THE NEW ZEALAND
MATHEMATICAL SOCIETY (INC.)

NEWSLETTER

CONTENTS

Number 50 December 1990 ISSN 0110-0025

PUBLISHER'S NOTICE

The Newsletter is the official organ of the New Zealand Mathematical Society Inc. This issue was assembled at the University of Auckland and offset-printed in Dunedin. The official address of the Society is:

The New Zealand Mathematical Society,
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Private Bag, Wellington, New Zealand.

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

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

NZMS COUNCIL AND OFFICERS

NEWSLETTER CORRESPONDENTS

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LOCAL NEWS

DEPARTMENT OF STATISTICS
Mathematical Statistics Division, Wellington

A large contingent attended and contributed to ICOTS 3 in Dunedin. Dominique Ladiray of INSEE and S.Bandyopadhyay of the Indian Statistical Institute visited the Department for discussions during their visit to New Zealand for this Conference.

A recent recruitment drive resulted in the appointment of Rodney Jer in Wellington and Michelle Reyland, Penny Barber, Carolina Kol and Jim Young in Christchurch.

In November Alistair Gray goes to Arizona to attend the International Conference On Measurement Errors.

Helen Stott will go to Papua-New Guinea in November, to assist with the post-enumeration check of their Census. Once back in Wellington, she will take up a secondment as Executive Officer, Household Income and Expenditure Survey.

Minoo Meimand has returned from maternity leave.

Mike Doherty

UNIVERSITY OF AUCKLAND
Mathematics and Statistics

Dr. Peter Danaher has been appointed as a Lecturer in the Statistics Unit, from the start of the 3rd term of 1990. However, he stayed in Hamilton for the 3rd term to complete the courses which he was giving at the University of Waikato, and in exchange Dr. David S. Whitaker (*en route* from DSIR to Waikato) taught a statistics course here. Dr. Margaret Morton, who has been a Tutor since 1985, has now been appointed as Lecturer. Nick Wormald, who went on leave to ANU, has now resigned from the Department and has been appointed as Lecturer at the University of Melbourne.

Mr. Li Yuanhu, from the Southwest China Teachers University in Qungking, is visiting for a year, to work with George Seber on linear regression analysis. Professor Marcel F. Neuts (University of Arizona) was a University of Auckland Foundation Visitor in the 2nd term. Professor David S. Moore, the NZMS 1990 Lecturer, visited here on August 1st to 3rd, and gave two addresses. Associate-Professor Mila Mrsevic, from Belgrade University, is visiting the Department until June 1991, to work with Ivan Reilly on topology. Dr. Hans-Peter Künzi, from the University of Berne, is visiting for the 3rd term, to work with Ivan Reilly and Mila Mrsevic on topology.

Kevin Burrage has returned from 15 months leave at Liverpool University, where he worked with Len Delves on applying the massive computing capacity of networks of transputers to ODE's. He gave talks at five conferences and nine universities, and was an invited speaker at both the Dundee Biennial Conference and the Amsterdam Conference on ODE's. Ganesh Dixit returned to Auckland from his leave earlier than he had intended, in August. He had been scheduled to spend the rest of his leave at the University of Kuwait! In September, Ivan Reilly prepared to address a conference on topology at Cairo. His tickets arrived only a few days before the conference, and they provided for a journey through Manila, flying over the Persian Gulf to Cairo! Ivan telephoned the conference organisers, and expressed his regret that he would not be able to undertake that journey and accordingly he would not be able to deliver his address in person.

In early July, Jill Ellis, Margaret Morton, Barbara Reilly and Alastair McNaughton went to Hobart for the conferences of the Mathematics Education Research Group of Australasia, and of the Australian Association of Mathematics teachers. Margaret and Barbara presented a paper on "Student performance in NZ mathematics examinations at tertiary entrance level". In August, Alastair McNaughton attended ICOTS3 at the University of Otago. Alastair Scott spoke on "A simple method for analysing clustered binary data", George Seber spoke on "Two methods of estimating phenotype probabilities", Wiremu Solomon spoke on "A Maori view of statistics – New roles for teachers" and Garry Tee spoke on "Charles Babbage's contributions to statistics". In September, Colin Fox attended the Ice Technology 90 Conference at Cambridge, visiting colleagues at the Scott Polar Institute and at the Cavendish Laboratory. He wrote the final lecture for his course 26.463 (on boundary-value problems) on the Isle of Mull, and posted it from Fort William.

Gordon Hookings and Ivan Reilly are arranging a certificate course for the NZ Mathematics Olympiad Committee. They had estimated that perhaps as many as 100 secondary students might enrol for that correspondence course – but 150 students have already applied.

In August, an impromptu party was held in the Department, when word was received from ICM90 that Vaughan Jones had been awarded the Fields Medal.

Seminars

Dr. S. Bandyopadhyay (Indian Statistical Unit), "Effect of sample selection probabilities on efficiency of estimators".

Dr. Adele Cutler (Utah State University), "A deterministic algorithm for global optimization".

Dr. Horst Gerlach (University of Auckland), "Probabilistic primality testing, based on Fermat's Little Theorem and on Euler's criterion" (2 seminars).

Professor David Griffiths (University of Wollongong), "A statistician's view of the AIDS epidemic in Australia and New Zealand".

Dr. Ian Hawthorn (University of Minnesota), "Fitting classes of finite groups".

Professor Ralph Kopperman (City University of New York), "When is a topology quasi-metrizable?".

Professor David S. Moore (Purdue University), "Statistics on television: the making and use of a telecourse", and "Teaching statistics as a respectable discipline".

Professor Marcel F. Neuts (University of Arizona), "A class of integral equations arising in stochastic modelling".

Dr. Kevin Burrage (University of Auckland), "The development of parallel numerical algorithms for an array of transputers".

Lawrence Lau, Melissa White, Mark Copeland, John Butcher and Cecil Smith (University of Auckland), "The Not-So-Simple Pendulum: an introduction to numerical differential algebraic equations".

G. J. Tee

UNIVERSITY OF CANTERBURY
Mathematics

Our latest Erskine fellow has been Professor Dennis Lindley, formerly head of the Statistics department at University College London. His area of interest is Bayesian Statistics, and he has given a series of seminars to staff and students (see below).

Another visitor has been Dr. Zoltan Perjes from the Central Research Institute of Physics (CRIP) at the Hungarian National Academy of Sciences. His interests are in the area of relativity. Roy Kerr will be returning this visit later in the year: he has accepted the position of Director of the Hungarian Workshops for a few months around Christmas each year.

Murray Smith has recently returned from his year's study leave. Most of his year was spent visiting the Department of Statistics at Purdue University, where he worked mainly on Bayesian Statistics. Derrick Breach will be the next one to go on sabbatical, this coming summer.

Rick Beatson spent a few weeks on study leave in England during their (hot!) summer. He spent a week at the SERC Summer School on approximation theory at the University of Lancaster, and followed that with three weeks at Cambridge working with Mike Powell (who was here as an Erskine fellow last year). He also saw lots of interesting bookshops!

Congratulations to Zhang Baoping who has won a fees scholarship from MERT. Baoping joined us earlier in the year from the University of Inner Mongolia, and is studying global optimization with Graham Wood.

Seminars

Professor Inessa Levi (University of Louisville), "Range sets, partition sets, and congruences on semigroups."

Nick Dudley Ward (York University), "Atomic decomposition theorems."

Dr. Günter Steinke (University of Kiel), "Topological geometry."

Professor C.C. Lindner (Auburn University), "Maximal packings of K_n with triangles."

Professor J.C. Mason (Royal Military College of Science, Shrivenham), "Some applications of Chebyshev polynomials."

Professor David Moore (Purdue university), "Teaching Statistics as a respectable discipline" and "Statistics as a liberal arts subject."

Dr. Grant Keady (Te Whare Wananga O Waikato and University of Western Australia), "The concavity of positive solutions of some elliptic boundary-value problems."

Dr. Tony Lun (Monash University), "The static and stationary axisymmetric vacuum solutions in general relativity - some open problems."

Professor Dennis Lindley, "Why we shouldn't use point estimation", "Multiple comparisons", "Hierarchical Models", "Bayesian decision making", and "Evaluating your probabilities."

Professor Daniel Finley (Department of Physics, University of New Mexico), "Prolongation methods for

finding symmetries of partial differential equations" (a series of four or five talks).
Professor Jerome Spanier (Claremont Graduate School, California), "Quasi-random methods for numerical integration using relatively small samples."

John Hannah

MASSEY UNIVERSITY
Mathematics and Statistics

Graeme Wake returned to the fold in October after an exciting six months in the U.K. as an SERC Visiting Fellow. In some ways it was a bit too exciting—Graeme's campus flat in Leeds was burgled and passports, air tickets and other valuable items stolen. However, Graeme's time in Oxford, Leeds and elsewhere was professionally very fruitful, and resulted in the establishment of several new collaborative relationships.

Gillian Thornley represented NZ at the 11th General Assembly of the IMU in Kobe, Japan during August, and took the opportunity to stay on for the 1990 ICM in Kyoto. She reports elsewhere in this Newsletter.

Professor Jerome Spanier from the Claremont Graduate School is currently with us as a Visiting Fulbright scholar. The primary purpose of his visit is to help develop the work of the Quantitative Problem Solving Consultancy, which was started last year by Graeme Wake in collaboration with the 1989 Fulbright visitor, Stavros Busenberg. However, Professor Spanier, like his predecessor, is proving a great stimulus to us all, quite apart from his work with the QPSC.

The QPSC held its second workshop on 6 November. Problems discussed ranged from the estimation of pasture mass in a field to the determination of strategies for the forward purchase of energy (the latter presented by Synthetic Fuels Ltd).

Our seminar activity reflects the presence of a large number of visiting statisticians moving to or from ICOTS 3:

Seminars

M. Borovcnik (Universität Klagenfurt, Austria), "An intuitive approach to conditional probability and the Bayesian theorem".
David Moore (Purdue University) "Statistics on television—the making and use of a telecourse" and "Theory of multinomial tests of fit–a survey".
Marcel Neuts (University of Arizona), "The Markovian arrival process".
J.C. Mason (Royal Military College of Science, Shrivenham, U.K.), "Some applications of Chebyshev polynomials".
David Griffiths (University of Wollongong), "Rugby league and the spread of AIDS—are statisticians really necessary?"
David Green (Loughborough University), "Assessing children's understanding of probability concepts using diagrammatic questions".
Flavia Joliffe (Brunel University), "Understanding of concepts in probability and statistics"
Gillian Thornley (Massey), "International Congress of Mathematicians, Kyoto, Japan".
Leigh Roberts (Victoria) "Actuarial education in New Zealand—the VUW diploma in Financial Mathematics".
Calvin Long (Washington State University), "Some generalizations of Moessner's theorem".
Jerome Spanier (Claremont Graduate School), "Quasi-random methods for numerical integration using relatively small samples", "Monte Carlo applications to particle transport problems: how to cheat successfully" and "A multistage procedure for systematic variance reduction in Monte Carlo applications".
Ingrid Rinsma (Waikato), "Optimal sequence alignments".
Roger Mead (University of Reading), "Designing experiments in natural blocks".

M.R. Carter

OTAGO UNIVERSITY
Mathematics and Statistics

ICOTS 3 was held during August of this year. The conference was well-attended, and most found it a profitable experience. A full report has been prepared.

A special day of mathematical activities and competitions for sixth-form students was held at the University on Friday 9/11/90, providing an opportunity for nearly 100 interested sixth-form students to find out a little more about the world of mathematics.

Professor Roger Mead is currently visiting from Reading University, and Professor Richard Anstee from the University of British Columbia is also visiting.

Shorter-term visitors have also made their way to Otago and assisted in keeping up a lively seminar series in the department.

Seminars

Prof J. P. Dempsey (Clarkson University, New York), "The Fracture of Ice". 4/7/90
Prof Bert Hartnell (Toronto University), "On well - covered graphs." 6/7/90
David Ospina (Quantitative and Computer Studies, Otago), "Sampling with unequal probability." 13/7/90
Prof P.M. Cohn (University College London), "An algebraist looks at coding theory, or how to parse without punctuation." 16/7/90
H. Gitay (Botany Department, University of Otago), "Crisp versus fuzzy classification." 20/7/90
Nick Ward (York), "Atomic decomposition theorems." 26/7/90
Fred Lam (Otago), "Taguchi method." 3/8/90
David S. Moore (Purdue)," Theory of multinomial tests of fit - A survey." 17/8/90
Prof Toby Lewis (University of East Anglia), "Inferences for one or more mean directions in the analysis of spherical data." 29 and 30/8/90
Dr David Farmer (Institute of Ocean Sciences, Patricia Bay, British Columbia), "Cracks in Sea Ice: Acoustical Detection and Interpretation." 31/8/91
Richard Anstee (University of British Columbia), "Combinatorics is great stuff (but what is it?)." 20/9/90
Prof Jerome Spanier (Claremont Graduate School, California), "Quasi-random methods for numerical integration." 28/9/90
Calvin Long (Washingtom State University), "Some generalisations of Moessner's theorem." 1/10/90
Richard Anstee (University of British Columbia), "Bridged Graphs." 2/10/90
Ivan L. Reilly (University of Auckland), "On non-Hausdorff spaces." 10/10/90
Gillian Thornley, (Massey University) "Differential geometry - connections and curvature." 15/10/90
Richard Anstee (University of British Columbia) "Some linear algebra associated with forbidden configuration theorems." 2/11/90

Robert Aldred

UNIVERSITY OF WAIKATO
Mathematics and Statistics

John Turner headed off on leave in May to firstly Florida and now the UK.

Ian Craig went to Australia and will soon be at the University of Hawaii. Then he will go to the Glasgow University and St. Andrews, but not for the golf, rather to model the aurora. Ian Urch has returned from Adelaide and has now given the Department's new high-performance workstations a good work-out.

Douglas Bridges attended the International Congress in Kyoto and the 4th Asian Logic Conference in Tokyo in August/September where he presented papers, both individually and with Dr Hajime Ishihara.

Ingrid Rinsma and Matthew Melchert were married in Nelson, celebrated in Hamilton and will soon complete the trilogy of celebration in the United States.

Judy McWhirter was appointed to a Lectureship in Mathematics and Statistics from the beginning of 1991. Hamish Spencer received a double-increment special promotion. Ernie Kalnins received a merit award from the University for his research.

Andy Begg has been appointed to the staff of the university in the Centre for Science and Mathematics Research Education (CSMER). CSMER is hosting a UNESCO conference in November of 1991 that is trying to develop a school mathematics language database in Maori, Cook Island Maori, Fijian, Niuean, Samoan, Tokelauan, and Tongan. If any universities have people with mathematics background and a good knowledge of these indigenous languages, please contact Andy Begg.

Felicity and Peter Danaher's expected child is due as the Newsletter goes to press—we wish them well. Good wishes are also in order for next year as Peter takes up his new position at the University of Auckland.

Flavia Jolliffe, formerly of Brunel University and now Surrey, a leading researcher in statistics education, visited Fay Sharples on her way home from ICOTS.

In 1990 the University offered Mathematics Education as an honours paper for the first time (a NZ first we believe). Two students have now completed this course and one of them will go on to do her masters thesis in mathematics education next year. The University of Waikato is joining Auckland and Otago in offering a Diploma in Mathematics Education in 1991. The main way that the Waikato course differs from the others is that it is not taught during term time but in four intensive stages during school vacation time (two weeks in January, one in May, one in August, and two in December) and it is hoped that this will suit full-time teachers.

A very successful workshop on the Design of Complex Experiments was held here, sponsored by the Centre for Applied Statistics and assisted by MAF and the DSIR. Attendees included 1 from the UK and 5 from Australia. The current major contract now being completed by the Centre is a computer simulation study for the

Auckland International Airport.

The Mathematical Software Project signed distribution contracts for SENAC with the University of London Computer Centre for the UK and Europe and Mitchell and Gauther Associates (MGA) for North America. SENAC has been updated to Mark 14 of the NAG Library and is available under VAX/VMS, Sun-3 and Sparcstation I computers. Further details from Kevin Broughan (kab@waikato.ac.nz). A separate notice appears elsewhere in this Newsletter.

