought, to have an immortal truth revealed to him. We feel that we, along with Pythagoras and Euclid, have glimpsed that beauty too. When we discovered our method and proof for solving $a^2 + b^2 = c^2$, we repaired to the local tavern and celebrated our joy by clinking glasses over a couple of cold beers. Oxen were out of season.

Reference, for the full mathematical treatment:

New Methods for Solving Quadratic Diophantine Equations, Pts. I & II. A.G. Schaake and J.C. Turner, University of Waikato, Hamilton, New Zealand (July 1989): price US$25.00.

A G Schaake and J C Turner
University of Waikato

REPORT ON
30TH INTERNATIONAL MATHEMATICAL OLYMPIAD

Braunschweig, West Germany. July, 1989

The New Zealand Mathematical Olympiad Committee wishes to thank the Society most sincerely for the donation which helped to fund this country's participation in the Thirtieth International Mathematical Olympiad held at Braunschweig, West Germany in July. Stuart Faulds of Otago Boys High School and Michael Porteous of St Paul's Collegiate School, Hamilton, gained bronze medals. Karl Tomlinson of Edgewater College, Auckland and Shane Blackett of Melville High School, Hamilton, received honourable mentions. Samantha Stephenson of Epsom Girls Grammar, Auckland and Neal Glew of Newlands College, Wellington, were the other two members of the team, with Robert O'Callaghan of Auckland Grammar as reserve. The New Zealand team came thirty-third among the fifty countries which competed, an improvement on last year's result—34th out of 37 teams. However the team's total of 69 was a distinct improvement compared with last year's 47. It is interesting to note that among the top twelve nations only two were from the western bloc. China's total of 237 was a distinct advance on last year's winning total—217 scored by the USSR which again secured 217 points. Some of the top-ranking nations are listed in the table, which is followed by the problems set for the contestants.

Rank	Country	Score
1	China	237
2	Roumania	223
3	USSR	217
4	GDR	216
5	USA	207
6	Czechoslovakia	202
7	Bulgaria	195
8	FRG	187
9	Vietnam	183
10	Hungary	175
13	France	156
19	Canada	123
20	UK	122
22	Australia	119
33	New Zealand	69

IMO PROBLEMS

1. Prove that the set $\{1, 2, \ldots, 1989\}$ can be expressed as the disjoint union of subsets A_i $(i = 1, 2, \ldots, 117)$ such that
   (i) each A_i contains 17 elements;
   (ii) the sum of all the elements in each A_i is the same.

2. In an acute-angled triangle ABC the internal bisector of angle A meets the circumcircle of the triangle again at A_1. Points B_1 and C_1 are defined similarly. Let A_0 be the point of intersection of the line AA_1 with the external bisectors of angles B and C. Points B_0 and C_0 are defined similarly. Prove that
   (i) the area of the triangle $A_0B_0C_0$ is twice the area of the hexagon $AC_1BA_1CB_1$;
   (ii) the area of the triangle $A_0B_0C_0$ is at least four times the area of the triangle ABC.

3. Let n and k be positive integers and let S be a set of n points in the plane such that
   (i) no three points of S are collinear, and
   (ii) for every point P of S there are at least k points of S equidistant from P. Prove that
   $$k < 1/2 + \sqrt{(2n)}.$$

4. Let ABCD be a convex quadrilateral such that the sides AB, AD, BC satisfy AB = AD + BC. There exists a point P inside the quadrilateral at a distance h from the line CD such that AP = h + AD and BP = h + BC. Show that
   $$\frac{1}{\sqrt{h}} \geq \frac{1}{\sqrt{AD}} + \frac{1}{\sqrt{BC}}.$$

5. Prove that for each positive integer n there exist n consecutive positive integers none of which is an integral power of a prime number.

6. A permutation $(x_1, x_2, \ldots, x_{2n})$ of the set $\{1, 2, \ldots, 2n\}$, where n is a positive integer, is said to have property P if $|x_i - x_{i+1}| = n$ for at least one i in $\{1, 2, \ldots, 2n-1\}$. Show that, for each n, there are more permutations with property P than without.

G A Hookings

CALL FOR NOMINATIONS

NOMINATIONS FOR THE NZMS COUNCIL

The terms of three present members of the Council will expire in May 1990. They are those of Rob Goldblatt, Alfred Sneyd and Chris Triggs. At the 1990 Annual General Meeting an Incoming Vice-President must be elected. Nominations are invited for

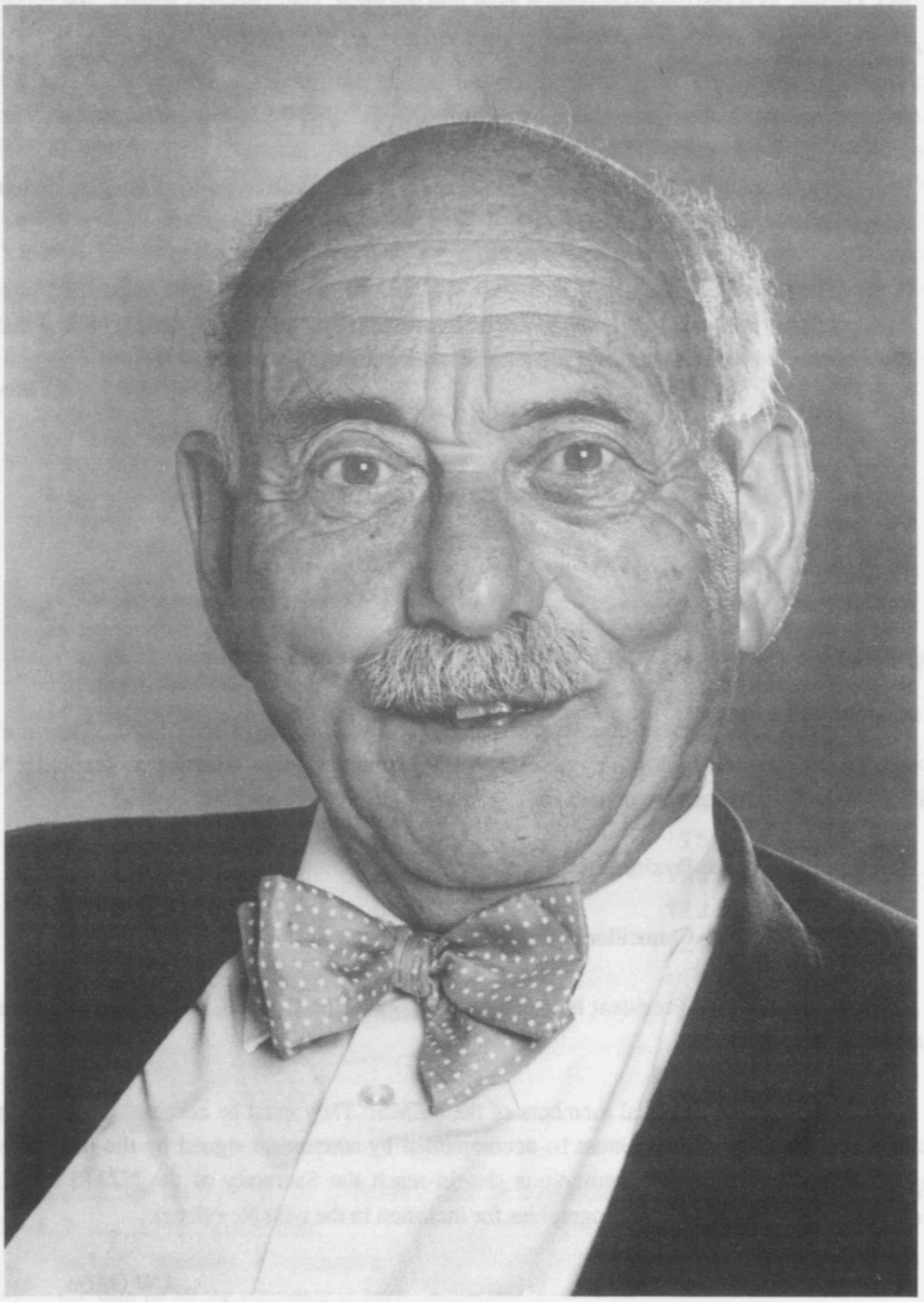
(i) Incoming Vice-President

(ii) Three ordinary Councillors.

Note: If the Incoming Vice-President is already a member of the Council, then a further ordinary Councillor will have to be elected.

Candidates must be financial members of the NZMS. They must be nominated in writing by two other financial members. Nominations must be accompanied by statements signed by the nominees that they are willing to accept nomination. Nominations should reach the Secretary of the NZMS by 1 March, 1990. Candidates are invited to send brief biographies for inclusion in the next Newsletter.

