THE NEW ZEALAND MATHEMATICAL SOCIETY

NEWSLETTER

FEATURE ARTICLE

FRANCOIS VIETA

CENTREFOLD

J.T. CAMPBELL

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Editorial

The discerning reader of the Newsletter will perhaps be surprised to see the editorial team still firmly ensconced at Canterbury (see colophon, Newsletter number 22). The inability of the editors to correctly read correspondence led to the mistaken belief that the editorship was to fall into the immensely capable hands of Graeme Wake in Wellington. Alas the error was realised before the transfer was negotiated and so the readership must put up with us for at least another year. Rumours travel quickly however, and much of the material in this edition seems to have been routed through Graeme. We tender our apologies for any inconvenience caused.

The Editor, Brent Wilson, is now overseas on study leave and with him goes the talent that has inspired the Newsletter cartoons. Because Graham Wood goes on leave in May the editorial team is in a rather transient state. This issue has been produced with the assistance of John De la Bere, Michael Carter, Bob Long, David Robinson, Ann Tindall and Graham Wood.

Articles for publication in the Newsletter should be sent to The Editor, NZMS Newsletter, Department of Mathematics, University of Canterbury. However, institutions with Honorary Correspondents are encouraged to submit items through their correspondent.

Copy date for the next issue is June 30.

Ian Coope, Acting Editor

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CENTRE OF EXCELLENCE IN ANALYSIS

Professor Neil Trudinger has won from the Australian Government a grant of $1.2 million to establish a Centre of Excellence in Canberra for research into mathematical analysis and in particular, partial differential equations. His Centre of Excellence will be one of ten to be established in Australia, each in a different branch of science.

Local News

AUCKLAND UNIVERSITY

DEPARTMENT OF MATHEMATICS

Peter Danaher, Dr. M. Erceg and Paul Goodyear have been appointed Assistant Lecturers. Mr. Peter Hughes has been appointed a part-time lecturer.

Dr. T. O'Hagan arrived from the University of Warwick at the end of January and is attached to the Statistics Unit.

Professor T. Berger, University of Minnesota, will be visiting the department from July to November.

Dr. Lee Kaiser returned to the Colorado State University on 19 February 1982.

Professor J. Kalman will be going on leave in the third term.

Mr. C. King has volunteered to organise Open Day in 1983 and Dr. B. Calvert has arrangements for the department's contribution to the University Centenary well in hand.

Enrolment figures (at the end of enrolment week) indicate a substantial increase in Stage I enrolments.

Seminars:

Professor P. Lambrinos, (University of Thrace) "Function Spaces and Convenient Categories".
Professor H. Morin (Laval University) "Some Practical Aspects of Survey Sampling".
Dr. D.S. Bridges (University College at Buckingham) "Recent Advances in Constructive Mathematics".
Dr. Mila Mršević (University of Belgrade) "The Fifth Prague Topological Symposium 1981".
Mr. R. Felton (Auckland University) "Use of the Jack Knife in Wildlife Sampling".
Dr. A. O'Hagan (University of Warwick) "Exchangeability".
Mr. M. Paulin (Auckland University) "The Cerebellum: an Adaptive Filter in the Brain"?

E.D.

DEPARTMENT OF COMPUTER SCIENCE

Robert Doran has been appointed to an Associate-Professorship. He took up this position in March 1982.

A decision has now been taken to provide practical facilities for first year Computer Science students in a laboratory of 16 Zenith Z89 microcomputers. This type of facility has shown itself to be very successful at an advanced level and the decision to provide it at Stage I also is an important step for the department. The laboratory comes into operation in March 1982.

In 1982 number restrictions on all undergraduate courses are being imposed. The most drastic are at Stage I (a limit of 200 per course) and at Stage II (a limit of 100 per course). These restrictions will ensure that students actually accepted have reasonable access to computing facilities.

P.S.

MASSEY UNIVERSITY

The presence of several visitors is making this an interesting year for us. Graham Read, a founder member of the Open University Mathematics Faculty, is visiting us for a year, accompanied by his wife and three sons. Originally a pure mathematician, Graham is now more interested in methods of teaching mathematics, particularly in relation to distance education. He has worked with the BBC in the production of many television programmes, radio programmes, films and cassettes, and has recently become interested in the use of microcomputers in education. Graham arrived at Massey equipped with quantities of TV films from the Open University, as well as plenty of ideas. Also visiting for a year is our Visiting Teaching Fellow, Peter Comer. He comes to us after 11 years teaching at Marlborough Boys College, where he was coordinator of the regional School Certificate Mastery Levels programme. He is particularly interested in individualised teaching and mastery learning, and while at Massey is gaining some experience of the student's viewpoint by taking our Keller-plan statistics and computing papers.