The Department of Mathematics and Statistics currently has two vacancies: one in statistics and the other in computer algebra or numerical analysis. An advertisement appears elsewhere in this Newsletter.

Grant Keady has received a grant-in-aid from the Australian Mathematical Society for the workshop on Symbolic Computation in Applied Mathematics he is organising for Friday 8 February 1991 at the University of Canterbury, to be held in conjunction with the Australasian Applied Mathematics Conference. Further details on the Workshop may be obtained from Grant (math3091@waikato.ac.nz).

The NAG Library was installed on a DECstation, a Mathematica front end for the Mac now connects to Mathematica on a Sparcstation, and the Mac Lab now has 24 workstations and a Datashow projection device.

Seminars

Nicholas F Dudley Ward (York), "Atomic decomposition theorems".
Roland T Rust (Vanderbilt), "Flexible regression—a nonparametric regression technique."
Judi McWhirter (Waikato) "Modelling pulsatile data."
Professor David Moore (Purdue), "Theory of multinomial tests of fit—a survey," and "Teaching statistics as a respectable discipline."
Anthony Lun (Monash), "The static Weyl metrics—some open problems."
Simo Puntanen (Tampere, Finland) "Ordinary least squares vs. best linear unbiased estimation."
Professor T Krishnan (Indian Statistical Institute, Calcutta), "Some aspects of the EM algorithm."
Professor S Bandyopadhyay (Indian Statistical Institute, Calcutta), "Use of selection probabilities for estimation ratios."
Steven Galbraith (Georgia Inst of Technology), "How to make intriguing fractals."
Gavin Pearce (Waikato), "Modelling molecular imprinting."
Professor J Spanier (Claremont), "Quasi-random methods for numerical integration using relatively small samples."

KA Broughan

NOTICES

A FIELDS MEDAL FOR VAUGHAN JONES
Report by Gillian Thornley

Many of us knew long ago that Vaughan Jones had been nominated for a Fields Medal—in fact some New Zealanders had a hand in the nomination. As the International Congress of Mathematicians drew nearer there were rumours that he had a "good chance" and promptings to make contingency plans for press releases. Then two days before the event I was joined at lunch in Kobe by a delegate to the general Assembly of the International Mathematical Union who confidently announced that New Zealand had won a Fields Medal. My informer was a burly gentleman whose meal, ordered with equal confidence, turned out to be the "children's special"—a veritable bargain complete with free gift (a matchbox doll) and mickey mouse plate! Certainly he knew no more Japanese than I, but did he know about the Fields medals?

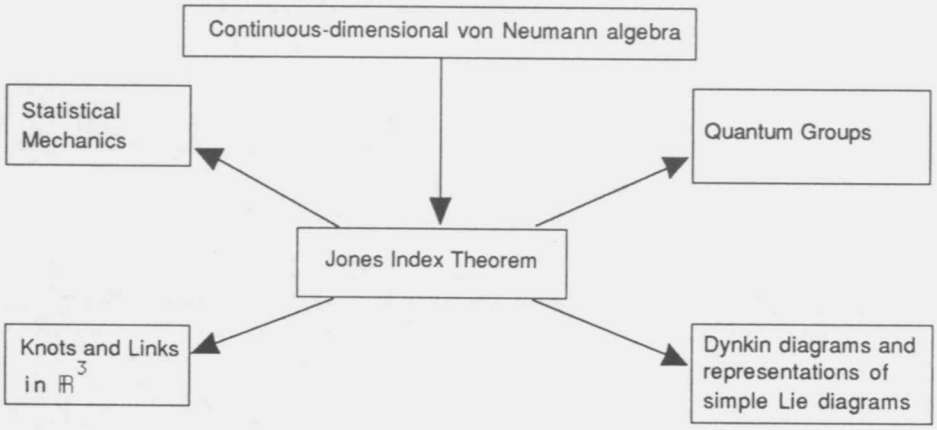
There was nothing for it but to wait for the Opening ceremonies of the International Congress of Mathematicians at Kyoto on 21 August. The ceremonies took all morning, commencing with Gagaku ("elegant" music from 9th century Japan) followed by no less than ten speeches of introduction and welcome from presidents and politicians (the latter speeches in Japanese followed by the translation) and the presentation of commemorative postal stamps. Then further items of Bugaku (stately court dances and music) and finally the presentation of four Fields medals and the Rolf Nevanlinna prize. Following a fanfare (blast) on a traditional Japanese instrument, Ludwig Fadeev, President of IMU, announced the name only (Vaughan rhyming with Morgan) and the medal was presented. I guess it was assumed that we all knew the award winners as we got no more information and had to wait till the afternoon session to hear about their work. For the record here is the list.

Fields Medals:

V.G. Drinfeld (USSR) for work in differential equations and analysis,
Vaughan F.R. Jones (USA/New Zealand) for work on Von Neumann algebras,
Shigefumi Mori (Japan) for the classification of higher dimensional algebraic varieties,
Edward Witten (USA) for work in quantum mathematical physics.

Rolf Nevanlinna Prize: A.A. Razborov

Joan Birman of Berkeley spoke on Vaughan Jones' work. Her diagram indicates the importance of his index theorem and its links with other areas.



She also commended his informal style of working which encourages interaction with colleagues. Through his willingness to share ideas with others at an early stage he has become a rich source of ideas for the work of others.

Later in the week the medallists had the honour of an audience with the Emperor of Japan.

On a less formal note the NZ group, Rob Goldblatt, Douglas Bridges and I, took Vaughan to lunch. (We couldn't find Huy Bui of Canterbury among the 4,000 that morning.) Vaughan is coming to the 1991 Colloquium at Otago so you will all get a chance to meet him. He says we keep on asking him to be an invited speaker at Colloquium—one hazard of having a different group organise each colloquium.

On the final morning of the Congress Vaughan gave his plenary address "Von Neumann Algebras in Mathematics and Physics". He took his role of NZ national hero very seriously and turned up wearing an All Black outfit to deliver the address!

11TH GENERAL ASSEMBLY OF THE IMU
Report by Gillian Thornley

It was my privilege as President of NZMS to represent New Zealand at the General Assembly of the International Mathematical Union in Kobe, Japan, 18-20 August 1990. This was a gathering of 101 delegates (including 8 women) from 42 different countries. The Assembly was chaired by the President of the IMU, Ludwig Fadeev of Russia. The proceedings were in English with no simultaneous translation which made it difficult for some delegates to contribute fully.

The reports of the various committees have been published in the *Bulletin of the International Mathematical Union* so I will only report on the matters that arose.

Membership

Israel was promoted from group II to group III status and Saudi Arabia was admitted as a group I member. An application from the Republic of Georgia, USSR was deferred.

A few countries had fallen behind in their payment of dues and there was considerable discussion over the membership status of 3 countries who were more than 4 years in arrears. It was decided to expel Pakistan, to reduce Romania to group I status and to remove voting rights from both Romania and Turkey until the dues are paid. (None of these countries sent delegates to the meeting anyway.)

The Assembly voted to increase dues by 10% to cover inflation over the four-year period.

Special Development Fund

This fund provides assistance to enable young mathematicians to attend the International Congress of Mathematicians. In the past four years it has received donations from nine mathematical societies and generous support from The Royal Society (U.K.). The President reminded members of the continuing need for contributions to this fund. This year 47 young mathematicians received grants from the fund.

International Commission on Mathematical Instruction (ICMI)

The Assembly agreed that normally national delegates to ICMI should not serve more than two consecutive four-year terms. National Committees will be asked to review their delegates regularly.

International Congress of Mathematicians (ICM)

The next International Congress of Mathematicians will be held in Zürich, Switzerland in 1994.

The Executive Committee was instructed to set up a group to plan for a suitable celebration of mathematics for the turn of the century, along the lines of Hilbert's 1900 address.

Election of Committees

This followed the usual IMU pattern whereby nominations are called some months in advance and the Executive Committee selects a slate of candidates and presents it to the Assembly to vote on (without any information about the candidates)! The Assembly is not informed of any other nominations and the mechanism of receiving nominations from the Assembly (these required the signature of 10 delegates) seemed to be ineffective.

These procedures were questioned and there was some discussion on the powerful role of the Executive Committee in this and other matters but there was no indication that this would change. The following committees were so "elected".

IMU Executive Committee

President:	J.L. Lions (France)
Vice-Presidents:	J. Coates (U.K.)
	D. Mumford (USA)
Secretary:	J. Palis (Brazil)
Members:	J. Arthur (Canada)
	A. Dold (Germany
	H. Komatsu (Japan)
	L. Lovasz (Hungary)
	E. Zehnder (Switzerland)

The Past President is an ex-officio member of the Executive Committee.

ICMI Executive Committee

President:	M. de Guzman
Vice-Presidents:	J. Kilpatrick
	Lee Peng-Yee
Secretary:	M. Niss
Members:	Yu. L. Ershov
	E. Luna
	A. Sierpinska

The ex-officio members are: the Past President of ICMI, the President of IMU, the Secretary of IMU and the IMU representative at CTS (ICSU).

Commission on Development and Exchange

Chairman:	M.S. Narasimhan
Members:	P. Berard
	C. Camacho

A. Grunbaum
A.O. Kuku
J. Mawhin
T. Ochiai
P.L. Papini
Wu Wen Tsun

The ex-officio members are: the Past Chairman of CDU, the President of IMU, the Secretary of IMU and the IMU representative at COSTED (ICSU).

INTERNATIONAL MATHEMATICAL CONGRESS KYOTO, 21-29 AUGUST, 1990

Report by Gillian Thornley

The International Congress of Mathematicians with almost 4000 participants offered a wide variety of plenary addresses and specialist lectures. It was interesting to note the fundamental role of geometry, topology and non-linear analysis in many of the plenary addresses and to see a number of examples of research in very pure mathematics which is motivated by physics.

A highlight of the Congress was the award of The Fields Medals which is reported elsewhere.

The congress was a significant one for women in mathematics as it was only the second time that a woman had been invited to give a plenary address. Karen Uhlenbeck gave the opening plenary address on 'Applications of Non-linear Analysis in Topology'. (The previous one was Emmy Noether in 1932). There were also several women among the invited Section Lecturers.

During the Congress I was invited to join a panel on 'The Status of Women in Mathematics'. The other panelists were from Japan, China, India, Brazil and Canada. I gained the impression that the situation regarding women in mathematics is worse in New Zealand than in many other countries, both in terms of the proportion of tenured academic positions (particularly senior ones) held by women and the proportion of mathematics graduates who are women. One Canadian University is hiring only women at present to improve the balance. The panel led to a lot of contacts, both among women and among men who frequently came to apologise for the lack of women in their departments and occasionally to defend their position.

It was a surprise and pleasure to meet a number of people who knew my early research in Finsler geometry. I also made some valuable contacts for my current research, and for some of the research students in our department.

I hope more New Zealand mathematicians will be able to attend the 1994 Congress at Zürich.

ICME-7

August 6-23, 1992

The 7th International Congress on Mathematical Education (ICME-7) will be held in the city of Québec (Canada) from August 16 to 23, 1992 on the campus of Université Laval, which offers facilities and services making it a most convenient place to hold such an international event.

In an effort to meet the diverse needs and interests of the 3000-3500 expected participants, the program will cover all of the major areas of mathematics education at the elementary, secondary and post-secondary levels. Activities will include lectures, working groups, topic groups, workshops, short communications, posters, project presentations, and films, as well as exhibitions of textbooks, software, and other types of materials. Here are a few examples of themes that will be discussed during the congress:

Improving students' attitudes and motivation
Mathematics for early school leavers
Innovative assessment of students in mathematics
Students' misconceptions and inconsistencies of thought
The impact of calculators on the elementary school curriculum
The role of geometry in general education
Probability and statistics for the future citizen
Modelling activities in the classroom
Students' difficulties in calculus
Undergraduate mathematics for different groups of students
Pre-service and in-service teacher education
Methodologies for research in mathematics education

The Second Announcement of the congress will be published in 1991 and will contain detailed information about the program, as well as forms for registration, accommodation, and submission of short communications or posters. In order to receive it, please write to: **Congrés ICME-7 Congress, Université Laval, Québec QC, Canada G1K 7P4**, or communicate with the secretariat of the congress by phone: (418) 656-7592, or by fax: (418) 656-2000, or by electronic mail: ICME-7@LAVALVM1.BITNET

THE INSTITUTE OF COMBINATORICS AND ITS APPLICATIONS
New Learned Society

Professors W.L. Kocay, R.C. Mullin, R.G. Stanton, and S.A. Vanstone have taken the step of incorporating a non-profit educational company as The Institute of Combinatorics and its Applications Incorporated (ICAI). This company will serve as an umbrella for the development of the Institute of Combinatorics and its Applications as a learned society (ICA).

The ICA has the aim of promoting combinatorics in all its aspects, of encouraging publications in combinatorics, and of increasing contacts between research workers in theoretical combinatorics and research and development workers in government and industry. The Articles of Association of the members of the ICA have been modelled on those of the IMA, but can be amended at Extraordinary General Meetings as the need may arise.

A group of Founding Fellows has agreed to serve as the first Council of the ICA and get the organization off the ground. We have been fortunate in obtaining the agreement of Professor William T. Tutte to serve as the first President of the ICA. To date, the following have agreed to serve in the group of Founding Fellows:

> F. Hoffman, W.L. Kocay (Secretary), C.C. Linder, W.H. Mills, R.C. Mullin (Vice-President), R.C. Read, J.R. Seberry, G.J. Simmons, R.G. Stanton (Registrar), A.P. Street, W.T. Tutte (President), S.A. Vanstone (Vice-President), W. D. Wallis.

The headquarters of the Institute will be at 81 Walnut Street, Winnipeg, Manitoba (Canada), where space has been provided gratis by the Charles Babbage Research Centre, which has also agreed to become an initial institutional member of the ICA.

The following are the types of membership in the Institute.

(1) Fellow of the Institute (FICA).
(2) Honorary Fellow of the Institute (FICA (hon)).
(3) Associate Fellow of the Institute (AFICA).
(4) Member of the Institute (this includes Companion, Graduate, and Student Members) (MICA).
(5) Corporate Member of the Institute (CMICA).
(6) Institutional Member of the Institute (IMICA).

Qualifications for the various grades of membership, together with the schedule of annual membership fees and the one-time entrance fee are set forth in the Articles of Association. A summary of the fee structure for individual members appears at the end of this summary.

Procedures for application for the various grades of membership are set forth in the Articles of Association. However, during the first year of operation of the Institute (that is, during the period from April 1, 1990, to March 31, 1991), the Founding Fellows have agreed that membership will be open by invitation to established combinatorists and persons interested in combinatorics. Those persons who are invited to become Fellows during the said period will be designated as **Foundation Fellows of the Institute**, and their fellowship diplomas will indicate this appellation.

The Institute will publish the *Bulletin of the ICA*; this will appear two or three times a year and will be similar to the *Bulletin of the IMA*. It will contain news of members, news of forthcoming conferences, and short papers. These papers can very greatly in nature; some types of paper that would be welcome are expository papers, classroom notes, brief announcements of research, innovative presentations of combinatorial topics, accounts of applications of combinatorics. We expect that papers submitted will range from pure exposition to pure research, and any combination of the two.

The Institute has made an agreement with Utilitas Mathematica Publishing Incorporated (the publisher of the journals *Utilitas Mathematica* and *Congressus Numerantium*) and with the Charles Babbage Research Centre (the publisher of *Ars Combinatoria* and of the *Journal of Combinatorial Mathematics* and *Combinatorial Computing*) whereby any of these journals will be available to any individual member of the ICA at half the regular price.

The ICA will sponsor various combinatorial conferences. In the early stages of the ICA, sponsorship will involve sharing the cost of one invited speaker on a 50-50 basis with the organizers of the conference; the speaker shall be agreed upon by both the conference organizers and the ICA and must be a member of the ICA.

The said speaker will be designated as the ICA Lecturer at the conference in question.