J W Giffin
Hon Secretary, NZMS



Prof Bernhard Neumann

BERNHARD HERMANN NEUMANN

by Marston Conder

The Council of the New Zealand Mathematical Society congratulates Bernhard Neumann on the occasion of his eightieth birthday, 15 October 1989. Readers who know Bernhard well may not be surprised to learn that he celebrated it in style—by joining his wife Dorothea on an early morning flight over Canberra in a hot-air balloon!

Bernhard Hermann Neumann was born in Berlin on 15 October 1909. After studying at the Herderschule in Berlin and at the University of Freiburg, he obtained his Dr.phil. degree from the University of Berlin in 1932. He emigrated to Britain in 1933 (during a time of political upheaval in Germany), and continued his studies at Cambridge, where he was awarded a Ph.D. in 1935. Meanwhile he became secretly engaged to Hanna von Caemmerer, who had been a fellow student in Berlin, and in 1938 she also left for Britain, where they married. At that time Bernhard held a temporary assistant lecturership at Cardiff, but at the beginning of the Second World War he was interned for some weeks (as an enemy alien); upon his release he joined the British Army, serving in the Intelligence Corps from 1940 to 1945. In 1946 he was appointed as a lecturer at the University of Hull, and in 1948 he accepted a position at the University of Manchester, where he stayed for the next thirteen years.

Hanna and Bernhard had five children: Irene, Peter, Barbara, Walter and Daniel. Hanna was able to complete her doctorate at the University of Oxford, and after the war she became an assistant lecturer at Hull, and later (in 1958) she too obtained a position in Manchester. During these years both Hanna and Bernhard established fine reputations as mathematicians, with common research interests in algebra. In particular, their joint paper with Graham Higman (published in 1949) on embedding theorems for groups is a famous one, underlying the theory of what are now known as HNN-extensions. Bernhard was awarded the Wiskundig Genootschap te Amsterdam Prize in 1949, and the Adams Prize of the University of Cambridge in 1952. He gained a D.Sc. from the University of Manchester in 1954 (and Hanna the same from the University of Oxford in 1955), and in 1959 he was elected a Fellow of the Royal Society.

In 1962 Bernhard took up an invitation to set up a research department of mathematics in the Institute of Advanced Studies at the Australian National University. He was appointed as Professor and Head of the Department, and was also elected to a Fellowship of the Australian Academy of Science. Two years later Hanna became Professor and Head of the Department of Mathematics in the School of General Studies. In 1971, while on a lecture tour of Canada, Hanna became ill, and died shortly afterwards. Bernhard was re-married in 1973, to Dorothea Zeim, and since his retirement in 1974 they have continued living in Canberra, with Bernhard being made Emeritus Professor and Honorary Fellow of the A.N.U., and an Honorary Senior Research Fellow of the C.S.I.R.O. Division of Mathematics and Statistics.

Bernhard's contributions to the mathematical community during his long career are remarkable. He has published over 100 research papers, given supervision and valuable advice to numerous students and fellow workers, and lectured at many conferences and in universities all around the world. He served on the Council of the London Mathematical Society from 1954 to 1961, and was its Vice-President from 1957 to 1959. He also served on the Council of the Australian Mathematical Society for over 15 years, including three terms as its Vice-President and one term as its President (1964–66), and in 1969 he founded the *Bulletin of the Australian Mathematical Society*, acting as its Editor from then until 1979. Not surprisingly Bernhard is now an Honorary Life Member of that society. He was Foundation President of the Australian Association of Mathematics Teachers (from 1966 to 1968), Chairman of the National Committee for Mathematics of the Australian Academy of Science from 1966 to 1975, and a member of the Council of the A.A.S. from 1968 to 1971. Even following his retirement he has maintained a close association with organisations such as these, and with the Canberra Mathematical Association in particular, and he continues to serve the worldwide mathematical community with his regular edition of the *I.M.U. Canberra Circular*.

Here I would like to make special mention of the contributions Bernhard has made to the New Zealand mathematical scene. Along with Hanna he attended many of our annual Colloquia in the 1960's and early 1970's, and his suggestion that New Zealand mathematicians form a special geographical branch of the Australian Mathematical Society provided the catalyst for the formation in 1974 of the New Zealand Mathematical Society! In fact Bernhard became the Society's very first paid-up member, although very soon afterwards he was elected as an Honorary Life Member. Over the years he has continued his support, not only for the Society and for the Colloquium, but also in many ways for individuals and institutions in New Zealand. For example, he has often provided valuable assessment of candidates for university appointments, and his wish to maintain strong links between Australian and New Zealand mathematicians influenced the decision to hold the 25th Summer Research Institute of the Australian Mathematical Society at the University of Auckland in 1985. I personally owe Bernhard a great deal for the advice and encouragement he has given me.

Bernhard Neumann is a person who lives life to the full. Even at the age of 80 he may still be found riding his bicycle around the streets of Canberra, or out walking in the bush (and, at least once a year, up and down

Pigeon House Mountain), or entertaining friends and family, enjoying a fine bottle of wine or playing some Haydn divertimenti, or sitting at his typewriter—or in the front row of a lecture! He is, and should remain, an inspiration for us all.

[Author's Note: I am grateful to Mike Newman and Joe Gani for permission to extract biographical details from their article "Bernhard Neumann's 70th Birthday" which appeared in *Mathematical Scientist*, vol. 4 (1970), pp. 69–70. Much of Bernhard's research is documented in the six volumes of *Selected Works of B.H. Neumann and Hanna Neumann*, whose publication by the Charles Babbage Research Centre was reported in this Newsletter (No. 43), August 1988. The photograph (taken by Marie Colvill for A.N.U. Photo Services) was sent to me by Mike Newman at the request of Dorothea Neumann.]

NZMS LECTURER REPORT

R.B. Potts, August 1989

I was honoured to be appointed the New Zealand Mathematical Society Lecturer for 1989. The timing of my visit was arranged to include the annual conference of the Operational Research Society in Wellington on August 21, 22 and the inaugural conference of the Association of Mathematics Teachers in Hamilton, August 27-31. These constraints meant that some of the universities were on vacation and this occasionally limited the impact of my visit. Originally the timing was also arranged to coincide with my own university's vacation, but a change this year to semesters meant that it was instead in the middle of the second semester.

Professor Ivan Reilly undertook the responsibility of arranging my schedule and I appreciated very much his invaluable help. My wife, who accompanied me for part of my tour, and I were overcome by the kind of hospitality for which New Zealanders are renowned.

Canterbury, August 14, 15

My visit to the University fortunately coincided with the last two days of term. I gave the M.A. Bull Memorial Lecture at the University on Monday, 14 August, a lecture to about 200 6th and 7th form students. I talked on 'Voting Systems' and conducted an election using preferences. Wombat was voted in ahead of Kookaburra, Koala, and Kangaroo. I was impressed with the attention of the students and their ready participation. On Tuesday, 15 August, I gave a talk on 'Discrete Calculus of Variations' in the Department of Mathematics. In discussions with members of the staff I was rather surprised at a recent decision to discontinue the teaching of mathematics to engineering students, a decision apparently made under pressure to improve a very unsatisfactory student:staff ratio.

Otago, August 16, 17

I flew to Dunedin for my brief visit to Otago. The University was in the middle of its vacation and a visit to the Teachers College proved impracticable. I gave a talk to the Mathematics Department on 'Impact Problems'. Professor Derek Holton kindly arranged for me to visit Columbia College (a girls' school) to talk to two mathematics teachers. By this time I had become aware of the document 'Draft Syllabus for Mathematics Forms 5-7' which had just been circulated by the Department of Education in Wellington inviting comment from teachers and others. This important document did not seem to be producing the study it deserved and I decided to try to provoke discussion by drawing attention to it throughout my visit.

Victoria, August 20-22

My visit to Wellington centred on my participation in the annual conference of the N.Z. Operational Research Society at which I gave two keynote addresses, one on 'A Sheep-Shearing Robot' and the other on 'The Mathematics of Preferences'. The conference was very successful with about 60 attendees, including many non-academics. Members of the Mathematics Department at Victoria were especially invited to attend my second talk. My sheep-shearing talk attracted the attention of the media and an interview was recorded and played on the radio; reaction to this was to follow me for the rest of my visit. I called in to the head office of the N.Z. Wool Board in Wellington and had an interesting discussion with a top executive trying to convince him that

mathematics was very relevant to the sheep-shearing industry! Operational Research is strong in New Zealand, and the Society and its annual conference have done much to promote the discipline, especially in its practical applications to industry and business.