Finally, the Council of the ICA will be charged with the task of promoting co-operation and communication between theoretical combinatorists and practitioners of the combinatorial art. It will study the question of encouraging students by the provision of prizes or scholarships, and it will work towards the initiation of an ICA medal to be awarded annually to an outstanding combinatorist.

There is no fee for honorary members of the Institute. All other members will pay a one-time entrance fee of $15.00 which will be devoted towards the costs of preparation of the diplomas of membership or fellowship. Annual membership fees shall be $75.00 for Fellows, $55.00 for Associate Fellows, and $35.00 for Members. Retired Fellows or Associate Fellows retain their ranks but pay annual fees at the Member's level only (that is, $35.00). Student members need not pay the entrance fee, and have their annual fee dropped to $25.00. Fees for Corporate and Institutional Members are set forth in the Articles of Association. (All fees are in US dollars).

Enquiries may be referred to either Dr Derrick Breach or Prof Derek Holton, NZ Fellows of ICA.

SIR MICHAEL ATIYAH
President of the Royal Society of London

The five-year term of Presidency of Sir George Porter, O.M., came to an end on 30th November 1990. The candidate recommended by the Royal Society Council for election to the Council and to the office of President on 30th November 1990 is Sir Michael Atiyah, F.R.S., who is currently Royal Society Research Professor at the University of Oxford. Sir Michael toured New Zealand in 1990 as the Second Forder Lecturer.

AUSTRALASIAN JOURNAL OF COMBINATORICS
New Journal

The *Australasian Journal of Combinatorics* is a new journal devoted to the publication of research concerning all aspects of combinatorics, pure and applied. It is intended that at least two volumes of the journal will appear each year. Intending contributors should submit two copies of manuscripts to the Editor-in-Chief (A.P. Street), the Managing Editor (A.J. Rahilly) or any one of the Associate Editors (E.J. Billington, D.M. Donovan, J.N. Holt or S. Oates-Williams), all of whom are at the Editorial Office of the Australasian Journal of Combinatorics, Department of Mathematics, the University of Queensland, Queensland, 4072, Australia. The journal is produced using a photo-offset process. Because of this it is most important that authors submit manuscripts typed to as to occupy a 6 inch × 9 inch (152mm × 229mm) rectangular area centred on each page. Authors are also urged to submit papers the title page of which exhibits the following order: title, author/s, abstract, followed immediately by the body of the paper.

N.Z.M.S. VISITING LECTURESHIP
Special Notice from NZMS Council

The Council of the New Zealand Mathematical Society would be very pleased to know about visitors who may be suitable candidates for the annual N.Z.M.S. Visiting Lectureship. This lectureship usually entails a 3-week tour of the main centres of New Zealand, giving two or three lectures to general and specialist audiences in each place. Suggestions or nominations may be sent either to the NZMS. President (Dr. Gillian Thornley, Department of Mathematics & Statistics, Massey University, Palmerston North), or to David Robinson (Department of Mathematics, University of Canterbury, Christchurch).

1991 NZ MATHEMATICS COLLOQUIUM
19-23 May, 1991 University of Otago, Dunedin

1991 will mark the 25th anniversary of our first Colloquium, and we hope to make it a memorable occasion. At this stage many details of the programme are still to be decided, but the usual format will be followed:

- Plenary sessions addressed by invited speakers on subjects of general interest.
- Smaller groups in parallel streams covering more specialized topics.
- An Education day (23 May) of special interest to mathematics teachers.
- An afternoon of excursions. The possibilities include a visit to the albatross colony at Tairoa Head.
- A colloquium dinner.

Please note the dates above, and bring this notice to the attention of any colleagues who might otherwise miss it. You should also consider whether you may wish to give a paper on some area of current interest. An indication of your intention to speak will be asked for in the second notice. All enquiries to: The Colloquium Secretary, Department of Mathematics and Statistics, University of Otago, PO Box 56, Dunedin.

SENAC
Easy to use interactive time saving mathematical software

SENAC is a mathematical software system for performing symbolic and numeric calculations. It is the first example of a system which provides a comprehensive interface to a major numeric subroutine library. These libraries have been produced over a period of 20 years and are of such value that they should not be overlooked in the search for robust, efficient mathematical software.

These libraries are a product of the work of numerical analysts and software engineers. SENAC makes the full range, from solving matrix and non-linear equations through to time series and special function calculations, available in an easy-to-use form. Fast support via e-mail or fax, full documentation in both printed and on-line forms, a good range of computer implementations and a network of international distributors all indicate that this is serious software for teaching and research.

SENAC contains three modules, Sencore, Numlink and Graflink: Sencore - an interpreter giving a range of symbolic operations and data types, including elementary and rational functions, differentiation, matrices and function translation to Fortran. *Numlink* - a high level tailored interactive interface to the NAG Fortran Library of numeric subroutines at Mark 14 (NAG is a registered trademark of the Numerical Algorithms Group Ltd). *Graflink* - a high level interface to the NAG Graphics Library.

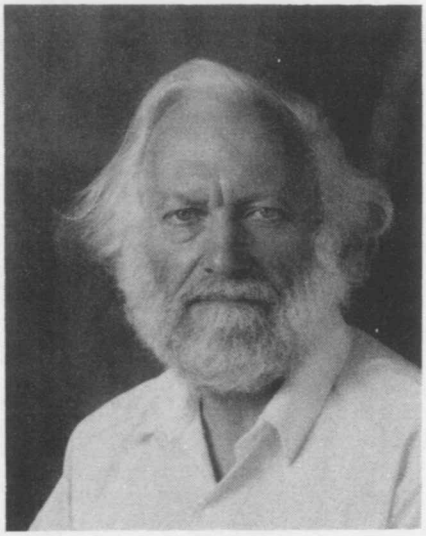
SENAC has been written for the person who needs to solve problems and process data using mathematical methods and who wants to code the problems in minimum time, i.e scientists, engineers, economists, mathematicians, university students and company researchers.

- What is needed to run SENAC? A VAX or micro VAX processor running VMS, Sun-3, Sun-4 or Sparcstation I running SunOS and a compatible version of the NAG Library. A DECstation implementation is expected to be ready by the end of 1990.

- To obtain information about Test Site Licences (NZ only) send e-mail to senac@waikato.ac.nz or write to Kevin Broughan, Mathematical Software Project Director, University of Waikato, Private Bag 3105, Hamilton.

OBITUARY AND TRIBUTE

PROFESSOR R.H.T. BATES



The University community and engineering scientists throughout the world were deeply saddened by the death on 4 November of Professor R.H.T. (Richard) Bates, D.Sc.(Eng.)(Lond.), F.I.E.E., F.I.E.E.E., F.I.P.E.N.Z., F.A.C.P.S.M., F.R.S.N.Z., F.Eng., M.E.A.

Born in Sheffield, Yorkshire, in 1929, Richard Heaton Tunstall Bates worked as an electrical engineer and researcher in England, Canada and the United States before joining the Department of Electrical Engineering at the University of Canterbury in 1967.

His wide-ranging and ingenious contributions to engineering research made him the most highly-acclaimed engineering scientist in the Southern Hemisphere and have substantially contributed to the now well secured standing of Electrical Engineering research and education in New Zealand.

Among the many prestigious honours and awards received by Professor Bates during his career were Fellowships of no fewer than six learned societies, three of which are fully international in membership. To be elected to just one such prestigious Fellowship is the aspiration of engineers and scientists throughout the world. In 1980 he received both the E.R. Cooper Memorial "Award for Physics and Engineering, awarded by the Royal Society of New Zealand, and the Michaelis Memorial Prize for Astronomy and Astrophysics, awarded by the University of Otago. In 1987 he won (together with former student Dr A.D.Seagar) the coveted Snell Premium Prize of the Institution of Electrical Engineers. His most recent honour, received this year, was his election to membership of the Electromagnetics Academy.

Being of shortish stature, with unruly leonine white hair and a cultivated eccentricity, one could have been forgiven, at first appearance, for labelling Professor Bates as the archetypal "mad professor", engaged in pursuits abstract, esoteric and theoretical. However, the latter activities were largely confined, he often stated, to the bath. Indeed, radio-astronomy, medical imaging, speech recognition, telecommunications and biomedical engineering are all areas in which Professor Bates made significant and practical contributions.

A prolific writer and charismatic communicator Professor Bates disseminated the results of his work widely. He participated regularly (often as an invited speaker) at international conferences, and published over 300 papers in learned journals, as ell as authoring a landmark book on image Restoration and Reconstruction.

A network of expertise in information Technology has been established in New Zealand, with strong international ties, in the form of more than 50 PhD graduates for whom Professor Bates acted not merely as supervisor, but more descriptively as mentor. These former students, who have met with an astonishing degree of success both here and overseas, maintain regular contact through a newsletter co-ordinated by Professor Bates' wife, Philippa.

Professor Bates enjoyed success at the highest levels in scholarship and research, and earned the respect and devotion of countless students. He enjoyed literature and poetry, classical music and the theatre, as both listener and, as he would have said, perpetrator. Leisure hours were spent trout fishing, jogging, tramping or enjoying rugby and cricket. Add to this a deeply-valued family of Philippa, four children and four grand-children, and it if consolation that although only 61 years long, a life more full and satisfying is difficult to imagine.

Excellence, an emphasis on obligations rather than right, and the importance of leadership (as opposed to management) were central to the philosophy of Professor Bates. His life, his achievements, the entire generation of students and colleagues whose lives have been enriched by him, and the demonstration he leaves to

all New Zealanders that international acclaim is not the prerogative of dwellers in the Northern Hemisphere, are all testimony to his adherence to these guiding principles. That others, especially those in positions of power and influence, adopt this philosophy as their own would be fitting tribute to Professor Bates.

There can be no doubt that the legend that Professor Bates has become will survive for generations of engineers to come, and that those of his colleagues who have had the honour and privilege to be associated with him will miss him profoundly, but remember him with joy.

Dr Kathy Garden
Electrical and Electronics Engineering
Canterbury University

My first encounter with RHTB was early in my 2nd pro year when I discovered the lecturer assigned to me as undergraduate advisor, and also who was to be teaching the course on engineering maths. My first vivid memory of Richard was the day he stormed in to the classroom proclaiming his 40th birthday and that we "had better watch our" as he was in "no mood for tom-foolery".

I may be mistaken but I believe that it was on that very day that he demonstrated for the first time his incredible prowess with chalk. Not so much on the blackboard (though he did also possess a certain skill in this direction also), but as a missile aimed between the eyes and at jolting the odd nodding student back to reality.

These classes were also memorable for the graphic demonstrations to the "great unwashed" of the nature of electromagnetism. As he gingerly walked along the top of the demonstrators table up front, arms representing electric and magnetic vectors would flail around wildly.

The following year I was fortunate enough to have drawn Richard as a supervisor for my 3rd-pro project. The idea was to build a "bird-flight monitor" and my task was to design the antennas to transmit and receive the microwave energy that was to detect, using doppler, the velocity of the bird as it flew down a tunnel. I'm not sure how well the objective was achieved, but we certainly began to develop a taste for research. Better yet, we were considered part of the team and were invited to the many parties, car-rallies and tramps that he and Phil organized at regular intervals.

I remember well the day John Hunter was seen stalking the corridors with a couple of bent brass welding rods in his hand. Imagine the scorn with which he was received when he announced that he was "dowsing" for water. Even most of "the boys" were sceptical about John's claims. Somehow, however, John managed to convince RHTB to try them, and much to his surprise, he discovered some sort of deterministic response as he paraded along the EE passageways the rods delicately balanced in each hand.

These same rods were to become necessary paraphernalia to accompany him on tramping and fishing trips for the next couple of years. At every available opportunity anyone within shouting distance would be exhorted to march up and down along a course marked out on the ground while the response of the dowsing rods was duly tabulated.

Who can forget the weekly blackboard sessions he held with his students. For those new to the game, these occasions were truly trials by fine, with more than one novitiate being burned in the process. These occasions were designed to teach us to think on our feet under pressure (and a certain amount of abuse!), and achieved their aim rather effectively. One of Richard's other missions was to ensure that his students were eventually able to express themselves intelligibly in writing. No mean task, given some of the material he had to deal with (KEE-RIIST, when are you buggers going to learn to write ENGLISH?)!

Richard, you have had a profound effect on my academic life, and I salute the dynasty of RHTBOBS (and OGS) that you have created. It has been an honour and a privilege to have been associated with you.

Dr. Terry Peters
PhD 1974

VACANT LECTURESHIPS

UNIVERSITY OF AUCKLAND
Department of Mathematics and Statistics

Applications are invited for a Lectureship in the Department of Mathematics and Statistics at the University of Auckland.

Applicants should have a proven record in teaching and research in some branch of Pure Mathematics. Applications from candidates with expertise in Combinatorial Mathematics or other areas of Pure Mathematics related to Computer Science are particularly welcome.

The Department of Mathematics and Statistics teaches a full range of undergraduate and postgraduate courses. Within the department there are two units which operate with a certain degree of autonomy. These are

the Statistics Unit and the Applied and Computational Mathematics Unit.

The Department has particular research strength in combinatorics and graph theory, finite group theory, functional analysis, complex analysis, topology, numerical analysis and statistics.

Commencing salary will be established within the range $NZ37,440 – $49,088 per annum.

Conditions of Appointment and Method of Application are available from the Assistant Registrar, Academic Appointments, University of Auckland, Private Bag, Auckland. Applications should be forwarded as soon as possible but not later than the closing date **28 February 1991**. The University of Auckland is an equal employment opportunity employer.

WB Nicoll
Registrar

UNIVERSITY OF WAIKATO
Department of Mathematics and Statistics

The University of Waikato invites applications for a Lectureship in Mathematics within the Department of Mathematics and Statistics. This Department, together with the Department of Computer Science, forms the new School of Computing and Mathematical Sciences. The department of Mathematics and Statistics has 17.5 full-time equivalent staff, and approximately 2500 course enrolments across all Schools of Study in the University. Teaching and research supervision is done at undergraduate, Masters, and Doctoral levels.

The Department wishes to develop research in computational aspects of mathematics, and to strengthen the links between the new Departments in the School of Computing and Mathematical sciences. The University therefore especially encourages applications from mathematicians with strong research records in computational areas, such as computer algebra or numerical analysis.

The salary range for Lecturers is currently $NZ37,440–$49,088 per annum.

Enquiries of an academic nature may be made to Professor D.S. Bridges, telephone (64)71 562889 or E-Mail: d.bridges@waikato.ac.nz (via Internet). Information on the method of application and conditions of appointment can be obtained from the Academic Staff Unit, University of Waikato, Private Bag 3105, Hamilton, New Zealand, telephone (64) 71 562 889, Fax(64)71 560135. Applications quoting reference number A90/97 close on 15 January 1991.

Places for appointees' children may be available in the creche run by the Campus Creche Society (Inc). The University welcomes applications from suitable people regardless of race, creed, marital status, or disability.

SESQUICENTENNIAL LETTER TO THE EDITOR

Dear Sir

A general solution to the Four-Fours-Problem, involving logarithms and strings of square root signs, has received some publicity and has been described as the last word on the problem. I disagree: the use of logarithms is not really in the spirit of the problem. Readers of the Newsletter may perhaps be interested to learn from the following article that one does not need logarithms in order to obtain a general solution to a very general representation problem which includes, in particular, the Four-Fours-Problem and other celebrated problems such as the Three-Threes-Problem and the annual Digits-Problem.

Yours sincerely
A. Zulauf

REPRESENTATION OF ARBITRARY POSITIVE INTEGERS USING GIVEN NUMERALS

by A. Zulauf,
University of Waikato

A hardy annual problem is to express positive integers using the digits of the current year, each once in the appropriate order, together with mathematical symbols and parentheses. In New Zealand's sesquicentennial year, the following may be of interest.

$$1990 = 1 - [-\sqrt{}^{4}([\sqrt{}^{4}((-[-\sqrt{}^{2}(9!)])!)]!)] \times [\sqrt{}^{3}(9!)] + 0!$$
$$= [-\ln\ln\sqrt{}^{2873}(1+9+9+0)]$$
$$= [\sqrt{}^{12}((\sqrt{}^{44887}(-[-\sqrt{}^{2}(1+9)]) - [\sqrt{}^{2}9]) * (-(0!)))] .$$

(Strings $\sqrt{}\sqrt{}\ldots\sqrt{}$ of n square roots have been rendered as $\sqrt{}^n$ for brevity.) The first, and shortest, of these three representations of 1990 involves 42 occurrences of symbols other than the digits; it was obtained by experimentation, and readers may amuse themselves by trying to find even shorter expressions. The second and third of our representations of 1990 involve, respectively, 2883 and 44928 occurrences of symbols other than the digits; they were obtained by using two new general methods that allow one to express any given positive integer in terms of any given numerals. This article is concerned with these new methods which apply, of course, not only to the Digits-Problem but also to others such as the Four-Fours-Problem and the Three-Threes-Problem.

Let (a, b, c, d, . . .) be any finite list of numerals denoting real or complex numbers, not necessarily distinct. Let the following be our list of approved symbols.

$$+ \quad - \quad \times \quad \div \quad * \quad ! \quad | \quad \sqrt{} \quad [\ ] \quad (\ )$$

It is to be understood that $x * y$, $x!$, $|x|$ and $[x]$ have their usual meanings, in particular $x * y = x^y$, $\sqrt{}x$ = positive square root of x, and $[x]$ = greatest integer not exceeding x. As mentioned before, $\sqrt{}^n$ will be used as an abbreviation of a string of n square root signs so that

$$\sqrt{}^n x = \sqrt{}\sqrt{}\ldots\sqrt{}x = x^{2^{-n}} .$$

The (a, b, c, d, ...)-Problem.

Given any positive integer N, express N by using exactly one copy of each of the numerals in the order in which they are listed, together with any number of copies of approved symbols.

We shall give a general solution of this problem provided that at least four numerals are listed or that $|a| > 1$ and three numerals are listed. As far as I know, all previously published general solutions of this kind employ forbidden devices such as the use of logarithms. Moreover, we shall see that if use of ln, the natural logarithm symbol, is permitted then we can solve even more difficult problems such as the (a, b)-Problem and, if $|a| \notin \{0, 1\}$, even the (a)-Problem.

We begin by establishing some lemmas.

Lemma 1 If a is any number then 1 can be expressed by using a exactly once together with approved symbols.

Proof If $|a| > 1$ then $\sqrt{}^p|a|$ decreases strictly to 1 as p increases, and we can determine the smallest non-negative integer p such that $1 < \sqrt{}^p|a| < 2$ and therefore $[\sqrt{}^p|a|] = 1$. If $|a| \leqq 1$ then $[|a|] = 0$ or 1 and therefore $[|a|]! = 1$.

Lemma 2 If $|a| > 1$ then 2 can be represented by using a exactly once together with approved symbols.

Proof As in the proof of Lemma 1, we can determine the smallest non-negative integer p such that $1 < \sqrt{}^p|a| \leqq 2$ and therefore $-[-\sqrt{}^p|a|] = 2$.

The next lemma has a bearing on Problem E3363 in the *American Mathematical Monthly*, the solution of which has not appeared yet.

Lemma 3 Let N be any positive integer. Then

$$N = [\sqrt{}^m((\sqrt{}^n 2 - 1) * (-1))] ,$$

where

$$m \text{ is the smallest integer } \geqq \frac{1}{\ln 2} \ln \frac{\ln 2 - \ln\ln 2}{\ln(1 + 1/N)} , \text{ and}$$

$$n \text{ is the integer nearest to } \frac{2^m \ln(N^2+N) + \ln\ln 2}{2 \ln 2} .$$

Proof Suppose that m and n are chosen as above. Then $m \geqq 1$, $n \geqq 1$, and

$$2^{-m} \leqq \frac{\ln(1+1/N)}{\ln 2 - \ln\ln 2}, \quad \left| 2^{-m} n \ln 2 - \frac{\ln(N^2+N)}{2} - \frac{2^{-m}\ln\ln 2}{2} \right| \leqq \frac{2^{-m}\ln 2}{2} .$$

Now let $x = 2^{-n}\ln 2$ so that $0 < x \leqq (\ln 2)/2$, and put

$$y = \sqrt[m]{((\sqrt[n]{2} - 1) * (-1))} = (e^x - 1)^{-2^{-m}} .$$

Note first that

$$1 < \frac{e^x - 1}{x} = \sum_{k=1}^{\infty} \frac{x^{k-1}}{k!} \leqq \frac{e^{(\ln 2)/2} - 1}{(\ln 2)/2} < \frac{1}{\ln 2}$$

and therefore

$$\ln\ln 2 < \ln \frac{x}{e^x - 1} = 2^m \ln y - n \ln 2 + \ln\ln 2 < 0 .$$

It follows that

$$\ln y > 2^{-m} n \ln 2 > \frac{\ln(N^2+N)}{2} + \frac{\ln 2 - \ln\ln 2}{2} 2^{-m} ,$$

$$\ln y < 2^{-m}(n \ln 2 - \ln\ln 2) < \frac{\ln(N^2+N)}{2} - \frac{\ln 2 - \ln\ln 2}{2} 2^{-m} .$$

But $$\frac{\ln 2 - \ln\ln 2}{2} 2^{-m} \leqq \frac{\ln(1+1/N)}{2} .$$

Hence $$\ln N = \frac{\ln(N^2+N) - \ln(1+1/N)}{2} < 2^{-m} n \ln 2$$

$$< \ln y < \frac{\ln(N^2+N) + \ln(1+1/N)}{2} = \ln(N+1) ,$$

which implies that

$$[y] = [2^{2^{-m}n}] = N .$$

This establishes Lemma 3. Note that $|2^{2^{-m}n}|$ is easier to compute than y . For instance,

$$1990 = [2^{44887/4096}] = [\sqrt[12]{((\sqrt[44887]{2} - 1) * (-1))}] .$$

We now turn to some applications.

General Solution of the (a, b, c)-Problem, given that $|a| > 1$.

Use Lemma 2 to express 2 in terms of a . Next use Lemma 1 to express 1 first in terms of b and then in terms of c . Finally use Lemma 3.

General Solution of the (a, b, c, d)-Problem.

If $|a| + |b| > 1$ let $a' = |a| + |b|$; otherwise let $a' = [|a|]! + [|b|]!$. The problem now reduces to the (a′, c, d)-Problem with $|a'| > 1$.

It is interesting to note first that a, b, c (and d) occur, as required, in precisely that order in the representation of N ; second that the Three-a's-Problem has a general solution if $|a| > 1$ and that the Four-a's-Problem has a solution for every a , even for $a = 0$; third that the (a, b, c, d, ... , g)-Problem reduces to the (a, b, c, d + ... + g)-Problem; fourth that the approved symbols $\times$ and $\div$ are not needed at all; fifth that the symbol $|$ is not needed if all listed numerals are real; and sixth that the single use of $*$ could be replaced by a use of $\div$ since $x * (-1) = 1 \div x$ (which, however, changes the order in which the numerals occur).

The last two results incorporate, in particular, general solutions to the Three-Threes Problem and the Four-Fours-Problem. For example, the following representaions of 1990 are obtained by our method

$$1990 = [\sqrt{}^{12}((\sqrt{}^{44887}(-[-\sqrt{3}]) - [\sqrt{3}]) * (-[\sqrt{3}]))] ,$$

$$1990 = [\sqrt{}^{12}((\sqrt{}^{44888}4 - [\sqrt{}^{2}4]) * (-[\sqrt{}^{2}(4+4)]))] ,$$

and so is the third of the representations given at the beginning of this article.

To make further advances, one would have to supersede Lemma 3 with a more powerful lemma that would yield a general solution of the (1,1,1)- or the (2,1)-Problem. It seems difficult to do this without adding to the list of approved symbols, and we shall now investigate what can be achieved if ln , the natural logarithm symbol, may be used.

Lemma 4 If $x > e^{e^{-2}}$, and N is any positive integer, then

$$N = [-\ln\ln\sqrt{}^{n}x] ,$$

where n is the largest integer less than $\dfrac{N + 1 + \ln\ln x}{\ln 2}$.

Proof Suppose that n is chosen as above. Then $n \geqq 0$ and

$$n \ln 2 < N + 1 + \ln\ln x \leqq (n+1)\ln 2 ,$$
$$2^n < e^{N+1}\ln x \leq 2^{n+1} < 2^n e , \quad e^{-N-1} < 2^{-n}\ln x = \ln\sqrt{}^{n}x < e^{-N} ,$$
$$-(N+1) < \ln\ln\sqrt{}^{n}x < -N ,$$

which implies the desired result.

General Solution of the Simplified (a)-Problem (simplified by adding ln to the list of approved symbols), given that $a \neq 0$ and $|a| \neq 1$.

If $|a| > e^{e^{-2}}$ use Lemma 4 with $x = |a|$.

If $0 < |a| < e^{-e^{-2}}$ use Lemma 4 with $x = 1/|a|$ and note that $\ln\sqrt{}^{n}(1/|a|) = -\ln\sqrt{}^{n}|a|$.

If $e^{-e^{-2}} \leqq |a| \leqq e^{e^{-2}}$ but $|a| \neq 1$, note that $0 < |\ln|a|| \leqq e^{-2}$ so that $-|\ln|\ln|a|| \geqq 2 > e^{e^{-2}}$, and use Lemma 4 with $x = -|\ln|\ln|a||$.

General Solution of the Simplified (a,b)-Problem (simplified by adding ln to the list of approved symbols).

If $|a| \notin \{0,1\}$ put $c = |a| + [|b|]$.
If $|a| \in \{0,1\}$ but $|b| \notin \{0,1\}$ put $c = [|a|] + |b|$.
If $|a| \in \{0,1\}$ and $|b| \in \{0,1\}$ put $c = [|a|]! + [|b|]!$.

In all cases $|c| \notin \{0,1\}$ and the problem reduces to the Simplified (c)-Problem.

We have thus found general solutions to the simplified versions of the Two-Twos-Problem, the Two-Ones-Problem and the One-Two-Problem. For instance

$$1990 = [-\ln\ln\sqrt{}^{2871}2] .$$

It is also worth mentioning that if use of ln is permitted then far fewer approved symbols are needed than are needed otherwise. For example,

$$1990 = [-\ln\ln\sqrt{2871}(-[-\sqrt{2}(3+3+3)])]$$

involves 2888 occurrences of approved symbols, whilst 44923 such occurrences are involved in the Three-Threes representation of 1990 given earlier. A similar comparison has already been made at the beginning of this article for the Digits representations of 1990 with and without use of ln .

Finally it should be noted that this article is concerned only with finding general solutions. It is conceivable that for each given set of numerals, and for each given positive integer, a particular solution can be found that is shorter than the solution obtainable by our general method. The annual Digits-Problem may thus live on, the prize going to the solver who finds the shortest possible expressions.

HISTORICAL NOTE

KELVIN ON THE FUTILITY OF PURE MATHEMATICS

By G. J. Tee

William Thomson (Baron Kelvin, 1824-1907) was a leading physicist of the 19th century, and one of the most effective developers of mathematical physics. He wrote to his friend Hermann von Helmholtz on 1864 July 31st, thanking Helmholtz for loaning him a memoir by Kirchhoff on the theory of linear elastic plates, in which Kirchhoff had solved a problem concerning an elastic circular plate.

> "The full working out of the solution, too, for the circular plate, shows no small amount of courage, skill and well-spent labour. Oh! that the CAYLEYS would devote what skill they have to such things instead of to pieces of algebra which possibly interest four people in the world, certainly not more, and possibly also only the one person who works. It is really too bad that they don't take their part in the advancement of the world, and leave the labour of mathematical solutions for people who would spend their time so much more usefully in experimenting."
>
> (Silvanus P. Thompson, *The Life of William Thomson, Baron Kelvin of Largs*, MacMillan & Co; London, 1910. Volume 1, page 433)

The solutions of problems such as that treated by Kirchhoff were usually expressed in forms such as infinite series of products of various Bessel functions, with tables of the coefficients. Nowadays such "solutions" are widely regarded as some of the dreariest part of classical mathematical physics. Practically usable solutions of partial differential equations are now computed numerically by using finite-element (or finite-difference) techniques, with matrices as essential tools throughout the formulation and computation of the problem.

One of the main "pieces of algebra" which Cayley was developing from 1858 onwards, to the displeasure of Thomson, was the theory of matrices!

BOOK REVIEWS

Commutative Coherent Rings, by Sarah Glaz, Lecture Notes in Mathematics, Volume 1371, Springer-Verlag, Berlin-Heidelberg-New York,1989, xi + 347pp, DM 61. ISBN 3-540-51115-6.

A ring in which every (left) ideal can be generated by a finite number of its elements is called a (left) *Noetherian* ring. Noetherian rings are probably the most widely studied rings, in both the commutative and noncommutative branches of ring theory, with their commutative roots in algebraic number theory (rings of integers of algebraic number fields are Noetherian) and in algebraic geometry (many coordinate rings are Noetherian). In the noncommutative branch the theory of Noetherian rings has had major consequences in the

representation theory of certain groups and Lie algebras. However many commonplace rings, including some arising in algebraic number theory and algebraic geometry, fail to satisfy the Noetherian property and to a large extent this has encouraged the investigation of a class of rings properly containing Noetherian rings but still satisfying useful finiteness conditions. These rings, *coherent* rings, are the subject of the book under review.

A ring R is called (left) *coherent* if (i) the intersection of any two finitely generated left ideals of R is also finitely generated and (ii) the left annihilator ideal, $\text{ann}(a) = \{r \in R : ra = 0\}$, of each $a \in R$ is finitely generated. This is not the definition used by Glaz but equivalent to it. The advantage of the one given here is that it immediately shows the nonexpert that Noetherian rings are coherent. Moreover it quickly provides examples of coherent rings which are not Noetherian. For example, let X be an infinite set, let P(X) be the power set of X, and let R be the (usual) Boolean ring obtained by defining addition on P(X) as symmetric difference and multiplication as intersection. Then all finitely generated ideals in R are in fact principal (i.e. generated by just one element), the intersection of two such ideals is their product and so also finitely generated, and the annihilator of an element $A \in R$ is the principal ideal generated by the complement of A in X. As another tangible example of a coherent ring which is not Noetherian we have the ring of all continuous functions from the reals to themselves with pointwise addition and multiplication.

Coherent rings were first introduced (but not named as such) in the seminal paper "Direct products of modules" by S. U. Chase published in the *Transactions of the American Mathematical Society* in 1960. Many of the results in this paper featured as exercises in Chapter 2 of Bourbaki's *Algebre Commutative*, where the term "coherent rings" was first used. The results show that coherent rings have useful homological characterizations. It is with these homological ideas that Glaz begins and we now describe her book's content and layout.

Although there is the occasional discussion of rings which are not necessarily commutative the aim of the book, as its title indicates, is to present the *commutative* story and so in what follows all rings will be commutative. As she mentions in her introduction the book does assume some basic knowledge of commutative and homological algebra. Nevertheless most of the background used is stated clearly in Chapter 1 with references to standard texts for the novice. Chapter 1 looks at projective and injective modules, flat modules and localization, and homological dimension. Of these topics probably flat modules would be the least known. Roughly speaking these are modules which behave well with regard to the tensor product, and they include projective modules as a special case.

In Chapter 2 finitely presented modules are defined. These are modules which can be realised as the quotient of a finitely generated free module by a finitely generated submodule so that, again roughly speaking, they are finitely generated modules which have only a finite number of "relations" between the generators. Glaz then defines a ring to be coherent if each of its finitely generated ideals is finitely presented and proves Chase's various characterizations of coherent rings including the one we used in our definition above and the interesting homological characterization that the ring R is coherent if and only if every direct *product* of flat R-modules is flat. (Direct *sums* of flat modules are always flat, regardless of the ring.)

With these first two chapters having set the scene the author in the remaining six chapters turns to more recent and ongoing research in coherence. Chapter 3 prepares for this with the development of commutative homological techniques while Chapters 4 and 5 look at special ring constructions which produce examples and counterexamples to illustrate the theory. In Chapter 6 uniform coherent rings are introduced. These are rings R such that any direct product of countably many copies of R is coherent. There is also an account here of the role coherence plays in W.V.Vasconcelos' work on rings of global and weak global dimension 2.