Massey, August 23-25

I hired a car for my North Island tour and drove to Palmerston North for a very interesting and exciting visit to Massey University. It was 'extra-murals' week, the campus crowded with eager, motivated, often mature students, and some were to swell my seminar audiences. Professor Graeme Wake arranged three lectures, one a more mathematical version of the 'Sheep-Shearing Robot' talk in Wellington, another on 'Impact Problems' and an evening talk on 'The Marriage Game' to teachers. I found the Mathematics and Statistics Department particularly lively, with an overseas visitor present with some interests common with my own, and a good sprinkling of research students. I was pleased to learn that Professor Wake was expanding his department's teaching of mathematics to technology students. I was overall impressed with mathematics at Massey.

Waikato, August 27-31

It was indeed an honour to be one of the guest lecturers at the inaugural conference of the N.Z. Association of Mathematics Teachers. The conference bubbled with the excitement of a 'first' which many hard workers were determined to make a success. The fact that over three hundred teachers attended confirmed the need felt for the holding of a conference where teachers with special common interests can share and learn. For my workshop I chose 'Mathematical Modelling in the School Curriculum' and based my presentation on talks I had given recently at a country school in South Australia. My keynote address on 'The Mathematics of Robotics' was a bit of a challenge both for me and the audience, as I aimed at 6th form level to introduce to the teachers the application of mathematics to the new science of robotics. I modelled my address on the format used in the Draft Syllabus document and at least that provoked discussion. I attended other workshops and the other keynote addresses, but probably enjoyed best the opportunity to mix and talk with teachers. It is not always appreciated that mathematics teachers at the tertiary level have much in common with teachers in the schools.

Auckland, August 31, September 1

My final stopover was at Auckland. By this time, familiar faces were reappearing and I was to repeat lectures I had given elsewhere. 'Discrete Calculus of Variations' was presented in the Mathematics Department on August 31 and 'Impact Problems' in the Engineering Science Department on the following day. It was extremely enjoyable to conclude my visit to New Zealand interacting with Professor Reilly and Dr. Philpott.

Summary

In my three week tour of New Zealand, I visited all universities, gave eleven lectures and one workshop. The itinerary which I had suggested, and which Professor Reilly approved and developed, proved very satisfactory. The decision to pick up a rented car when I left Wellington and drop it off when I arrived at Auckland was a good one as it gave me some independence and the opportunity to travel between different cities with the minimum of hassle. Indeed the only hassle was the necessity to rent a car to drive from Melbourne to Adelaide. I could hardly blame New Zealand for the Australian pilots' strike!

I conclude with my appreciation to the N.Z. Mathematical Society for choosing me as the Visiting Lecturer for 1989 and I thank all who made my tour so interesting and enjoyable. My special thanks to Professor Ivan Reilly for thinking of everything.

R.B. POTTS, D.Phil., D.Sc. (Oxford), B.Sc., F.T.S., F.A.A.
4 September, 1989.

SECRETARIAL

MINUTES OF THE TWENTY-SIXTH COUNCIL MEETING
17 November 1989

The meeting was held in the Council Room, Ground Floor, Science House, 11 Turnbull Street, Thorndon, Wellington and began at 10.14am.

PRESENT: Gillian Thornley (in the Chair), John Butcher, Marston Conder, John Giffin, Robert Goldblatt, Alfred Sneyd, Kee Teo, Chris Triggs, Pauline Boyle (for NZAMT).

1. APOLOGIES: Brian Woods, Dennis McCaughan.

It was moved from the Chair *that the apologies be accepted*. The motion was carried.

In her opening remarks, Gillian Thornley instructed the Secretary to write to Brian Woods, wishing him a speedy recovery from his recent operation. The Chair then paid tribute to the work that Brent Wilson had done for the Society and for Mathematics, and the Secretary was further instructed to write to his widow expressing this appreciation and condolences.

2. MINUTES:

The Chair noted that, in the previous minutes, the name of Rae Sullivan-Browne was incorrectly recorded as Rae Sullivan-Barnes in both the list of those present at the meeting and in section 6(ix). With these amendments, it was moved from the Chair that: *the minutes of the previous meeting be received and signed as a true and accurate record.* The motion was carried.

3. MATTERS ARISING FROM THE MINUTES:

(i) With reference to section 2(iii) G. Thornley reported that Gordon Knight had accepted the appointment as Officer for Mathematics Education.

(ii) M. Conder reported that the IBM Mathematics display remains in Canberra. R. Goldblatt noted that a permanent display was in existence there.

(iii) In the matter of the centenary of the birth of A.C. Aitken in 1995 (section 5(ii)), G. Thornley suggested an exploration of links with the Edinburgh Mathematical Society to gather more information and determine an appropriate commemoration. It was noted that a stamp issue would require a lead time of at least two years. Professor J. Campbell (a former student of Aitken) and Garry Tee are to be approached for further suggestions.

(iv) Regarding the Fellowship of the Royal Society of New Zealand, Mathematics now has a separate panel. G. Thornley noted that three applications are currently in the pipeline, and that four other names have been suggested. Eighteen months will elapse before the next call for nominations, because the Royal Society is "changing years". J. Butcher reminded the Council that Fellows of the Royal Society may nominate candidates, in addition to the NZMS and NZSA. Following a suggestion of J. Butcher, the President will write to the Royal Society endorsing the nominations of mathematicians put forward by others and restating support of our own nominee.

(v) M. Conder reported that Professor Bernhard Neumann had been presented with his present from the Society at a function held in Canberra in September. The suitably inscribed sterling silver decanter labels were now "adorning his port and madeira decanters". M. Conder was thanked for his efforts in this regard.

4. CORRESPONDENCE:

Further to 3(v), the Secretary reported that Professor Bernhard Neumann had sent a letter expressing his pleasure over receipt of his birthday gift, noting that the decanter labels will serve as "a permanent reminder (if a reminder were needed!) of my close association with the New Zealand Mathematical Society since its foundation".

5. (i) TREASURER'S REPORT:

The Treasurer reported that the savings account maintained a healthy $80,000 balance, but that the recent GST rise was causing difficulties.

(ii) MEMBERSHIP SECRETARY:

G. Thornley reported that J. Shanks is willing to continue in this position.

(iii) PUBLICATIONS:

(a) A. Sneyd presented a report on publications.

(b) A. Sneyd noted that the Statistics Association and the Operations Research Society were being asked to collaborate in producing the "Employment Opportunities" booklet. The need for sponsorship was discussed and approaches will be made to employers of mathematics graduates.

(c) In regard to distributing "Modelling Activities" in Australia through Project PAM (Practical Applications of Mathematics), G. Thornley recommended the inclusion of a clause that would change the Australian retail price in an event of a significant exchange rate fluctuation.

(iv) 1989 NZMS VISITING LECTURER:

(a) While he acknowledged the overall success of the visit of Professor Ren Potts, R. Goldblatt expressed disappointment over the "value" of the visit to Victoria University, overlapping as it did with the Operations Research Society Annual Conference. (It was noted, however, that ORSNZ provided significant funding for the visit and that R. Potts was the keynote speaker at the Conference.) The suggestion was made that there should be some guidelines proposed on the obligations of the visiting lecturer, especially where a tight itinerary is involved. After some discussion, the general feeling of the Council was that each University Mathematics Department should be on the itinerary if possible, and that the duration of stay at each centre be at least three days. Ivan Reilly was again thanked for his excellent organisation of R. Potts' visit.

(b) C. Triggs informed the Council that the ICOTS3 (International Conference on the Teaching of Statistics) organising committee had not yet contacted him regarding the NZMS offer to have the 1990 NZMS Visiting Lecturer associated with ICOTS 3. The ICOTS 3 committee appeared disappointed that NZMS does not pay the cost of overseas travel. Several other alternative candidates were mentioned. G. Thornley affirmed the Society's commitment to its offer to ICOTS 3, and C. Triggs will investigate.

(c) R. Goldblatt noted that the mechanism for choosing the NZMS Lecturer was rather haphazard. M. Conder suggested that a notice be appended (a year in advance) to the visitors column in the NZMS *Newsletter* inviting suggestions of likely people who are scheduled to be in the country at an appropriate time.

6. APPLICATIONS FOR FINANCIAL ASSISTANCE:

(a) Regular Commitments

(i) It was moved by R. Goldblatt (seconded by A. Sneyd) that: *the NZMS give $1500 (fifteen hundred dollars) to the organisers of the 1990 Colloquium.* The motion was carried.

The suggestion was made that the NZMS consider sponsoring a social reception at the Colloquium.

(ii) It was moved by J. Butcher (seconded by C. Triggs) that: *the NZMS give $1000 (one thousand dollars) to the Royal Society of New Zealand Prince and Princess of Wales Science Award Scheme.* The motion was carried.

G. Thornley noted that the amount of $1000 should not be considered a precedent, but that it represents a "catch-up" for the lack of funding in the previous year.

The meeting adjourned for lunch at 12.30pm and resumed at 1.30pm.

(b) Response to Applications:

It was moved from the Chair that

Mr Aroon Parshotam be given $500 (five hundred dollars) towards the costs of attending and presenting a paper at the 26th Australian Applied Mathematics Conference in Coolangatta in February 1990.

Mr Robert Sisson be given $500 (five hundred dollars) towards the costs of attending and presenting a paper at the 26th Australian Applied Mathematics Conference in Coolangatta in February 1990.

Mrs Marijcke Vlieg by given $500 (five hundred dollars) towards the costs of attending and presenting a paper at the 26th Australian Applied Mathematics Conference in Coolangatta in February 1990.

Dr C.H.C. Little be given $200 (two hundred dollars) to offset the costs of the visit of Franz Rendl to NZ.

Associate Professor Vamanamurthy be given $500 (five hundred dollars) towards the cost of a visit by Dr Matti Vuorinen to finalise collaborative research projects.

Dr K.K. Sankara be given $500 (five hundred dollars) towards the cost of attending and presenting a paper at the 26th Australian Applied Mathematics Conference in Coolangatta in February 1990.

Dr Marston Conder be given $500 (five hundred dollars) towards the cost of a visit by Dr Russell Blyth to further their collaborative research.

Dr Rod Downey be given $500 (five hundred dollars) towards the cost of attending and presenting a paper at the Third Logic Biennial in Bulgaria in June 1990.

The Mathematics Education Centre Auckland be given $1000 (one thousand dollars) towards supporting the visit of Afzal Ahmed and Honor Williams in N.Z.

The motion was carried.

Other applications were seriously considered and were declined.

There was a general discussion on the amount of money available in total for financial assistance. It was affirmed that, following the recommendations of the Financial Plan, essentially all of the interest on capital received during the current financial year could be used. Additional publication activities should be sought in order to boost capital, especially in times of reducing interest rates; G. Thornley noted the challenge of the proposed revisions to the 5-7 form Secondary Syllabus as providing an opportunity.

(c) Student Travel for 1990 Colloquium

The Secretary was empowered to disburse up to a total of $1000 in grants to students to travel to the 1990 Colloquium.

7. 1991 FORDER LECTURER:

The London Mathematical Society has announced the appointment of Professor Peter Whittle (Cambridge) as the 1991 Forder Lecturer. Robert Davies (AMD) is to be asked to organise his itinerary. Reservations were expressed that Sir Michael Atiyah's visit was too early in the year in 1989; dates later in the first term (or early second term) were suggested for 1991 but it depends on Professor Whittle's other commitments.

8. NZMS INVITED SPEAKER:

J. Butcher spoke on behalf of the 1990 Colloquium organisers suggesting that the Society President be the NZMS Invited Speaker at one Colloquium during his/her term of office, and that the Council be more actively involved in the selection of its invited speaker at the Colloquium in the alternate years.

G. Thornley agreed to take up the challenge for 1990 and give an Invited Lecture at the Auckland Colloquium.

9. NZMS MEDAL FOR MATHEMATICAL ACHIEVEMENT:

Considerable discussion arose from a letter by Peter Lorimer suggesting that the NZMS should set up an award to recognise the achievements of members of the local Mathematics community. Service to the Society could be recognised via Honorary membership, but the existence of perhaps a named award, with the associated support and publicity, could provided a mechanism for the promotion of mathematics as well as honour to the individual recipient.

It was agreed that this matter should be considered further, and G. Thornley proposed that P. Lorimer and M. Conder set up a group to investigate.

The Council felt that:

(i) a document or certificate may prove more practical than an actual medal;

(ii) recognition of research achievement by a promising young mathematician should probably be made in addition to a "general" award;

(iii) more promotion of candidates for overseas medals and awards should be undertaken;

(iv) in a related matter, a national (NZ) competition (c.f. the Canberra-based Australian one) for secondary school Mathematics students should be instigated.

10. NOMINATIONS FOR IMU COMMITTEES:

A report from Michael Carter referring matters from the National Committee for Mathematics was discussed.

(i) A nomination has been made for the Executive Committee of the International Commission on Mathematical Instruction.

(ii) The Council supported the idea that NZ nominate a candidate for the Executive Committee of the International Mathematics Union (and recognised the low probability of success), and supported two of the suggestions made.

(iii) The Council suggested three possible candidates for nomination to the Commission on Development and Exchange (particularly in terms of forging South Pacific links).

(iv) G. Thornley will represent NZ at the IMU General Assembly (and Congress) in Japan in August 1990; the Royal Society of NZ usually funds the travel of its member body Presidents.

11. LOBBYING FOR MATHEMATICS, SCIENCE AND TECHNOLOGY:

(i) M. Conder reported that he and Kevin Broughan were the NZMS representatives on the Ad Hoc Funding Committee set up by the May meeting of HOD's in Mathematical Sciences. He expressed concern about future funding in the Mathematical Sciences and the combined relative under-resourcing of Mathematics, especially in the light of the establishment of the proposed Foundation and Ministry of Research, Science and Technology.

Discussion followed. M. Conder said a draft a discussion document was being prepared by himself and David Gauld.

(ii) A document outlining the activities of the Federation of Australian Scientific and Technological Societies (FASTS) was received, via Derek Holton, provoking lengthy discussions. The Council felt that an "umbrella" lobby group in NZ for the Mathematical Sciences (Mathematics, Statistics, Operations Research, and, possibly, Computer Science) is needed. R. Goldblatt noted that "this will not be a game for amateurs; we will need persuasive people if we are to achieve anything". The acronym STORM-troopers carried favour!

12. OTHER BUSINESS:

G. Thornley mentioned that:

(i) Nominations for the Incoming Vice-President and three Councillors were open (a notice appears in this Newsletter); continued representation from Canterbury/Otago is desirable.

(ii) Councillors were reminded that fourth year plus students, Postdoctoral Fellows and new staff members qualify for a free first-year NZMS membership.

(iii) The next Council meeting is scheduled for 10am Sunday, May 13, 1990 in Auckland.

The meeting closed at 4.06pm.

John Giffin
Hon. Secretary

MATHEMATICAL VISITORS TO NEW ZEALAND

LIST NO.24 : 1 NOVEMBER 1989

The information for each item is arranged as follows:
Name of visitor; home institution; whether accompanied; principal field of interest; dates of visit; principal host institution; principal contact person; comments.

One of the main purposes of this list is to enable other institutions to invite visitors to spend time with them. Anyone wishing to issue such an invitation should do so through the principal contact person.

Professor Wim Blok; University of Illinois at Chicago; wife (Mary); logic, universal algebra; February – November 1989; University of Canterbury; Dr. Robert Bull. Professor Blok is an Erskine Visitor for 1989.

Professor R. Hemminger; Vanderbilt University, U.S.A.; graph theory; September 1989 – July 1990; University of Otago; Prof. Derek Holton.

Professor R.N. Horne; Stanford University, California; petroleum engineering; November 1989; University of Auckland; Prof. Ian Collins.

Dr. Grant Keady; University of Western Australia; wife & daughter; symbol manipulative computation, differential equations; 1 July 1989 – 30 June 1991; University of Waikato; Dr. Kevin Broughan.

Prof. D.V. Lindley; retired (U.K.); Bayesian statistics; 27 August – 5 October 1990; University of Canterbury; Prof. John Deely.

Professor E. Palm; University of Oslo; fluid mechanics; October – December 1989; University of Auckland; Prof. Ian Collins.

Dr. Ahmad Parsian; Shiraz University, Iran; multivariate statistics; January – December 1989; Victoria University of Wellington; Prof. David Vere-Jones.

Professor M.J.D. Powell; University of Cambridge; wife; optimization & approximation, numerical analysis; 10 September – 2 December 1989; University of Canterbury; Dr. Ian Coope. Professor Powell is an Erskine Visitor for 1989.

Professor Shayle R. Searle; Cornell University, U.S.A.; wife; statistics – linear models, components of variance; 26 February – 4 May 1990; University of Auckland; Prof. George Seber.