One of the disappointments in the theory of coherent rings is that the ring R[x] of polynomials in an indeterminate x over a coherent ring R need not be coherent (although R[x] is Noetherian if R is). Reasons for this instability from R to R[x] are investigated in Chapter 7. Finally Chapter 8 looks at coherence in certain algebras, in particular power series rings, groups, symmetric algebras and rings of continuous functions.

The book is very well-written and the author has taken much care in providing the reader with many illustrative examples and motivating comments. The style is clear and informative and the bibliography extensive. The book gives a comprehensive treatment of the research done to date in the commutative theory. Indeed this is a most coherent account!

John Clark
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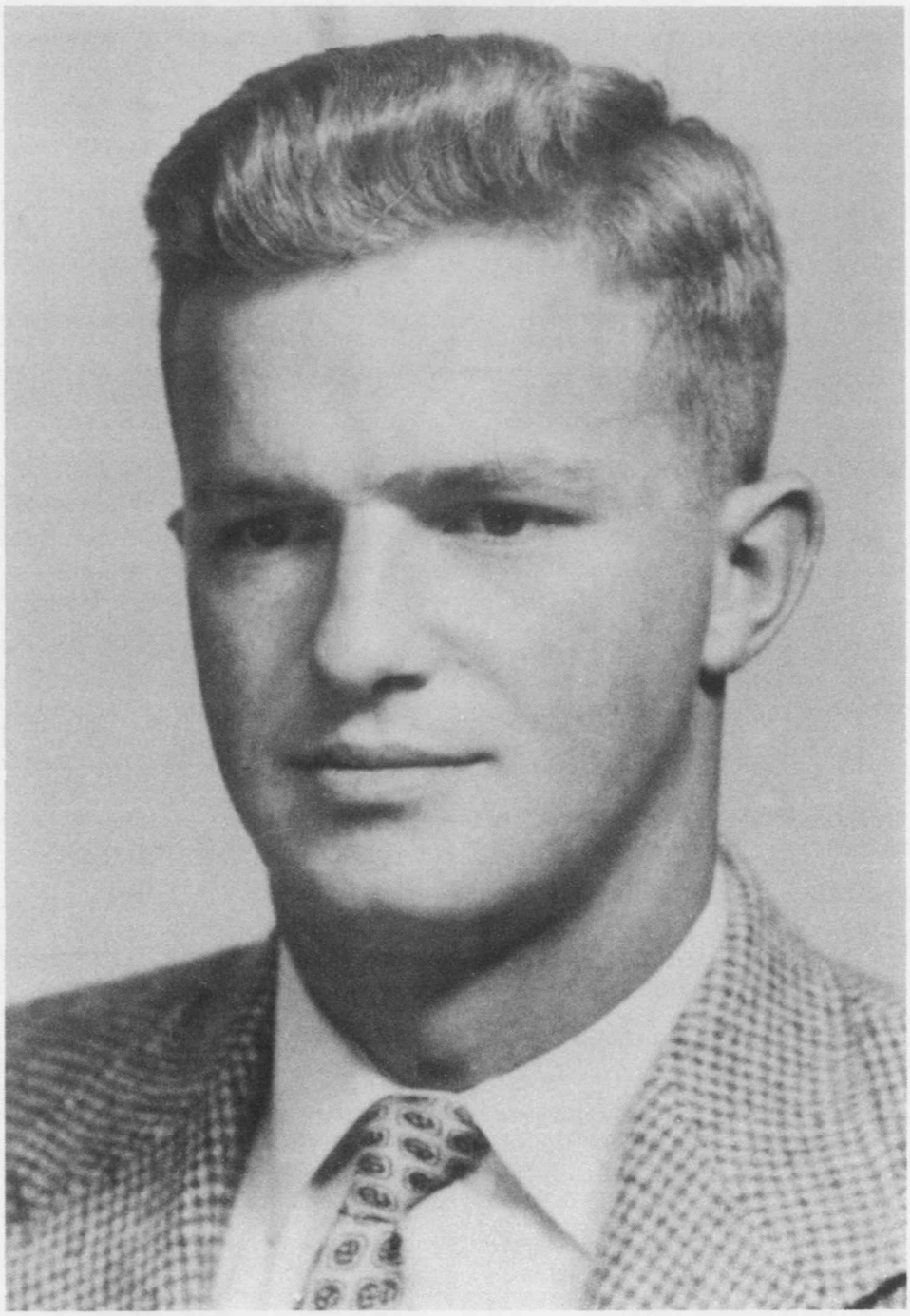
CENTREFOLD



Prof David Benney

DAVID J. BENNEY

By Peter J. Bryant

Dave Benney was educated at Wellington College and Victoria University College. He completed an M.Sc. with First Class Honours in Mathematics in 1951, when in examinations common to Auckland, Canterbury and Victoria University Colleges he was well ahead of any other candidate. Dave was appointed a junior Lecturer in Mathematics at Victoria for two terms of 1952 before enrolling at Emmanuel College, Cambridge on a NZ Postgraduate Scholarship. Like other NZ mathematics graduates of the 1950's, he took Parts 2 and 3 of the Mathematics Tripos because the NZ M.Sc. degree was considered insufficient, with justification, to proceed directly to a Ph.D. The offer of a Lectureship at Canterbury reached him in Sweden, where he was on holiday after the Part 3 exams in 1954, and was accepted by a letter and cable from Stockholm. One sentence in a reference written in his support is an indication of views at that time -- "His character is above reproach, and he has not been associated in any way with political activity."

He is remembered at Canterbury for the quality of the Applied Mathematics courses he taught, and for his enthusiasm at skiing and tennis. His third and fourth year courses in classical mechanics described a subject which regretfully has largely disappeared from current syllabuses. The photo with this article was submitted with his application in 1954. Those who attend the Applied Mathematics Conference in February can judge how little he has changed in 36 years, and can test his continuing tennis skills.

His file at Canterbury records that he was granted a year's leave of absence in August, 1957, to do graduate study in the Mathematics Department, Massachusetts Institute of Technology. He passed the first qualifying examinations with such ease that he was exempted from the remainder and completed his Ph.D. in 1959 in record time, under the supervision of C. C. Lin. Once difficulties about his immigrant status in the USA were sorted out, he severed his links with Canterbury and was promoted rapidly at MIT. Canterbury made one last effort to entice him back as Head of Department when Professor Lawden resigned in 1967, but unfortunately he had just been promoted to be a full Professor at MIT, and understandably saw an academically more rewarding future there. He is now Head of the Mathematics Department at MIT.

Dave Benney has established his reputation in nonlinear wave and stability problems. One paper he published in 1962 has equations which are pages long, showing a high degree of commitment, because this was before the days of symbolic computation packages. The principles he elucidated there were important even if most readers ignored the details. Many of his more than 50 papers develop new ideas which others have subsequently expanded, because Dave can never be accused of writing two words where one will do. Typical subjects include nonlinear waves in parallel shear flows, interactions between short and long waves, resonance in nonlinear wave systems, and nonlinear instabilities in hydrodynamics.

Among his graduate students are some, such as Alan Newell, who are now leaders in applied mathematics themselves. Dave is Managing Editor of the journal *Studies in Applied Mathematics*, which has been turned into one of the best journals in the subject. He wrote the undergraduate book *Calculus: An Introduction to Applied Mathematics* jointly with Harvey Greenspan in 1973. As expected, it is an excellent book on the application of mathematics, but unfortunately the publisher set a rather expensive New Zealand price.

We look forward to his invited address on 'Nonlinear wave and instability processes' to the Applied Mathematics Conference at Hanmer Springs in February.

(Continued from page 21)

Irregularities of Partitions, edited by G.Halász and V.T.Sós. Algorithms and Combinatorics, Study and Research Texts, Volume 8, Springer-Verlag, Berlin-New York, 1989, vii + 164pp, DM 74. ISBN 3-540-50582-2.

This is a collection of fourteen papers and some problems emanating from a workshop held at Fertöd, Hungary, in July 1986. The editors classify 5 of the papers as being on combinatorics, 4 on analytic number theory, 4 embracing generalisations of both topics, and one on the geometric theory of numbers. The unifying theme of these high level research papers is the study of the properties possessed by the classes into which the set of positive integers has been partitioned in some way. The flavour of this topic is given by the three theorems stated at the beginning of the paper by P.Frankl, R.L.Graham and V.Rödl;

Schur's Theorem (1916): *Any partition of the set of positive integers into finitely many disjoint classes must have at least one class which contains a set of the form* $\{x, y, x+y\}$.

Van der Waerden's Theorem (1930): *For any partition of the set of positive integers into a finite number of disjoint classes at least one one of the classes contains arbitrarily long arithmetic progressions.*

Ramsey's Theorem (1930): *If the set of all k-element subsets of the positive integers is partitioned into a finite number of disjoint classes then at least one of these classes contains all the k-element subsets of some infinite subset of the positive integers.*

Each of these has a finite form. Call the classes "colours", so all objects in the same class have the same colour. Let k, l, r be positive integers. Then, for example, we have Ramsey's Theorem (finite form): *There is a least integer R such that if the set of all k-element subsets of* $\{1, 2, 3, \ldots, R\}$ *is r-coloured then there is an l-element subset of* $\{1, 2, 3, \ldots, R\}$ *all of whose k-element subsets have the same colour.*

For particular values of k, l, r the determination of R is exceedingly difficult. For the case of two colours we have the allied problem; given m and n what is the minimum value of R such that the complete graph, K_R, on R points, in which the vertices are coloured either red or blue, contains either a red K_m or a blue K_n? These Ramsey numbers are usually qualified by the word "elusive". Only seven values of this R are known precisely; $R(3,3) = 6$, $R(3,4) = 9$, $R(3,5) = 14$, $R(3,6) = 18$, $R(3,7) = 23$, $R(3,9) = 36$, $R(4,4) = 17$. It seems very likely that $R(3,8) = 28$. There is a lively account of these results by R.L.Graham and J.H.Spencer in the July 1990 issue of the *Scientific American.*

Each one of the papers in this book would rate a review in its own right but to do justice to each would require a depth of specialised knowledge equal to that of the authors. The reviewer will content himself by recommending a preliminary reading of *Irregularities of Partitions* by one of the editors, V.T.Sós; it is in the Lecture Notes Series 82 of the London Math. Soc., 1983. The reviewer hopes that this and the *Scientific American* article will provoke the reader to probe deeper. The world is divided into three classes about Ramsey theory, those that adore it, those that abhor it, and those who, most unwittingly, ignore it. This book will at least get you out of the third class.

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The Theory of Fixed Point Classes, by T.Kiang. Springer-Verlag, Berlin-Heidelberg-New York / Science Press, Beijing, 1989, xi + 174pp, DM 98. ISBN 3-540-10819-X.

This book is a translation by the author of the revised second edition of the original Chinese text published by Science Press in 1979, with some minor modifications to the appendices.

On reading the epilogue one cannot help feeling pathos not only for the author but also for all other victims of governments espousing anarchistic and/or suppressive policies. In the case of the author, plans for this book were virtually suspended for a decade due to the upheaval in China associated with the "Gang of Four". China is not the only country whose official policies have for a time affected the development of the subject matter of this book. A generation earlier another major contributor to the field was killed in the Second World War. It is pleasing to note that at least some of the victims of the Gang of Four upheaval were able to return to their study of fixed point classes and make further significant contributions as recorded in this book.

The major aim of this book is to discuss the status of the question: "How many fixed points must a given continuous function have?" The tools used are from algebraic topology so the answers tend to be dependant only on the homotopy class of the map. Inspired by a student question as to how Lefschetz got his ideas to formulate and prove the Lefschetz fixed point theorem, the author tries to keep in mind the historical

development of the subject and the way in which one might best learn the subject. Thus chapter I considers the general problem in the context of maps of the circle, with illustrative examples as well as proofs of the Lefschetz and Nielsen fixed point theorems for the circle.

Chapter II discusses equivalent conditions of the fixed point classes of a map, the index of a fixed point class, the Nielsen number $N(f)$ of a map f and its standard properties. The standard properties of the index of a fixed point class are stated without proof; instead the reader is referred to an appropriate treatment elsewhere.

Evaluation of the Nielsen number, especially by way of the Jiang subgroups of the fundamental group, is the aim of chapter III. Thus, for example, if the Jiang group for the identity map of a (connected, finite) polyhedron is the fundamental group itself (as is the case for the circle) then any map f with non-zero Lefschetz number has $N(f) = \#\ coker(id - f_*)$ and hence at least this many fixed points, where f_* is the homomorphism induced by f at the first level of homology.

The aim of chapter IV is to evaluate the minimum number of fixed points of functions in a given homotopy class. It is rather combinatorial in nature. One nice result proved here is that if K is a simplicial complex of dimension ≥ 3 in which no vertex is locally separating then for any map f the minimum number of fixed points is $N(f)$.

The final chapter considers briefly two further topics. In the first, the Nielsen number of the H-class of f [H refers to the normal subgroup $p_* (\pi (\widetilde{X}, \widetilde{x}_0))$ of $\pi (X, x_0)$] is applied to show that every map homotopic to a certain map of the closed, orientable surface of genus 2 has at least 2 fixed points. The second is the root class of the equation $f(y) = x_*$, where $f : Y \to X$, $x_* \in X$ is fixed and $y \in Y$ is variable. A Nielsen number for this equation is defined and, using a kind of Jiang group, the number is evaluated in some special cases.

There are 3 appendices, covering the fundamental group, covering spaces and approximation theorems.

I would recommend this book to anyone wishing to know about fixed point theory as developed by topologists. It would be best to know about the Lefschetz number beforehand, or be prepared to take time out before long to read about it. As a monoglot, I admire those who understand well more than one language. Professor Kiang is to be congratulated for producing such a fine translation of his text. At times, though, I was distracted by unusual phrasing and occasional misspellings of words: it is a pity that the publishers did not set aside one of their native speakers of English for a day or two to cut the number of such distractions.

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The Topology of 4-Manifolds, by Robion C. Kirby. Lecture Notes in Mathematics, Volume 1374, Springer-Verlag, Berlin-Heidelberg-New York,1989, vi + 108pp, DM 25. ISBN 3-540-511148-2.

A mathematician need have no familiarity with topology to realise that there have been tremendous advances in low dimensional topology (dimensions 3 and 4) in the past 15 years. The fact that about one third of the Fields medals awarded since 1982 were to mathematicians who have made significant contributions in this area is strong evidence of these advances. One who has made major contributions is Robion Kirby, and the book under review includes a description of much of his work and that of others.

As the author notes in the introduction, much that was known about 4-manifolds in the early 1970's was a special case of more general results from higher dimensions, but often the higher-dimensional results applied only in dimensions 5 and more. A common intuitive explanation of the state of affairs when I was a graduate student in the late 1960's was "in dimensions 1 and 2 everything is trivial; by dimensions 3 and 4 there is room for things to go wrong; by dimension 5 there is room to right the wrong." While this book cannot be expected to remain up-to-date even 2 years after preparation, it does include most big developments of the 1970's and 1980's.

The book is divided into 14 chapters. Here is a list of the chapter titles and an indication of their contents.

I. Handlebodies and framed links. The framed link associated with the 1- and 2-handles of a handlebody decomposition of a 4-manifold. Simplification of the link. A particular homotopy 4-sphere from its link representation.

II. Intersection forms. The cup product $H^2(M)/T \otimes H^2(M)/T \to \mathbb{Z}$, T the torsion, as the intersection form. Characteristic classes and the index.

III. Classification theorems. Rohlin's, Freedman's and Donaldson's theorems.

IV. Spin structures. A discussion of several equivalent definitions.

V. T^3_{Lie} and $CP^2 \overset{9}{\#} (-CP^2)$. Three descriptions of a spin 4-manifold whose boundary is T^3 with the Lie group spin structure.

VI. Immersing 4-manifolds in $\mathbb{R}^6$. Criteria for the immersion of a smooth, closed, orientable 4-manifold in $\mathbb{R}^6$.