Dr. Günter Steinke; Christian-Albrechts Universität zu Kiel, West Germany; wife; topological projective planes; from 27 August 1989, indefinitely; University of Auckland; Prof. Peter Lorimer.

Prof. Mike Stob; Calvin College, Michigan; recursion theory, inductive learning; January 1990; Victoria University of Wellington; Dr. Rod Downey.

Prof. W.A. Thompson, Jr.; University of Columbia-Missouri, U.S.A.; wife; reliability theory, statistics; March – June 1990; University of Auckland; Prof. George Seber.

Please note: Production of these lists is dependent on my receiving information. When you know about a visit (whether it be definite, very likely, or possible), would you please forward the details to me at the earliest convenient time. Thank you.

Marston Conder
N.Z. Mathematical Society Visitors' Co-ordinator
Department of Mathematics & Statistics
University of Auckland

CONFERENCES

**** 1990 ****

January 1-6 (Oberwolfach, West Germany) **Zeitreihenanalyse**
Contact MGOG: see (1) below.

January 7-13 (Oberwolfach, West Germany) **Mathematische Optrimierung**
Contact MFOG: see (1) below.

January 14-20 (Oberwolfach, West Germany) **Nonlinear Evolution Equations, Solitons and the Inverse Scattering Transform**
Contact MFOG: see (1) below.

January 15-26 (Trieste, Italy) **Workshop on Composite Media and Homogenization Theory**
Contact ICIP: see (5) below.

January 21-27 (Oberwolfach, West Germany) **Modelltheorie**
Contact MFOG: see (1) below.

January 22-26 (Berkeley, California) **Workshop on Applications of Algebraic Topology to Geometry and Analysis**
Contact MSRI: see (2) below.

Jan. 28-Feb. 3 (Oberwolfach, West Germany) **Regelungstheorie**
Contact MFOG: see (1) below.

Jan. 29-Feb. 16 (Trieste, Italy) **Second College on Variational Problems in Analysis**
Contact ICTP: see (5) below.

February 4-10 (Oberwolfach, West Germany) **Funktiontheoretische Methoden Bei Partiellen Differential Und Integralgleichungen**
Contact MFOG: see (1) below.

February 4-10 (Oberwolfach, West Germany) **Nukleare Frechet-Räume**
Contact MFOG: see (1) below.

February 11-15 (Coolangatta, Queensland) **26th Australian Applied Mathematics Conference**
Contact Dr V.G. Hart, Department of Mathematics, University of Queensland, St Lucia, Queensland 4067, Australia.

February 11-17 (Oberwolfach, West Germany) **Funktiontheorie**
Contact MFOG: see (1) below.

February 18-24 (Oberwolfach, West Germany) **Mathematische Modelle in der Biologie**
Contact MFOG: see (1) below.

Feb. 25-March 3 (Oberwolfach, West Germany) **Eigenwertaufgaben In Natur Und Ingenieurwissenschaften Und Ihre Numerische Behandlung**
Contact MFOG: see (1) below.

March 4-10 (Oberwolfach, West Germany) **Interval Methods for Numerical Computation**
Contact MFOG: see (1) below.

March 5-7 (New Orleans) **SIAM Conference on Applied Probability in Science and Engineering**
Contact SIAM Conference Co-ordinator, Suite 1400, Architects Building, 117 S.17th Street, Philadelphia, Pennsylvania 19103-5052, U.S.A.

March 11-17 (Oberwolfach, West Germany) **Mathematische Stochastik**
Contact MFOG: see (1) below.

March 12-16 (Minneapolis, Minnesota) **Workshop on Twist Mappings and their Applications**
Contact IMA: see (3) below.

March 14-19 (Predela, Bulgaria) **East European Category Seminar**
Contact K.G. Preeva, Sofia 1000, POB 384, Institute of Applied Mathematics and Computer Science, VMEI "V.I. Lenin", Bulgaria.

March 18-24 (Oberwolfach, West Germany) **Masstheorie**
Contact MFOG: see (1) below.

March 18-24 (Hamburg, Germany) **Third Centenary Celebration of the Mathematische Gesellschaft in Hamburg**
Contact Mathematische Gesellschaft in Hamburg, Geschäftsstelle, Bundesstrasse 55, D-2000 Hamburg 13, Federal Republic of Germany.

March 19-April 3 (Minneapolis, Minnesota) **Workshop on Mathematical Physiology**
Contact IMA: see (3) below.

March 20-23 (Auburn, Alabama) **Directions in Matrix Theory**
Contact F. Uhlig, Department of Mathematics - ACA, Auburn University, AL 36849-5307, U.S.A.

March 25-31 (Oberwolfach, West Germany) **Kontinuumsmechanik der Festen Körper**
Contact MFOG: see (1) below.

March 26-April 6 (Trieste, Italy) **Workshop on Group Theory from a Geometrical Viewpoint**
Contact ICTP: see (5) below.

April 4-7 (Rome) **Symposium on Distributions with Given Marginals**
Contact Dipartimento di Statistica, Piazzale Aldo Moro 5, I-00185 Rome, Italy.

May 7-June 1 (Trieste, Italy) **College on Recent Developments and Applications in Mathematics and Computer Science**
Contact ICTP: see (5) below.

May 13-16 (Auckland) **1990 New Zealand Mathematics Colloquium**
Contact Garry Tee, Mathematics and Statistics Department, University of Auckland, Auckland, New Zealand.

May 21-25 (Tucson, Arizona) **Eleventh United States National Congress of Applied Mechanics**
Contact C.F. Chen, Department of Aerospace and Mechanical Engineering, University of Arizona, Tucson, Arizona 85721, U.S.A.

May 23-25 (Charlotte, N. Carolina) **1990 International Symposium on Multiple-Valued Logic**
Contact G. Epstein, Computer Science Department, University of North Carolina at Charlotte, Charlotte, North Carolina 28223, U.S.A.

May 25-31 (Atlantic City, New Jersey) **Tenth International Conference on Pattern Recognition**
Contact H. Freeman, CAIP Center, 605 Hill, Rutgers University, New Brunswick, New Jersey 08903, U.S.A.

May 29-30 (Boulder, Colorado) **Algebraic Logic Conference in Honour of Professor Don Monk**
Contact Walter Taylor, Department of Mathematics, Campus Box 426, Boulder, Colorado 80309-0426, U.S.A.

May 29-June 2 (Minneapolis, Minnesota) **Workshop on Dynamical Systems in Fluid Mechanics**
Contact IMA: see (3) below.

June 4-8 (Minneapolis, Minnesota) **Workshop on Nonlinear Phenomena in Atmospheric and Oceanic Sciences**
Contact IMA: see (3) below.

June 6-9 (Lahti, Finland) **Fifth Annual Conference of the European Consortium for Mathematics in Industry**
Contact S. Vaskelainen, University of Helsinki, Lahti Research and Training Centre, Kirkkokatu 16, SF-15140 Lahti, Finland.

June 6-12 (Barcelona) **1990 Barcelona Conference on Algebraic Topology**
Contact M. Castellet, Director, Centre de Recerca Matematica, Institut D'Estudis Catalans, Apartat 50-08193 Bellaterra, Barcelona, Spain.

June 11-14 (Helsinki) **Fourteenth Rolf Nevanlinna Colloquium**
Contact S. Rickman, University of Helsinki, Department of Mathematics, SF-00100, Helsinki, Finland.

June 11-14 (New York) **8th International Conference of Systems and Cybernetics**
Contact Professor C.V. Negoita, Department of Computer Science, Hunter College, City University of New York, 695 Park Avenue, New York, N.Y. 10021, U.S.A.

June 11-15 (Uppsala, Sweden) **Third International Conference on Hyperbolic Problems**
Contact Professor Dr B. Gustafason, Department of Computer Sciences, University of Uppsala, Sturegatan 4B 2TR, Uppsala, Sweden.

June 11-15 (Minneapolis, Minnesota) **Workshop on Chaotic Processes in Geophysical Phenomena**
Contact IMA: see (3) below.

June 11-15 (Liblice Castle, Czechoslovakia) **Rigorous Results in Quantum Dynamics**
Contact J. Dittrich, Theoretical Department, Institute of Nuclear Physics, 250 68 Rez, Czechoslovakia.

June 27-30 (Xanthi, Greece) **Fourth International Congress on Algebraic Hyperstructures and Applications**
Contact L. Konguetsof, Democritus University of Thrace, 67100 Xanthi, Greece.