VII. 3-manifolds; a digression. Orientable 3-manifolds are spin, spin bound special 4-manifolds and embed in $\mathbb{R}^5$.

VIII. Bounding 5-manifolds. Smooth, closed, orientable 4-manifolds with index 0 bound and, if spin, then they bound as spin manifolds.

IX. $p_1(M) = 3\sigma(M)$, $\Omega_4^{SO} = \mathbb{Z}$ and $\Omega_4^{spin} = \mathbb{Z}$. The first equation is proved for a smooth, closed, orientable 4-manifold and the second and third drawn as corollaries.

X. Wall's diffeomorphisms and h-cobordism. Smooth, simply connected, closed 4-manifolds are cobordant if they have isomorphic intersection forms. In certain circumstances an automorphism of an intersection form is realised by a diffeomorphism.

XI. Rohlin's theorem. Calculation of some bordism groups. The Rohlin and Arf invariants.

XII. Casson handles. Whitney's trick for removing a pair of double points of an immersion. Casson's finger moves. Casson's immersed handles; as handlebodies and related to the Whitehead continuum.

XIII. Freedman's work. Application and refinement of the Bing shrinking criterion to Casson handles leading to a proof that each Casson handle is homeomorphic to a standard handle.

XIV. Exotic $\mathbb{R}^4$'s. The construction of infinitely many exotic smooth structures which do not embed smoothly in S^4, and of an exotic smooth structure which does embed smoothly in S^4.

This book provides a nice introduction to the machinery developed to prove such profound results in the 1980's as the 4-dimensional h-cobordism theorem, the 4-dimensional Poincaré conjecture and the existence of exotic $\mathbb{R}^4$'s. It is tough going at times and the prerequisites are significant — familiarity with handlebody decompositions, characteristic classes and immersion theorems to mention three. The author helps by giving the discussion a geometric flavour and providing many figures (over 70 in the book's 100 or so pages).

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Infinite Dimensional Dynamical Systems in Mechanics and Physics, by R.Teman. Applied Mathematical Sciences, Volume 68, Springer-Verlag, Berlin-New York-Heidelberg, 1988, xvi + 500pp, DM 124. ISBN 3-540-96638-2.

The study of nonlinear dynamics is a fascinating question which lies at the very heart of many important problems such as the motion of bodies in the solar system, turbulence in fluids, chemical dynamics, plasma physics, nonlinear optics etc. Many of these problems define an infinite-dimensional dynamical system. Nevertheless one would like to know to what extent one can study dynamical behaviour using techniques and insights gained from studies of finite dimensional dynamical systems. This book gives a comprehensive account of a general set of techniques that have been developed to rigorously justify the use of finite-dimensional techniques for the study of the dynamics of a large variety of nonlinear partial differential equations.

The partial differential equations that are included as examples are the Navier-Stokes equations in two dimensions, reaction diffusion equations, nonlinear wave equations such as the sine-Gordon, and pattern formation equations such as the Kuramoto Sivashinsky equation.

In the process of reducing an infinite-dimensional system to a finite-dimensional one is the question of existence and uniqueness of solutions with specified initial conditions. What is required to be shown is that the long-time behaviour of solutions is characterised by a finite-dimensional subset of phase space. The existence of such sets into which all orbits eventually enter gives rise to the concept of an attractor. It is also evidence of the dissipative nature of the equation in question.

The next step in the reduction to finite dimensions addresses the question of estimating the Hausdorff dimension or fractal dimension of the universal attractor. The estimates of this quantity are made by linearising

the system along its trajectories and computing a Liapunov spectrum. An estimate of part of the Liapunov spectrum can be obtained by looking at the growth rates of d-dimensional volumes in the linearised flow. If there is a d for which all d-dimensional volumes decrease along the flow then d is an upper bound on the dimensions of the universal attractor. The final step in the reduction of a finite-dimensional system is the least successful of the concepts described so far. If the attractors of an infinite-dimensional system are finite then there may be a smooth finite-dimensional subsystem that is invariant under the flow which contains the universal attractor. Such a subsystem is called an inertial manifold. In looking for such an object one asks when a smooth invariant submanifold in a dynamical system will persist under perturbation. The conditions for this to happen require that one knows the separation of trajectories within the inertial manifold are less than in the normal directions. Teman presents these conditions in terms of invariant cone fields, the construction of which is based on the existence of spectral gaps for the linearisation of the partial differential equations.

The book provides an up-to-date and pretty comprehensive treatment of these topics. However the book is not easy reading. References quoted are often simply pointers to standard sources. The style incorporates the minimum amount of supporting material and refers the reader to original papers for details of proofs. The actual dynamical behaviour found in the universal attractor and invariant manifolds of the different samples is not discussed in much detail. The emphasis is primarily on the process of proving the existence of attractors and invariant manifolds for a broad class of systems.

E. G. Kalnins
University of Waikato

Skills in Mathematics, Volumes 1 and 2, by Sharleen Forbes, Margaret Morton and Heather Rae. Forbes, Morton and Rae (SHAM CO-OP), 1989, $45.00 per vol. ISBN 0-473-00835-1; 0-473-00836-X.

When mathematics educators from universities and polytechnics meet, inevitably their shared concern about poorly -repared students becomes a focus of discussion. The needs of these students along with those of 'mature' students returning to study after a break, are met by bridging courses, remedial courses, and private study in different ways at different places. It is an indication of the common need that authors from three different institutions have together produced these two volumes which so successfully provide the 'bridge', and furthermore are easily adapted to different teaching and learning situations.

The topic Modules are divided into digestible sized sections with clear explanations, worked examples, and well-paced exercises each with a solution showing all working. Module tests use questions referring to the appropriate section. These opportunities for diagnosis and reinforcement are a wonderful resource for students who are taking responsibility for their own understanding, either in a class or more particularly, working on their own.

Students are led through understanding to mastery by repeated practice and then are nurtured through to simple applications and understanding of word problems, past the critical point where many of these students have panicked in their earlier experiences, with key points written in boxes for easy identification. 'Notes' are asterisked as reminders, and short comments in brackets explain a step in a solution, like '(this is the V intercept)'.

These two books are a replacement for and extension of Sharleen Forbes' very successful 'Basic Skills in Mathematics'. The result is a more logical ordering of material, improved pace in some sections and an introduction of further topics, notably beginning calculus, a gap which many students suffer and one which they find is important to bridge. Set theory and complex numbers are also useful additions.

The down side? It is not easy finding your way round. The very good index refers the reader to Module number and section number, eg. 2 § 3 meaning module 2 section 3; but the page numbered 2.3 in large numerals has module 2 section 1. Module 2 section 3 is on page 2.8. Confused? Yes , and so are the students. Also, although it is not an uncommon use of notation, it seems a pity in a book such as this to have page 2.9 followed by 2.10.

The best advertisement is to see on campus a well thumbed, 'tatty' copy of a book published earlier this year. Congratulations and thanks to Sharleen Forbes, Margaret Morton and Heather Rae for producing an affordable and very readable pair of books, which are caring for those students who are keen to help themselves.

Lyn Holland
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Introduction to Proofs in Mathematics, by J. Franklin and A. Daoud, Prentice-Hall, 1988, $16.95. ISBN 0-7248-1009-9.

The difficulties that students of mathematics have with proofs poses one of the major problems for the teaching of the subject. This book purports to introduce proof techniques in the context firstly of elementary mathematics and then of stage one linear algebra and calculus, keeping context and motivation in mind, exposing strategy and tactics, linking proofs to computational methods and avoiding symbolic logic. No propositional logic is to be used, the main logical emphasis being on the role of the quantifiers.

It would seem indeed that the authors have some antipathy to formal logic; certainly they successfully avoid the introduction of both jargon and symbolism, but a number of peripheral remarks suggest some misunderstanding of deeper facets, especially in respect of Gödel's results and the semantics of formal systems. Occasionally some remark is made that might confuse the more attentive student but, putting such minutiae apart, the book appears as a laudable attempt to fulfill a real need with a fair degree of success.

The first eight chapters are concerned with basic logic and proof techniques. Firstly direct proof of simple propositions is exemplified using pattern recognition and arithmetic transformations, emphasizing the importance of checking for the reversibility or otherwise of the implicational steps. Universal quantification (sorry! "'All' statements") introduces generalization and considers implication further. "If and only if statements" are then considered followed by existential quantification, where the distinction between constructive and non-constructive existence proofs is emphasized. The problems of multiple quantifiers are then faced, with many illustrative examples.

Negation, contradiction and counterexamples are next explored (with the contrapositive introduced by example!). A chapter on Sets serves to introduce conjunction and disjunction and to exemplify the problems associated with the subset relation. An omission here is that of the problem of negating conjunctions and disjunctions. A chapter on mathematical induction follows which does not fail to point out that a non-inductive proof may often have greater explanatory power then an inductive alternative.

All the chapters thus far, except the first, are illustrated with pertinent examples from linear algebra and calculus, all proofs receiving a detailed discussion.

The next four chapters are devoted to specific topics that invariably cause problems for students. In linear algebra, vector spaces are illustrated and proofs of elementary properties are derived from the axioms. The problems associated with the subspace concept are then focussed upon. The chapter on limits and convergence is mainly devoted to $\varepsilon - \delta$ proofs, divergence not being forgotten. In "Counting", the emphasis is on pairing techniques, and finally the concepts of surjective and injective functions are considered.

All of the above material is well-chosen, well-explained and very valuable, but I found the final three chapters and the appendix less rewarding.

"Real-life problems", examines the difficulties of the mathematization of problems, via three diverse examples.

"Non-deductive logic", considers confirmation of results by example as opposed to proof considered in the light of history and of computer technology. "Axioms, symbolic logic and insight", discusses the status of axioms, rules of deduction and demonstrates three specific proofs relying on insightful tricks. The appendix on applications to computer programs offers only one weak example of a proof that a simple program is correct.

All chapters end with a copious list of exercises, many excellent, with selected ones solved in an appendix, although some of the solutions are actually references to the literature.

Techniques of specialization and the generation of results by more general pattern matching are not considered.

Despite a number of flaws, this book can be warmly recommended especially to first-year university students and to their teachers.

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Matched Asymptotic Expansions, by P.A.Lagerstrom. Applied Mathematical Sciences, Springer-Verlag, New York - Berlin - Heidelberg, 1988, xii + 250 pp. ISBN 0-387-96811-3.

Two of the most significant and lasting achievements of the great German engineering scientist Ludwig Prandtl, on which much of the subsequent development of aerodynamics were based, are the theory of the boundary layer in high-Reynolds-number fluid flow, and the lifting-line theory of flow about high-aspect-ratio wings. These both represent approximations to the general boundary-value problem for the Navier-Stokes equations, and may be said to have generated a very great deal of mathematical activity, in the sense, at least,

that a great many mathematicians have earned their bread and butter working on them during the twentieth century. Notwithstanding these two great benefits—the support of aircraft in the air, and of mathematicians on the ground—both theories have been regarded with suspicion by workers in fluid mechanics with a more rigorous cast of mind than Prandtl's, since both appeared to have been arrived at in somewhat intuitive ways, and since for neither could it be shown that the solutions obtained were in any sense asymptotic limits of the solutions of the corresponding exact problems. Nor were they the only instances of approximations to the Navier-Stokes equations leading to equivocal results: At low Reynolds numbers, the linearisations of Stokes and Oseen, although apparently more rational, had also produced their paradoxes.

Beginning in the 1950s, P.A.Lagerstrom, who died in 1989, led a group at Caltech devoted to the systematic study of linearised viscous flow problems, including the Stokes and Oseen approximations. They made remarkable progress in this field, beginning with a definitive resolution of the Stokes and Whitehead parodoxes, and the method they developed for the purpose sprang from Prandtl's intuitive creation of boundary-layer theory, and systematised the insights of later workers, including notably Goldstein and Friedrichs. It became known as the method of matched asymptotic expansions, and has spread in application far beyond its origin, subsuming, incidentally, Prandtl's other creation, lifting line theory. The book under review is aimed at an exposition of this method.

The book begins with an introductory chapter in which basic ideas on approximation and asymptotics are outlined, and the distinction between regular and singular perturbations, and the concepts of overlap and matching discussed. Then, in the second chapter, which takes up more than half of the book, these ideas are developed in the context of a small number of second-order ordinary differential equations which model the distinctive difficulties presented by the boundary-layer equations, Stokes' equations, and some other singular perturbation problems. The use of these simplified model equations serves Lagerstrom's avowed purpose, which is to present in as perspicuous a form as possible the ideas and techniques of the method, and in this he is largely successful. Indeed, the material in the first two chapters is marked by the depth and charm of a master, and gives evidence of the long maturing of his thoughts on the problems of presenting what is, despite the fact that so many disparate problems have, in a practical sense, yielded to it, a method which is not completely well defined, and which still lacks rigorous justification in many of its most important applications. Lagerstrom makes no attempt to disguise the status of the method. Here is what he has to say when, having proved Kaplun's "Extension Theorem", he proposes to proceed to the analysis of the specific model problems of Chapter 2:

> "In particular we shall introduce an idea, necessary to complement the use of the Extension Theorem. We shall call this idea *Kaplun's Ansatz about the Domain of Validity*. ... We use the German word "Ansatz" deliberately. It is an abomination to the purist: Not only is it not proved but it is unprovable; taken too literally it is false since counterexamples are easily found. Still it contains a genuine idea of great practical importance."

The third and final chapter begins with a fairly terse review of boundary-layer-type problems for partial differential equations, continues with a discussion of shock-like phenomena arising in the solutions of evolution equations, and ends with perhaps the most intriguing part of the book; a short section entitled "Examples from Fluid Dynamics". Introducing this, Lagerstrom explains that in view of the existence of the book by Van Dyke (Van Dyke 1975) devoted to perturbation methods, he will devote himself not to detailed analysis, but rather "...will put great emphasis on heuristic ideas ...". The passages that follow are of extraordinary interest and value: any reader, from the student who has used the first two chapters as an introduction to the subject, to the seasoned practitioner, will find in them insights to aid him.

The book is well stocked with exercises, for the most part grouped at the end of each section, and aimed at filling out and expanding the material presented in that section. The first two chapters, as I have suggested above, would serve very well as a first course in matched asymptotic expansions at the masters level. But I think that it is to those already acquainted with the method that the book will make its greatest appeal, as the distilled views on a rather hard-to-pin-down subject, set down with clarity and charm by one of its creators.

Finally, a general regret, and some criticisms in detail. The regret, which must be felt by anyone who has been following the development of the method since the fifties, is that the book has been so long coming. Lagerstrom refers in his preface to "... The long sequence of earlier drafts ...", and there is internal evidence that some of them may have been early indeed, for example the footnote on p212, in which it is stated that "...A *recent* exhaustive study of waves in compressible fluids is given by Courant and Friedrichs (1948) ...". The italics are mine. There are a few shortcomings in editing and proofreading, the most serious of which is that the extensively cited reference, (Cole 1968), presumably J.D. Cole's "Perturbation Methods in Applied Mathematics", Ginn, Boston, 1968, is missing from the list of references. Less seriously, I suspect that on p118, the word "prolification" should be "proliferation".

Brian Woods
University of Canterbury

SPRINGER AND BIRKHÄUSER 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

Applied Mathematical Sciences

86.	Dendrinos DS	Chaos and socio-spatial dynamics. 184pp.

DMV Seminar (Birkhäuser)

15.	Schatz AH	Mathematical theory of finite and boundary element methods. 276pp.

Encyclopaedia of Mathematical Sciences

14.	Tikhomirov VM	Convex analysis and approximation theory. 270pp.

Ergebnisse der Mathematik und ihre Grenzgebiete.3.Folge

19.	Ekeland I	Convexity methods in Hamiltonian mechanics. 247pp.

Grundlehren der mathematischen Wissenschaften

292.	Kashiwara M	Sheaves on manifolds. 512pp.

ISNM (Birkhäuser)

89.	Gürlebeck	Quaternionic analysis and elliptic boundary value problems. 253pp.
95.	Hoffmann K-H (ed)	Free boundary value problems. 275pp.

Lectures in Mathematics, ETH Zürich (Birkhäuser)

	LeVeque RJ	Numerical methods for conservation laws. 214pp.
	Monk JD	Cardinal functions on Boolean algebras. 152pp.

Lecture Notes in Mathematics

1443.	Dovermann KH	Equivariant surgery theories and their periodicity properties. 227pp.

Problem Books in Mathematics

	Gelbaum BR	Theorems and counterexamples in mathematics. 305pp.

Progress in Mathematics (Birkhäuser)

	Ghys E (ed)	Sur les groupes hyperboliques d'apres Mikhael Gromov. 288pp.

Springer Series in Computational Mathematics

13.	Allgower EL	Numerical continuation methods. 388pp.

Texts in Applied Mathematics

2.	Wiggins S	Introduction to applied nonlinear dynamical systems and chaos. 672pp.

Undergraduate Texts in Mathematics

	Edgar GA	Measure, topology and fractal geometry. 230pp.

Universitext

	Aksoy AG	Nonstandard methods in fixed point theory. 139pp
	Curtis Ml	Abstract linear algebra. 168pp.
	Oberhettinger F	Tables of Fourier transforms and Fourier transforms of distributions. 259pp.
	Samelson H	Notes on Lie algebras. 162pp.

Miscellaneous

Arnol'd VI	Huygens & Barrow, Newton & Hooke. 118pp.
Dautray R	Mathematical analysis and numerical methods for science and technology. Vol.3: Spectral theory and applications. 515pp.
Fienberg SE (ed)	A statistical model. 283pp. (Frederick Mosteller's contributions to statistics, science, and public policy)
Gerber HU	Life insurance mathematics. 131pp.
Narkiewicz W	Elementary and analytic theory of algebraic numbers. 2nd ed. 746pp.
Onishchik AL	Lie groups and algebraic groups. 328pp.
Rotman J	Galois theory. 108pp.

MATHEMATICAL VISITORS TO NEW ZEALAND

List No.27: 1 November 1990

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 Richard Anstee; University of British Columbia, Canada; combinatorics; September 1990 to June 1991; University of Otago; Prof. Derek Holton.

Professor F.H. Chipman; Acadia University, Nova Scotia; wife and one son; numerical analysis; 20 December 1990 to 30 June 1991; Auckland University; Prof. John Butcher.

Dr. David Clark; University of Canberra, Australia; wife & two children; optimization, numerical analysis; July to December 1990; University of Auckland; Dr. David Ryan.

Professor Dennis Cook; University of Minnesota; regression analysis, diagnostics and graphics; mid-February to mid-April 1991; University of Waikato; Prof. J. A . John.

Professor James Dickey; University of Minnesota; spouse (Martha); subjective probability, decision theory, computational methods; 6 June to 15 August 1991; University of Canterbury; Prof. John Deely.

Professor Chris Godsil; University of Waterloo, Ontario; wife (Gillian Nonay) & daughter; graph theory & algebraic combinatorics; March to April 1991; University of Auckland; Dr. Marston Conder.

Professor W.K. Hayman, F.R.S.; University of York, U.K.; complex function theory; March 1991; University of Otago; Dr. Peter Fenton.

Ms Helen Joseph; University of California, Berkeley; educational equity in mathematics and technology; 3 February to 20 May 1991; Auckland College of Education/ Auckland University; Margaret Morton.

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

Dr. Hans-Peter Künzi; Universität Bern, Switzerland; topology; 1 October to 20 December 1990; University of Auckland; Prof. Ivan Reilly.

Professor F.R. McMorris; University of Louisville, Kentucky; combinatorics, mathematical phylogeny; 2 to 17 December 1990; Massey University; Dr. Mike Hendy .

Professor Roger Mead; University of Reading, U.K.; wife; statistics; August 1990 to April 1991; University of Otago; Prof. Brian Manly.

Professor Mila Mrsevic; University of Belgrade, Yugoslavia; topology; August 1990 to July 1991; University of Auckland; Prof. Ivan Reilly.

Dr. Gillian Nonay; Wilfrid Laurier University, Ontario; husband (Chris Godsil) & daughter; graph theory, combinatorics; March to April 1991; University of Auckland; Dr. Marston Conder.

Dr. Philip Rottier; University of Cambridge, U.K.; geophysical acoustic modelling; May 1991; University of Otago; Prof. Vernon Squire.

Dr. Jiang Shouli; Shandong University, Peoples' Republic of China; topology; February to July 1991; University of Auckland; Prof. Ivan Reilly.

Professor Jerome Spanier; Claremont Graduate School, California; wife; numerical analysis, applied mathematical modelling, Monte Carlo methods; 1 September to 30 November 1990; Massey University; Profs Jeff Hunter & Graeme Wake. Professor Spanier is a Fulbright Visiting Professor.

The following overseas visitors are expected to attend the **NZAMT Conference** to be held at Victoria University of Wellington in September 1991. Further information from Dr Rod Downey, Victoria University, Wellington.

Keynote speakers: Mary Barnes, Mathematics Learning Centre, University of Sydney, NSW 2006, AUSTRALIA Topic: Developing gender inclusive curriculum.

Dr Martin Hughes, School of Education, Exeter University, Exeter EX1 2LU, ENGLAND. Topic: Children and Number.

Alan Rogerson, 22 Violet Grove, Hawthorn, VIC 3122, AUSTRALIA. Topic: Unknown.

Hilary Shuard, CAN Continuation Project, Homerton College, Cambridge CB2 2PH, ENGLAND. Topic: Towards 2000.

Others (workshops etc): Dr Dudley Blane, Director of Maths Education Centre, Faculty of Education, Monash University, Clayton, VIC 3168, AUSTRALIA (Unconfirmed)

Dr Jules Tibeiru, University of Moncton, 636 Elmwood Drive, Moncton, New Brunswick E1A 2X5, CANADA.

In addition to those in the main list, the following overseas visitors are expected to attend the **16th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing**, to be held at Massey University, 3 to 7 December 1990:

Dr. Latif Al-Hakim (Chisholm Institute of Technology) Dr. Brian Alspach (Simon Fraser University) Sharon Boswell (University of Newcastle) Richard Buskens (University of Manitoba) Dr. Fan Chung (Bell Communications Research) Dr. Charles Colbourn (University of Waterloo) Dr. Nathaniel Dean (Bell Communications Research) Diane Donovan (University of Queensland) Dr. Ron Graham (A.T.&T. Bell Laboratories) Ken Gray (University of Queensland) Dr. Katherine Heinrich (Simon Fraser University) Sampei Kageyama (Hiroshima University) Miro Kretzl (Curtin University) Kam Wing Leung (Chinese University of Hong Kong) Tao Lin (University of Queensland) Xuemin Lin (University of Queensland) G. Maxwell (University of British Columbia) Dr. Kevin McAvaney (Deakin University) Dr. Brendan McKay (Australian

National University) Prof. B.H. Neumann (Australian National University) Prof. Peter O'Halloran (University of Canberra) Prof. Cheryl Praeger (University of Western Australia) Dr. A. Rahilly (University of Queensland) Prof. Jennifer Seberry (Australian Defence Force Academy) Prof. Douglas Shier (College of William and Mary) W.F. Smyth (McMaster University) Prof. Ralph Stanton (University of Manitoba) Dr. Doug Stinson (University of Manitoba) R.P. Sullivan (University of Western Australia) Prof. George Szekeres (University of New South Wales) Dr. W.D. Wallis (Southern Illinois University) Xiaoji Wang (Australian National University) Dr. Douglas Woodall (University of Nottingham) X. Zhang (Australian Defence Force Academy).

Further details may be obtained from Dr Charles Little (Department of Mathematics & Statistics, Massey University, Palmerston North).

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.

David Robinson
NZMS Visitors' Co-ordinator
Department of Mathematics
University of Canterbury

CONFERENCES

**** 1991 ****

January 2–5 (Fort Lauderdale, Florida) **Third International Workshop on Artificial Intelligence and Statistics**
Contact David Hand, Statistics Department, The Open University, Milton Keynes MK7 6AA U.K.

January 6–12 (Oberwolfach, Germany) **Automorphe Formen und Anwendungen**
Contact MFOG: see (1) below.

January 7–9 (Breckenridge, Colorado) **SIAM Workshop on Automatic Differentiation of Algorithms: Theory, Implementation and Application**
Contact SIAM: see (6) below.

January 7–10 (St Augustine, Trinidad) **Sixth Caribbean Conference on Combinatorics and Computing**
Contact E.J. Farrell, 6cccc, Department of Mathematics, The University of the West Indies, St. Augustine, Trinidad.

January 13–19 (Oberwolfach, Germany) **Combinatorial Optimization**
Contact MFOG: see (1) below.

January 16–19 (San Francisco) **Annual Meeting of the American Mathematical Society**
Contact H. Daly, AMS, P.O. Box 6248, Providence, RI 02940, U.S.A.

January 20–26 (Oberwolfach, Germany) **Spektraltheorie Singulärer Gewöhnlicher Differentialoperatoren**
Contact MFOG: see (1) below.

January 21–25 (Minneapolis, Minnesota) **Statistical Thermodynamics and Differential Geometry of Microstructured Material**
Contact IMA : see (3) below.

January 27–February 2 (Oberwolfach, Germany) **Harmonischer Analyse und Darstellungstheorie Topologischer Gruppen**
Contact MFOG: see (1) below.

January 28–30 (San Francisco, California) **Second ACM–SIAM Symposium on Discrete Algorithms**
Contact SIAM: see (6) below.

February 3–7 (Hanmer Springs, New Zealand) **27th Applied Mathematics Conference**
Contact Peter J. Bryant, Mathematics Department, University of Canterbury, Christchurch, New Zealand. (email pjb @ math. canterbury. ac. nz)

February 3–9 (Oberwolfach, West Germany) **Konstruktive Methoden in der Komplexen Analysis**
Contact MFOG: see (1) below.

February 8 (Christchurch, New Zealand) **Workshop on Symbolic Computing in Applied Mathematics**
Contact G. Keady, Mathematics Department, University of Waikato, Hamilton, New Zealand (email math3019@waikato.ac.nz).

February 10–16 (Oberwolfach, Germany) **Endlichdimensionale Lie-Algebren**
Contact MFOG: see (1) below.

February 10–16 (Oberwolfach, Germany) **Affine Differentialgeometrie**
Contact MFOG: see (1) below.

February 17-23 (Oberwolfach, Germany) **Experimentelle, Insbesondere Computergraphische Methoden in der Mathematik**
Contact MFOG: see (1) below.

February 17-23 (Oberwolfach, Germany) **Krein Spaces and Applications to Differential Operators**
Contact MFOG: see (1) below.

February 24–March 2 (Oberwolfach, Germany) **Medical Statistics: Statistical Models for Longitudinal Data**
Contact MFOG: see (1) below.

March 3–9 (Oberwolfach, West Germany) **Partielle Differentialgleichungen**
Contact MFOG: see (1) below.

March 7–10 (Marrakech, Morocco) **International Conference on Differential Equations**
Contact A. El Koutri, Universite Cadi Ayyad, Department of Mathematics, Boulevard de Safi, B.P. S15, Marrakech, Morocco.

March 10–16 (Oberwolfach, Germany) **Mathematische Stochastik**
Contact MFOG: see (1) below.

March 11–15 (Minneapolis, Minnesota) **Free Boundaries in Viscous Flows**
Contact IMA : see (3) below.

March 13–15 (Toulouse, France) **IMACS Workshop on Decision Support Systems and Qualitative Reasoning**
Contact M.-T. Ippolito, DSSQR–IMACS Workshop, L.A.A.S/C.N.R.S.7, Avenue de Colonel Roche, 31077 Toulouse Cedex, France (email louis @ laas, laas, fr)

March 13–16 (Mashhad, Iran) **22nd Annual Iranian Mathematics Conference**
Contact M.R.R. Moghaddan, Mathematics Department, P.O. Box 1159, Mashhad University, Mashhad, Iran.

March 17–23 (Oberwolfach, Germany) **Elementare und Analytische Zahlentheorie**
Contact MFOG: see (1) below.

March 17–24 (Haifa, Israel) **Sixth International Conference on Geometry**
Contact Professor J. Zaks, Department of Mathematics, University of Haifa, Haifa 31999, Israel.

March 19–21 (Loughborough, U.K.) **Joint IMA and ERCOFTAC Conference on New Techniques in Mathematical and Computational Modelling of Turbulent Diffusion and Mixing in Industrial and Environmental Problems**
Contact IMA: see (7) below.

March 22–24 (Houston, Texas) **Fifth SIAM Conference on Parallel Processing for Scientific Computing**
Contact SIAM: see (6) below.

March 24–30 (Oberwolfach, Germany) **Gewöhnliche Differentialgleichungen**
Contact MFOG: see (1) below.

March 25–28 (Barcelona) **International Conference on Mathematical Linguisitics**
Contact C.M. Vide, Univ. de Barcelona, Facultat de Filogia, Seccio de Linguistica General, Gran Via de les Corts Catalanes 585, 08007 Barcelona, Spain.

April 2–4 (Brussels) **IMACS International Symposium on Iterative Methods in Linear Algebra**
Contact R. Beauwens, IMACS International Symposium, Universite Libre de Bruxelles, C.P. 165, 50 Av. F.D. Roosevelt, 1050 Brussels, Belgium.

April 7–13 (Oberwolfach, Germany) **Algebraische Gruppen**
Contact MFOG: see (1) below.

April 8–12 (Kobe, Japan) **Seventh International Conference on Data Engineering**
Contact N.J. Cercone, Center for Systems Science, Simon Fraser University. Burnaby, British Columbia, Canada V5A 156 (email nick @ cs. sfu. ca)

April 8–12 (Cooper Mountain, Colorado) **NASECODE VII—Numerical Analysis of Semiconductor Devices and Integrated Circuits**
Contact J. Miller, 26 Temple Lane, Dublin 2, Ireland.

April 10–12 (Como, Italy) **Fourth International Conference on Rewriting Techniques and Applications**
Contact R.V. Book, RTA–91, Theoretische Informatik, Institut für Informatik, Univ. Würzburg. Am Hubland, D–8700 Wurzburg, Germany.

April 11–16 (Calogne, Spain) **Assessment in Mathematics Education and Its Effects**
Contact Professor Mogens Niss, IMFUFA, Roskilde University, P.O. Box 260, DK-4000, Denmark (participation by invitation only).

April 14–20 (Oberwolfach, Germany) **Brauer Groups and Representation Theory of finite Groups**
Contact MFOG: see (1) below.

April 15–19 (Minneapolis, Minnesota) **Variational Problems**
Contact IMA : see (3) below

April 21–24 (Seattle, Washington) **Computing Science and Statistics: Symposium on the Interface**
Contact J. Kettenring, Statistics Research Group, Bellcore, 445 South Street, Morristown, New Jersey 07960, U.S.A.

April 21–27 (Oberwolfach, Germany) **Numerical Linear Algebra**
Contact MFOG: see (1) below.

April 23–26 (Strasbourg, France) **Mathematical and Numerical Aspects of Wave Propagation Phenomena**
Contact INRA, Service des Relations Exterieures, Domain de Voluceau, B.P. 105–Rocquencourt, 78153 Le Chesnay Cedex, France.

April 28–May 4 (Oberwolfach, Germany) **Deductive Systems**
Contact MFOG: see (1) below.

May 5–11 (Oberwolfach, Germany) **Darstellungstheorie Endlich–Dimensionaler Algebren**
Contact MFOG: see (1) below.

May 6–8 (Norfolk, Virginia) **Fifth SIAM International Symposium on Domain Decomposition Methods for Partial Differential Equations**
Contact SIAM: see (6) below.

May 7–10 (Casablanca, Morocco) **IMACS Symposium on Modelling and Simulation of Control Systems**
Contact A. El Moudri, Laboratoire d'Automatique, Faculte des Sciences, BP 5366–Maarif, Casablanca, Morocco.

May 7–14 (Singapore) **Singapore Number Theory Workshop**
Contact S.L. Ma, Secretary, Singapore Number Theory Workshop, Department of Mathematics, National University of Singapore, Kent Ridge, Singapore 0511, Republic of Singapore.