July (Sydney) **10th Australian Statistical Conference and 2nd Pacific Statistical Congress**
Contact Dr. S.H. Huxham, School of Mathematical Sciences, University of Technology, Sydney, P.O. Box 123, Broadway, New South Wales, Australia.

July 1-7 (Oberwolfach, West Germany) **Modulfunktionen In Mehreren Variablen**
Contact MFOG: see (1) below.

July 1-18 (Saint-Flour, France) **Twentieth Summer Session on Probability Theory**
Contact P.L. Hennequin, Mathématiques Appliquées, F63177 Aubiere Cedex, France.

July 2-6 (Budapest) **XVth International Biometric Conference**
Contact Ms Eva Sos, Computer and Automation Institute, Hungarian Academy of Sciences, H-1502 Budapest, P.O. Box 63, Hungary.

July 2-6 (Townsville) **34th Annual Meeting of the Australian Mathematical Society**
Contact Professor R.J. Hosking, Department of Mathematics, James Cook University, Townsville, Queensland 4811, Australia.

July 8-14 (Oberwolfach, West Germany) **Variationsrechnung**
Contact MFOG: see (1) below.

July 9-20 (Hamilton, Ontario) **Geometry and Topology of Four-Manifolds**
Contact I. Hambleton, Department of Mathematics, McMaster University, Hamilton, Ontario, Canada L85 4K1.

July 15-21 (Oberwolfach, West Germany) **Stochastic Image Models and Algorithms**
Contact MFOG: see (1) below.

July 15-23 (Luminy, France) **Colloquium in Honour of Roland Fraisse**
Contact R. Bonnet, Department of Mathematics and Mechanics, Case Postale 322, Université Aix Marseille III, 13 397 Marseilles Cedex 13, France.

July 22-28 (Oberwolfach, West Germany) **Konvexgeometrie**
Contact MFOG: see (1) below.

July 29-Aug. 4 (Oberwolfach, West Germany) **Mechanik Und Algebraische Geometrie**
Contact MFOG: see (1) below.

July 30-Aug. 3 (Winston-Salem, North Carolina) **Fourth International Conference on Fibonacci Numbers and their Applications**
Contact Dr John Turner, Dept of Mathematics and Statistics, University of Waikato, Private Bag, Hamilton, New Zealand.

July 31-Aug. 2 (Bristol, England) **Dynamics of Numerics and the Numerics of Dynamics**
Contact Conference Officer, The Institute of Mathematics and its Applications, Maitland House, Warrior Square, Southend-on-Sea, Essex, SS1 2JY, England.

August (Uppsala, Sweden) **53rd Annual Meeting of the Institute of Mathematical Statistics and 2nd World Congress of the Bernoulli Society**
Contact Lynne Billard, Department of Statistics, University of Georgia, Athens, Georgia 30602, U.S.A.

August 5-11 (Oberwolfach, West Germany) **Mathematical Methods in Tomography**
Contact MFOG: see (1) below.

August 12-18 (Oberwolfach, West Germany) **Algebraische Zahlentheorie**
Contact MFOG: see (1) below.

August 12-18 (Honolulu) **Pre-Congress Topology Conference**
Contact K.H. Dovermann, Department of Mathematics, University of Hawaii, Honolulu, Hawaii 96822, U.S.A.

August 15-19 (Osaka, Japan) **International Conference on Knot Theory and Related Topics**
Contact A. Kawauchi, Department of Mathematics, Osaka City University, Osaka 558, Japan.

August 19-24 (Dunedin) **Third International Conference on the Teaching of Statistics**
Contact the Secretary, ICOTS 3, Department of Mathematics and Statistics, University of Otago, P.O. Box 56, Dunedin, New Zealand.

August 19-25 (Oberwolfach, West Germany) **Mathematische Methoden Des VLSI-Entwurfs Und Des Distributed Computings**
Contact MFOG: see (1) below.

August 21-29 (Kyoto, Japan) **International Congress of Mathematicians**
Contact ICM-90 Secretariat, RIMS: see (4) below.

August 26-Sept. 1 (Oberwolfach, West Germany) **Komplexe Analysis**
Contact MFOG: see (1) below.

August 28-30 (Esztergom, Hungary) **IMACS European Simulation Meeting on Problem Solving by Simulation**
Contact A. Javor, Central Research Institute for Physics of the Hungarian Academy of Sciences, H-1525 Budapest 114, P.O. Box 49, Hungary.

Aug. 30-Sept. 4 (Nagoya, Japan) **International Conference on Potential Theory**
Contact M. Kishi, Office of the Organizing Committee of International Conference on Potential Theory, Department of Mathematics, College of General Education, Nagoya University, Nagoya 464-01, Japan.

September 2-8 (Oberwolfach,West Germany) **Topologie**
Contact MFOG: see (1) below.

September 3-6 (Tokyo) **Fourth Asian Logic Conference**
Contact K. Kakahi, Department of Mathematics, Waseda University, 3-4-1 Okubo, Shinjuku-ku, Tokyo 169, Japan.

September 3-7 (Brussels) **IMACS Symnposium on Intelligent Models in Systems Simulation**
Contact S. Tzafestas, National Technical University of Athens, Division of Computer Science, Department of Electrical Engineering, 157 73 Zographou, Athens, Greece.

September 9-15 (Oberwolfach, West Germany) **Surgery and L-Theory**
Contact MFOG: see (1) below.

September 10-14 (Dresden) **Mathematiker-Kongress**
Contact Professor G. Burosch, Sektion Mathematik, Wilhelm-Pieck-Universität, Universitätsplatz 1, Rostock 1, 2500 German Democratic Republic.

Sept. 10-Oct. 5 (Trieste, Italy) **School on Qualitative Aspects and Applications of Nonlinear Evolution Equations**
Contact ICTP: see (5) below.

September 16-22 (Oberwolfach, West Germany) **Risikotheorie**
Contact MFOG: see (1) below.

September 23-29 (Oberwolfach, West Germany) **Random Graphs and Combinatorial Structures**
Contact MFOG: see (1) below.

Sept. 30-Oct. 6 (Oberwolfach, West Germany) **Diophantische Approximationen**
Contact MFOG: see (1) below.

October 14-20 (Oberwolfach, West Germany) **Geometrie**
Contact MFPG: see (1) below.

October 21-27 (Oberwolfach, West Germany) **Mathematische Methoden in der Robotik**
Contact MFOG: see (1) below.

Oct. 28-Nov. 32 (Oberwolfach, West Germany) **Mathematical Economics**
Contact MFOG: see (1) below.

November 18-24 (Oberwolfach, West Germany) **Komplexitätstheorie**
Contact MFOG: see (1) below.

Nov. 25-Dec. 1 (Oberwolfach, West Germany) **Stochastische Approximation und Optimierungsprobleme In Der Statistik**
Contact MFOG: see (1) below.

December 2-8 (Oberwolfach, West Germany) **Multigrid Methods**
Contact MFOG: see (1) below.

December 3-7 (Palmerston North) **1990 Australasian Conference on Combinatorial Mathematics and Computing**
Contact Dr C.H.C. Little, Department of Mathematics and Statistics, Massey University, Palmerston North, New Zealand.

December 9-15 (Oberwolfach, West Germany) **Allgemeine Ungleichungen**
Contact MFOG: see (1) below.

December 16-22 (Oberwolfach, West Germany) **Mathematische Logik**
Contact MFOG: see (1) below.

Dec. 25-Jan. 1 (Oberwolfach, West Germany) **Lineare Modelle Und Multivariate Statistische Verfahren**
Contact MFOG: see (1) below.

**** 1991 ****

July 8-12 (Washington D.C.) **Second International Conference on Industrial and Applied Mathematics**
Contact Conference Officer, The Institute of Mathematics and its Applications, Maitland House, Warrior Square, Southend-on-Sea, Essex SS1 2JY, England.

July 22-26 (Dublin) **Thirteenth IMACS World Congress on Computing and Applied Mathematics**
Contact J.H. Miller, University of Dublin, School of Mathematics, 39 Trinity College, Dublin 2, Ireland.

Special Contact Addresses:

(1) **MFOG:** Mathematisches Forschungsinstitut Oberwolfach Geschäftstelle, Alberstrasse 24, D-7800 Freiburg in Breisgau, Federal Republic of Germany.

(2) **MSRI:** I. Kaplansky, Director, MSRI, 1000 Centennial Drive, Berkeley, California 94720, U.S.A.

(3) **IMA:** Willard Miller, Jr., Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, Minnesota 55455, U.S.A.

(4) **RIMS:** Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 606, Japan.

(5) **ICTP:** International Centre for Theoretical Physics, P.O. Box 586, 34100 Trieste, Italy.

PROBLEMS AND QUERIES

The editors have received a pleasing number of solutions and one new problem. On the eve of his departure to Nepal for a trekking holiday and subsequent post-doc. at Bielfeld (Germany), Mike Steel submitted a new problem (**P16**) and solutions to **P7** and **P14**. We also received solutions from Garry Tee (**P15**), Mikes Carter and Hendy (**P15**), David Gauld (**P14**) and from Ted Zulauf a shortening and trivialisation of the homonymous quotient group (**P12**). We also apologise for the omission of scent from the first list in David Gauld's solution to **P12** printed in *Newsletter* No. 46.

P16 Colouring Trees (Mike Steel, Massey University)

Let T be a tree. Colour a fixed vertex v_0 red, and randomly colour the other vertices red or blue—the probability of each such colouring being defined by two rules:

Rule 1: For each edge $e = \{u,v\}$ of T, assign a probability, p(e), to the event, DIFF(e), that u and v are differently coloured.

Rule 2: DIFF(e) and DIFF(e') are independent if $e \neq e'$.

Let $\lambda = 1 - 2p(e)$, and order the edges of T so that the $\lambda(e)$'s form a vector λ. Let V be any subset of the vertices of T which excludes v_0. For each bicolouring, π, of V, let $f_\pi(\lambda)$ denote the total probability of generating π under the above rules with λ specified, and let $\mathbf{f}(\lambda)$ be the vector obtained from the $f_\pi(\lambda)$'s by ordering the $2^{|V|}$ different π values.

Establish the Euclidean inner product identity

$$\langle \mathbf{f}(\lambda) , \mathbf{f}(\lambda') \rangle = f_{\pi_0}(\lambda\lambda') ,$$

where π_0 colours V red, and $\lambda\lambda'(e) = \lambda(e)\lambda'(e)$.

SOLUTIONS

P7 The bowling problem (Mike Steel, Massey University).

The problem was posed by Mark Schroder in *Newsletter* No 39, April 1987. "The weight and bias of all bowls are constant. Bowlers tend to find that on a given green and a calm day all bowls delivered with the same initial direction and coming to rest between 20m and 34m away come to rest on a straight line. Is this just an old bowler's tale? If not, what is the explanation?"

The bowlers' claim is a consequence of a fundamental property of systems of linear differential equations. Let A be a real n×n matrix, $\mathbf{u}$ a vector in $\mathbb{R}^n$. Then there exists a unique vector function $\mathbf{x} = \mathbf{x}(\mathbf{u},A,t)$ such that $\mathbf{x}' = A\mathbf{x} + \mathbf{u}$ with $\mathbf{x}(0) = \mathbf{0}$. ($\mathbf{x}'$ is the vector whose i-th component is $\frac{\partial x_i}{\partial t}$.) It follows immediately that:

For t fixed, the function $f:\mathbb{R}^n \to \mathbb{R}^n$, $f(\mathbf{u}) = \mathbf{x}(\mathbf{u},A,t)$, is linear. (1)

Now the bowling ball, of mass m, is subject to two forces: frictional resistance, (resp. the "bias" force) directed parallel (resp. 90° clockwise) to the instantaneous direction of travel. We assume that for bowls travelling at speeds which bring them to rest in the range described (20m to 30m) both forces have magnitude proportional to the ball's speed, with constants of proportionality $a,b > 0$, respectively.

[Editor's note: The assumption of linearity is crucial to the success of this solution. Linearity is a good first approximation.]

Position the complex plane so that the balls are hurled at $t = 0$ from the origin with speed v along the real axis, and let $\mathbf{r} = x + iy$. The equation governing the motion of the ball can then be conveniently written:

$$m\mathbf{r}'' = -a\mathbf{r}' - bi\mathbf{r}',\ \mathbf{r}'(0) = v,\ \mathbf{r}(0) = 0$$

(since $-i\mathbf{r}'$ has magnitude $|\mathbf{r}'|$ and is directed 90° clockwise to $\mathbf{r}'$.) Equivalently, letting $c = a/m$, $d = b/m$, we have

$$x'' = -cx' + dy'$$
$$y'' = -dx' - cy'$$

Integrating both equations with respect to time and applying the initial conditions to evaluate the constants of integration gives

$$x' = -cx + dy + v$$
$$y' = -dx - cy$$

We could now solve these equations directly and verify the claim. However, a more direct approach is to invoke (1) with $\mathbf{u} = v[1,0]^t$. Thus, for fixed t, both $x(t)$ and $y(t)$ are proportional to v, so that $y(t)/x(t)$ is independent of v, which entails that $\lim_{t\to\infty} y(t)/x(t)$ is independent of v. And this is the bowlers' claim.

P12 Homonymous quotient group G (Additional comments by Ted Zulauf, University of Waikato. For a statement of the problem and a solution, cf *Newsletter* No. 46).

The definition of G depends not only on one's pronunciation but also on one's vocabulary (e.g. use of old-fashioned words) and one's preferred spelling (where alternatives are available). Within my own frame of reference, I can fill a gap in David Gauld's solution and can also answer his two questions.

Note the following:

our (belonging to us), hour (3600 seconds)
rep (representative), repp (fabric)
ulan (lancer), yulan (magnolia)
filter (purify), philtre (love potion)
divi (dividend), divvy (divide)

Now add to list 1: hour, repp, yulan. [Editor's comment: This solution included buss, as a consequence of the omission in the printed solution.] Add to list 2: filter = philtre, divi = divvy. Scrap lists 3 and 4. Thus G is trivial, and two lists suffice to prove this.

P14 Postcards (David Gauld, University of Auckland.)

I: $\pi_1(S^3 - S^2) \neq \pi_1(S^3 - S^2)$.

I have two alternative explanations.

(a) There is a misprint; $\neq$ should be $=$.
(b) There is a misprint; the second S should be Σ or some such .

Explanation (a) may not be very satisfying, especially as it ignores the delightful artwork accompanying the statement.

To elaborate on explanation (b), let Σ^2 be the surface of the object pictured, i.e. the Alexander Horned Sphere. One may think of Σ^2 as being constructed in S^3 $(= \{(x_1, x_2, x_3, x_4) \in \mathbb{R}^4 : x_1^2 + x_2^2 + x_3^2 + x_4^2 = 1\}$, the 1-point compactification of $\mathbb{R}^3$) as follows: start with a pair of horns joined at the base and let the

tips grow towards each other. When the tips get close together, let each sprout into two with each smaller pair like the original, arranged in such a way that the horns of one pair grow around the horns of the other. Repeat the sprouting and linking process indefinitely. The postcard illustrates this well. Then Σ^2 is the limiting surface. It is a good exercise to show that Σ^2 is homeomorphic to S^2 $(= \{(x_1, x_2, x_3) \in \mathbb{R}^3 : x_1^2 + x_2^2 + x_3^2 = 1\})$. S^2 sits in S^3 in a natural way (append the 4th coordinate of 0).

One can fairly readily convince oneself that the fundamental group of $S^3 - S^2$ is trivial—any loop in S^3 but off S^2 must be either inside or outside S^2; in either case it can be shrunk to a point avoiding S^2. Thus $\pi_1(S^3 - S^2) = 0$. On the other hand one can fairly readily convince oneself that the fundamental group of $S^3 - \Sigma^2$ is not trivial—consider a loop outside Σ^2 running around one of the horns; such a loop cannot be shrunk to a point outside Σ^2 because the (Cantor) set of limit points of the horn tips gets in the way. There is a discussion of this and related matters in §2.4 of T. B. Rushing's book "Topological Embeddings". Thus $\pi_1(S^3 - \Sigma^2) \neq 0$.

II: $3x = x + h$; $2x \neq h$.

Any compact connected surface without boundary may be built up starting with S^2 using two types of building blocks.

(i) Cut two nice round holes in S^2 and run a tube outside S^2 from one hole to the other, sewing each end of the tube (each end is topologically a circle) to the boundary of a hole. The result looks like a handle and the process is called "adding a handle". Clearly the process may be repeated as many times as we like. Topologically S^2 with one handle is a torus. Every orientable, compact, connected surface without boundary may be obtained by adding handles to S^2.

(ii) Cut one nice round hole in S^2 and sew it up by identifying antipodal points of the bounding surface. An alternative way of repairing the hole is to use a Möbius strip, sewing the boundary of the strip (topologically a circle) to the boundary of the hole. This process is called "adding a crosscap". Every non-orientable, compact, connected surface without boundary may be obtained by adding crosscaps to S^2. One crosscap gives the projective plane and the following tells us what happens when two are added.