May 12–18 (Oberwolfach, Germany) **Nichtlineare Evolutionsgleichungen**
Contact MFOG: see (1) below.

May 13–17 (Minneapolis, Minnesota) **Degenerate Diffusions**
Contact IMA: see (3) below.

May 13–17 (Princeton, New Jersey) **Conference in Harmonic Analysis in Honor of E.M. Stein**
Contact S. Kenney, Mathematics Department, Princeton University, Princeton, NJ 08544, U.S.A.

May 19–25 (Oberwolfach, Germany) **Differentialgeometrie im Grossen**
Contact MFOG: see (1) below.

May 22–24 (Iowa City, Iowa) **Second International Conference on Algebraic Methodology and Software Technology**
Contact T. Rus, University of Iowa, Department of Computer Science, Iowa City, IA 52242, U.S.A. (email rus@herky.cs.uiowa.edu)

May 26–June 1 (Oberwolfach, Germany) **Optimalsteuerung und Variationsrechnung-Optimal Control**
Contact MFOG: see (1) below.

May 29–June 1 (Wheaton, Illinois) **Eighth Biennial Conference of the Association of Christians in the Mathematical Sciences**
Contact R.L. Braberec, Wheaton College, Wheaton, Illinois 60187, U.S.A.

June 2–8 (Oberwolfach, Germany **Diskrete Geometrie**
Contact MFOG: see (1) below.

June 9-15 (Oberwolfach, Germany) **Singuläre Störungsrechnung**
Contact MFOG: see (1) below.

June 10–14 (Nahariya, Israel) **Bernoulli Society Twentieth Conference on Stochastic Processes and their Applications**
Contact R. Adler, Industrial Engineering and Management, Technion, Haifa 32000, Israel.

June 12–19 (Barcelona) **Symposium on the Current State and Prospects of Mathematics**
Contact Centre de Recerca Matematica, Institut d'Estudis Catalans, Aparat 50–08193 Bellatera, Spain.

June 17–21 (Port á Mousson, France) **European Conference on Elliptic and Parabolic Problems**
Contact C. Bandle, Mathematisches Institut der Univ, Rheinsprung 21, CH–4051 Basel, Switzerland.

June 17–21 (Kobe, Japan) **1991 International Symposium on the Mathematical Theory of Networks and Systems**
Contact H. Kimura, Department of Mechanical Engineering for Computer-Controlled Machinery, Faculty of Engineering, Osaka University, Yamada-oka, Suita, Osaka 565, Japan.

June 23–29 (Oberwolfach, Germany) **Mathematische Methoden der VSLI-Entwurfs and des Distributed Computing**
Contact MFOG: see (1) below.

June 26–28 (Cambridge, Massachusetts) **Third IMACS International Symposium on Computational Acoustics**
Contact D. Lee, Code 3122, Naval Underwater Systems Centre, New London, CT 06320, U.S.A.

June 30–July 6 (Oberwolfach, Germany) **Elliptische Operatoren auf Singulären und Nichtkompakten Mannigfaltigkeiten**
Contact MFOG: see (1) below.

July 1–5 (Bath, England) **The Mathematics of Nonlinear Systems**
Contact J.F. Toland, School of Mathematical Sciences, University of Bath, Claverton Down, Bath BA2 7AY, England.

July 2–5 (Grenoble, France) **European Control Conference**
Contact Secretariat de la Conference, GR Automatique/ENSIEG, B.P. 46, F–38402 saint-Martin d'Heres, France.

July 7–13 (Oberwolfach Germany) **Computational Number Theory**
Contact MFOG: see (1) below.

July 8–10 (Sydney) **Sixth International Conference in Australia on Finite Element Methods**
Contact C. McIvor, Department of Aeronautical Engineering, University of Sydney, NSW 2006, Australia.

July 8–12 (Melbourne) **35th Annual Conference of the Australian Mathematical Society**
Contact J.H. Rubinstein, Mathematics Department, University of Melbourne, Parkville, Victoria 3052, Australia (email rubin@mundoe.maths.mu.oz.au).

July 8-12 (Washington D.C.) **Second International Conference on Industrial and Applied Mathematics**
Contact IMA: see (7) below.

July 8–14 (Szekszárd, Hungary) **ICOR '91 International Conference on Radicals**
Contact L. Márki, Mathematical Institute, Hungarian Academy of Science, PF. 127, H-1364 Budapest, Hungary.

July 14–20 (Oberwolfach, Gemany) **Dynamische Systeme**
Contact MFOG: see (1) below.

July 21–27 Oberwolfach, Germany) **Halbgruppentheory**
Contact MFOG: see (1) below.

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.

July 28–August 3 (Oberwolfach, Germany) **Gruppen und Geometrien**
Contact MFOG: see (1) below.

August 3–7 (Coral Gables, Florida) **Interamerican Conference on Mathematics Education**
Contact U. D'Ambrosio, Institute of Mathematics, Univ. Estadual de Campinas, CP6063 (13081), Campinas (SP), Brazil.

August 4–10 (Oberwolfach, Germany) **Effiziente Algorithmen**
Contact MFOG: see (1) below.

August 5–8 (Beijing) **ICMI China Regional Conference on Mathematics Education**
Contact Professor Zhong Shanji, Department of Mathematics, Beijing Normal University, Beijing 100875, People's Republic of China.

August 5–9 (Amsterdam) **Fourteenth International Symposium on Mathematical Programming**
Contact 14th International Symposium on Mathematical Programming, Paulus Potterstraat 40, 1071 DB Amsterdam, The Netherlands.

August 11–17 (Oberwolfach, Germany) **European Young Statisticians Meeting**
Contact MFOG: see (1) below.

August 18–24 (Oberwolfach, Germany) **The Navier-Stokes Equations: Theory and Numerical Methods**
Contact MFOG: see (1) below.

August 18–September 4 (Saint Flour, France) **Twenty-first Summer Ecole des Calcul des Probabilites**
Contact P.L. Hennequin, Mathématiques Appliquées, F-63177 Aubiere Cedex, France.

August 21–25 (Barnaul, U.S.S.R) **International Conference on the Theory of Rings, Algebras and Modules in Honor of A.I. Shirshov**
Contact Organising Committee, International Conference on Ring Theory in Memory of A.I. Shirshov, Institute of Mathematics, Novosibirsk 630090, U.S.S.R.

August 25–31 (Oberwolfach, Germany) **Klassifikation Komplex-Algebraischer Varietaten**
Contact MFOG: see (1) below.

September 1–7 (Oberwolfach, Germany) **Topologie**
Contact MFOG: see (1) below.

September 8–14 (Oberwolfach, Germany) **Niedrigidimensionale Topologie**
Contact MFOG: see (1) below.

September 8–14 (Oberwolfach, Germany) **Knoten und Verschlingungen**
Contact MFOG: see (1) below.

September 9–17 (Cairo, Egypt) **International Statistical Institute: 48th Biennial Session**
Contact ISI Permanent Office, 428 Prinses Beatrixlaan, P.O. Box 950, 2270 A2, Voorburg, The Netherlands.

September 15–20 (Bieleveld, German) **DMV-Jahrestagung 1991**
Contact MFOG: see (1) below.

September 15–21 (Oberwolfach, Germany) **Geometrie der Banachräume**
Contact MFOG: see (1) below.

September 16–19 (Minneapolis, Minnesota) **Fourth SIAM Conference on Applied Linear Algebra**
Contact SIAM: see (6) below.

September 22–28 (Oberwolfach, Germany) **Nonlinear and Random Vibrations**
Contact MFOG: see (1) below.

September 23–29 (Kazimierz Dolny, Poland) **Sixth Symposium on Classical Analysis**
Contact T. Mazur, Technical University, Department of Mathematics, Malczewskiego 29, 26-600 Radom, Poland.

September 25–27 (Lausanne, Switzerland) **Ninth GAMM Conference on Numerical Methods in Fluid Mechanics**
Contact I.L. Ryhming, IMHEF/DME, EPFL, Lausanne CH–1015, Switzerland.

September 29–October 5 (Oberwolfach, Germany) **Kombinatorik Geordneter Menger**
Contact MFOG: see (1) below.

October 13–19 (Oberwolfach, Germany) **Geometrie**
Contact MFOG: see (1) below.

October 20–26 (Oberwolfach, Germany) **C* - Algebren**
Contact MFOG: see (1) below.

November 3–9 (Oberwolfach, Germany) **Mengenlehre**
Contact MFOG: see (1) below.

November 17–23 (Oberwolfach, Germany) **Singularitäten der Kontinuumsmechanik: Numerische und Konstruktive Methoden zu Ihrer Behandlung**
Contact MFOG: see (1) below.

November 24–30 (Oberwolfach, Germany) **Numerische Methoden der Approximationstheorie**
Contact MFOG: see (1) below

December 1–7 (Oberwolfach, Germany) **Statistik Stochastischer Prozesse**
Contact MFOG: see (1) below.

December 8–14 (Oberwolfach, Germany) **Stochastic Geometry, Geometric Statistics, Stereology**
Contact MFOG: see (1) below.

December 15–21 (Oberwolfach, Germany) **Quantenstochastik**
Contact MFOG: see (1) below.

December 27–31 (Las Cruces, New Mexico) **Holiday Symposium on the Impact of Software Systems in Mathematical Research**
Contact R.J. Wisner, Homotopy Theory Symposium, Dept. of Mathematical Sciences, New Mexico State University, Box 30001, Las Cruces, New Mexico 88003–0001, U.S.A.

** 1992 **

June 15–19 (Toronto, Canada) **Twenty First International Conference on Stochastic Processes and their Applications**
Contact G.L. O'Brien, Department of Mathematics, York University, 4700 Keele Street, North York, Ontario M3J 1P3, Canada.

August 16–23 (Quebec City, Canada) **ICME7 : Seventh International Congress on Mathematics Education**
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M.R. Carter

PROBLEMS AND QUERIES

There are no new problems or solutions for Problems this time. We present a report prepared by Gordon Hookings on the 31st International Mathematical Olympiad together with the questions that were used.

31st INTERNATIONAL MATHEMATICAL OLYMPIAD
Beijing, China, July 1990

The New Zealand team at the 31st IMO in Beijing acquitted themselves well. Timothy Sturge and Christopher Tuffley won bronze medals, while Philip Vialoux and Philip Saysell received Honourable Mentions. The team's ranking improved by three places over last year to 31st out of 54 countries and the team's aggregate score was 14 up on the 1989 result. The team members and their individual scores were: Michael Burns (Christchurch) 11, Diane Maclagan (Christchurch) 15, Philip Saysell (Christchurch) 9, Timothy Sturge (Christchurch) 9, Chris Tuffley (Christchurch) 16, Philip Vialoux (Auckland) 12. The team was accompanied by Team Leader Derek Holton, Deputy Leader Alan Parris and Observer Ivan Reilly. The questions set at the IMO are as follows.

1. Two chords of a circle, AB and CD, intersect at E. M is a point on the interior of segment EB. The line through E tangent to the circumcircle of triangle EMD intersects BC, AC at F, G respectively. If $AM/AB = t$, find EF/EG in terms of t.

2. Of $2n - 1$ points on a circle, $n \geq 3$, k are coloured black. A colouring is said to be "good" if there are two black points such that one of the interior arcs between them contains exactly n points. Find the smallest possible k in terms of n such that every possible colouring of k points is good.

3. Find all $n > 1$ such that $\frac{2^n + 1}{n^2}$ is an integer, where $n \in \mathbb{N}$.

4. Find a function $F : Q^+ \to Q^+$ such that $F(xF(y)) = \frac{F(x)}{y}$.

5. A game is played between two people as follows:
   $n_0 \in \mathbb{N}$ is chosen. Given n_{2k}, A chooses $n_{2k+1} \in \mathbb{N}$ such that $n_{2k} \leq n_{2k+1} \leq n_{2k}^2$. Given n_{2k+1}, B chooses n_{2k+2} such that n_{2k+1}/n_{2k+2} is a positive power of a prime. A wins by choosing 1990, B wins by choosing 1.
   For what values of n_0 does A win? B win? nobody win?

6. Prove that there exists a 1990-gon with sides of length $1^2, 2^2, \cdots 1990^2$ and all of whose interior angles are equal.

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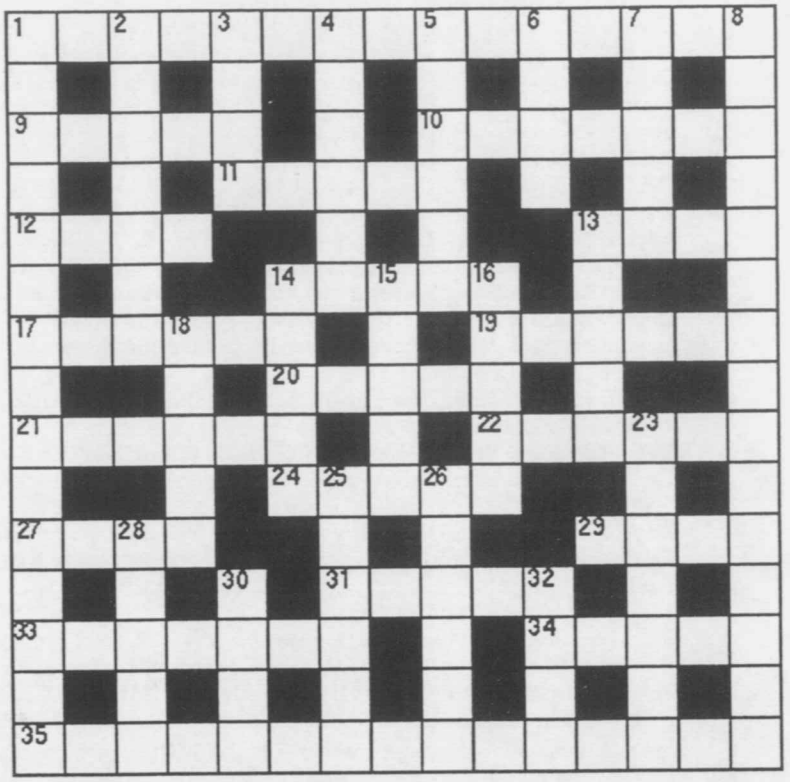
Crossword No. 31 Solution

CROSSWORD

No 32 — Re-claim in-verse — by Matt Varnish



Starting at 1 and running around the edges of the grid, so it fits it to a t, is a paraphrase of a comment by 4 down 25 down (6, 6). The unchecked letters around the edges give " BRING ON TRUTH, THEN THAT MIGHT IMPROVE." One of the letters used in this exhortation is not found in the interior of the grid.

ACROSS

9. Almost one for place near fender (5)
10. Letter of pet lies, Paul the sender (7)
11. From no Royal Mail Service the standards came (5)
12. From bins with his give the guy no name (4)
13. Fibre tag from which the mystery reader learns (4)
14. Flask with moisture and god returns (5)
17. The naughty one's food (from Dublin ?) (6)
19. Bursts in dental or geological troublin' (6)
20. He does not give up the German town (5)
21. South! South! True but mixed to brown (6)
22. In our bin or place in it (6)
24. Frequently the decimal bit? (5)
27. A yellow ide, found near plaice? ... (4)
29. ... with current to two directions mars the face (4)
31. Of an alphabet, direct the head is aft (5)
33. Out of holy spirit giving shady draught (7)
34. Where some souls dance beneath the sinking shaft? (5)

DOWN

2. Topic leading to large BA (7)
3. Level, before tide after day (4)
5. As does for the port with famous steps (6)
6. If LP in turn once said by heps (4)
7. To that time about one with fifty take (5)
13. Spirit in order for piece of cake (5)
14. Do it about the joint, the same (5)
15. For joint change *the letter* in the game (5)
16. Show again but not allowed at cricket? (5)
18. Bulk with east and vertically stick it (5)
23. Incorporated more about arrival at the wicket (7)
26. Opera is beheaded work of Hugo (6)
28. From loud outsize state to pit you go (5)
30. Briefly without insect French and edible (4)
32. Historic one in nine (4) (Rhyming to the end, incredible!)

(The solution to Crossword No. 31 is on the previous page.)