A mathematician named Klein
Thought the Möbius strip divine.
He said, "If you glue
The edges of two
You get a bottle like mine!"

What happens when we add handles and crosscaps? Well it turns out that if we have already added at least one crosscap then adding two further crosscaps is equivalent to adding a handle. (See chapter 14 and pages 226-229 of *Differential Topology; an introduction* by David Gauld, for example.) Summarising algebraically, if $mx + nh$ denotes a surface obtained from S^2 by adding m crosscaps and n handles then for $m \geq 1$,

$$(m + 2)x + nh = mx + (n + 1)h,$$

where $=$ in this context means topologically the same. In particular, $3x = x + h$. However $2x$ is a Klein bottle whereas h is a torus; as these two are not homeomorphic, we have $2x \neq h$.

P15 Twisted Triangular Toroidal Ring. (Garry Tee, University of Auckland.)

The inner radius of a torus is a, and its axial section has radius b. Within the axial section a rotating inscribed equilateral triangle generates a twisted triangular toroidal ring, with rotation θ of the section around the axis of the torus corresponding to rotation $\theta/3$ of the triangle within that section (as in the Massey University logo). The volume of that ring is required.

We observe that the centre of area of the triangle is always at radius $a+b$ from the axis of rotation. Rather than treating this special problem in detail, it is more convenient to give a more abstract treatment of a general problem, producing a generalization of Pappus's Theorem that the volume of a solid of revolution equals the area of the section times the length of the arc traced by the centre of area of that section.

Consider a general twisted ring generated by rotation within the axial section of any plane figure F (not intersecting the axis) with area A, about its centre of area Q at radius r from the axis. Let all points of F have bounded distance from Q. Let the rotation ϕ of F within the plane section be a piecewise-continuous function of the rotation θ about the axis. (A finite number of discontinuities in ϕ are acceptable.)

Consider a rotation of the section through angle increment $\delta\theta$ around the axis. Denote by I and U the intersection and the union of the regions within the axial section covered by F rotating continuously about Q. The areas of I and of U will vary continuously with $\delta\theta$, and so will the distances from the axis of their centres of area. Therefore, the moments of I and of U will vary continuously with $\delta\theta$:

$$\text{moment}(I) = Ar + \iota(\delta\theta), \quad \text{moment}(U) = Ar + \upsilon(\delta\theta),$$
$$\text{where } \iota(x) \to 0 \text{ as } x \to 0 \text{ and } \upsilon(x) \to 0 \text{ as } x \to 0.$$

During the rotation of F about Q, F will always be contained in U, and F will always contain I. Throughout that angle increment $\delta\theta$, the solid generated by F is contained within the solid of rotation formed by U, and it contains the solid of revolution formed by I. Hence the increment of volume δV generated by F is bounded by the increments of volume of those solids of revolution, which are given by Pappus's Theorem:

$$\text{moment}(I)\,\delta\theta \le \delta V \le \text{moment}(U)\,\delta\theta.$$

Therefore,

$$\delta V = (Ar + \alpha(\delta\theta))\,\delta\theta,$$

where $\alpha(x) \to 0$ as $x \to 0$. Summing the increments $\delta\theta$ over a finite range Θ of angle (without any discontinuity of ϕ), and taking the limit as $\max \delta\theta \to 0$, the volume generated by F is:

$$\text{Lim} \sum (Ar + \alpha(\delta\theta))\,\delta\theta = Ar\Theta + \text{Lim} \sum \alpha(\delta\theta)\,\delta\theta = \Theta rA.$$

That result holds for a complete rotation if ϕ is continuous (or has only 1 discontinuity), and if ϕ has finitely many discontinuities then those results for each such range of θ may be summed over 2π.

Thus, the general twisted ring has been shewn to have volume

$$V = 2\pi rA,$$

where the rotating figure F, with area A, always has its centre of area at radius r from the axis of rotation.

This result for a general twisted ring may be applied to the case of the triangular section, in which the figure F is an equilateral triangle inscribed in a circle of radius b, so that its area is $A = 3\sqrt{3}b^2/4$, and the centre of area is at radius $a+b$ from the axis of rotation. Hence, in the case of the Massey University logo, the volume of the twisted triangular ring is:

$$V = 3\sqrt{3}\pi(a+b)b^2/2.$$

Merry Christmas and Happy 1990.

Mike Hendy and Graeme Wake
Editors
Massey University

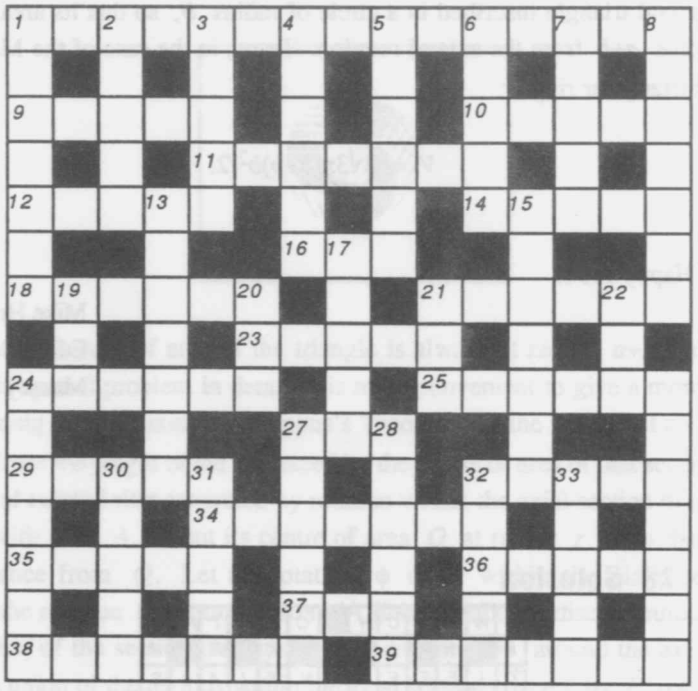
Crossword No. 28 Solution

1 S	W	2 I	T	3 C	H	■	4 C	5 E	N	6 T	R	7 E
A	■	N	■	L	■	8 T	■	X	■	R	■	A
9 D	I	F	F	E	R	E	N	T	I	A	L	S
I	■	I	■	A	■	N	■	R	■	N	■	T
10 S	U	N	T	R	A	P	■	11 A	I	S	L	E
T	■	I	■	■	■	O	■	C	■	P	■	R
■	12 A	T	T	13 E	N	U	A	T	I	O	N	■
14 S	■	E	■	N	■	N	■	■	■	S	■	15 H
16 U	P	S	E	T	■	17 D	O	18 R	M	I	C	E
M	■	I	■	R	■	E	■	E	■	T	■	I
19 M	I	M	E	O	G	R	A	P	H	I	N	G
E	■	A	■	P	■	S	■	L	■	O	■	H
20 R	E	L	A	Y	S	■	21 C	Y	G	N	E	T

CROSSWORD

No 29 by Matt Varnish

BN 80



14 across (5) to *1 across (8,7)*, *16 across (3)* *29 across (5)* *17 down (5)* years *34 across (7)*, an *23 across (5)*, a *5 down (6)* lion of *36 across (5)* *21 across (6)* (like *31 down (5)*).

Across

9. Evidence can be positive or negative (5)
10. The tube that is a group automorphism (5)
11. Group ingredient (7)
12. The fruit of time? (5)
18. UFO causer (6)
24. Replied the same on reflection (6)
25. Essence of life is about being round sixty in all (6)
27. Greek letter (3)
32. A girl in Yucatan I take it (5)
35. Add to the list mad Nero at fifty (5)
37. One of ten to the east (3)
38. Road for taxing bell ringers? (7)
39. Apply the whip to the caricaturist for watery effect (7)

Down

1. Moreover sounds of secondary boundaries (7)
2. Not left correct (5)
3. Tubes from shoes (5)
4. Not long ago about a small amount (6)
6. With the United Nations it's all ones (5)
7. Wipe out a stuttering cypher (5)
8. Where plants and children are found (7)
13. Give directions to cathedral area to surround (7)
15. Commutative group (7)
19. Circular component (3)
20. Colour not quite as read (3)
21. A little support (3)
22. The French king (3)
24. Beg from tan tree (7)
26. About a soft answer, submit again (7)
27. Fairness for the actors' group (6)
28 Gleans could be the acute ones (6)
30. On the Wall with the painter inside (5)
32. Deposited from wines (in a slow fashion) (5)
33. The actor's evening clubs? (5)

The solution to Crossword 28 is on the previous page.