On the statistics side, Professor Raymond E. Roth (Bush Professor of Mathematics at Rollins College, Florida) is visiting us for the first term, in the course of a sabbatical leave period in Australasia and the South Pacific. His interests are in modelling, design of experiments and data analysis.

Mike Hendy was invited to take part in a research workshop on pattern analysis in nucleic acid and protein sequences, held in France during October-November 1981. Mike has been working for a number of years on the construction of phyletic trees from nucleic acid and protein sequence data, and found the workshop extremely stimulating.

Seminars:

Professor Vidar Thomée (University of Queensland) "Galerkin Finite Element Methods for Elliptic and Parabolic Problems"
Professor G.F.D. Duff (University of Toronto) "James Cook in Canada" and "Hyperbolic Differential Equations and Waves"
Terry Moore "The Cantor Group"
Hugh Morton "Ultimate World Records and a Theory of Competitive Running"
Professor Raymond E. Roth (Rollins College, Florida) "Models: Empirical versus Theoretic"

M.R.C.

VICTORIA UNIVERSITY OF WELLINGTON

We are glad to welcome Peter Donelan as a half-time lecturer in pure mathematics; his field is singularity theory.

Philip Rhodes-Robinson has returned from sabbatical at Stanford.

Chris Atkin went during the long vacation on an exchange visit to Poland. After his arrival the authorities imposed a "war state" (the English translation of the Polish term, not to be confused with a "state of war" in which actual fighting occurs). We hope his wife and baby will soon be able to rejoin him here.

Three overseas visitors have been in the Department for short periods. Professor Raymond E. Roth from Rollins College, Florida, U.S.A. who was a Visiting Fellow for a month working and giving seminars on teaching methods, especially statistics; Dr. Yosi Ogata, Inst. of Statistical Mathematics, Tokyo, giving a course on inference, and modelling of earthquake sequences - through point processes, and Dr. Don Anderson, University of Wyoming, gave a seminar on search designs. By the time this is printed Dr. Andrew Lacey, our Postdoctoral Fellow, will have returned to Oxford.

This year Sharleen Forbes is running a larger "remedial" course on basic skills for first-year students, after a successful trial run last year. Enrolment is voluntary, after diagnostic tests on manipulation at the beginning of several of the mathematics courses.

J.F.H.

CANTERBURY UNIVERSITY

John Spain has been appointed as programmer/technician in the department, replacing Terry Hills who resigned early in 1982.

Malcolm Ludvigsen has joined the department as a post-doctoral fellow. Malcolm was previously at the University of York, and is currently working with Roy Kerr.

Brent Wilson left in February on twelve months study leave, to be spent mainly at Cambridge University.

Peter Waylen has just returned from study leave at the same institution.

We look forward to visits from two Erskine Fellows, each of approximately one months duration. They are (with dates subject to confirmation):

Professor S.J. Taylor (University of Liverpool); Measure Theory, Theory of Stochastic Processes; 15 July - 19 August.

Professor C.C. Lindner (Auburn University, Alabama); Combinatorics; 29 August - 27 September.

Seminars:

Professor George Duff (University of Toronto), "Universal covers in the plane."
Professor Vidar Thomée (Chalmers University, and University of Goteborg), "Galerkin finite element methods for elliptic and parabolic equations."
Dr. Douglas S. Bridges (University College at Buckingham), "Constructive approximation theory" and "The mathematical description of consumer preferences."
Professor James R. Bunch (University of California at San Diego), "Stable decomposition of symmetric and skew-symmetric matrices."
Professor John Baker (University of Waterloo), "Iteration groups of C^n Functions."

R.S.L.

D.S.I.R.

APPLIED MATHEMATICS DIVISION, WELLINGTON

Gary Eng, whose interests include Optimization of Forest Management, is to join the O.R. section from the University of Canterbury.

Jim Bunch (University of California) has recently visited.

The Hewlett-Packard 2100A minicomputer (which provided Time Shared Basic and interactive links to V.U.W.'s B6700) has been retired to P.E.L. The Division now has access to V.U.W.'s new IBM 4341.

G.W.

MT. ALBERT RESEARCH CENTRE, AUCKLAND

Chris Triggs arrived in October 1981 and is now deeply involved with the design and analysis of food tasting experiments. He insists on being included in any Avocado taste panels. Sarah Euren, who recently completed a Diploma in Statistics at Oxford University, started work in mid-January. Deborah Donnell has a temporary appointment, working on models for predicting the time of insect emergence. She expects to go to England in July 1982, for a tour with the National Youth Choir and perhaps Ph.D. study. Russell Miller, who has been working as a vacation student, now returns to Auckland University to study for the M.Sc. degree.

Our activities are varied. Nevertheless we were surprised to receive recently a letter, in an envelope bearing the University crest, addressed to: Meteopological & Bacterial Cult Collection, Applied Mathematics Division, Private Bag, Auckland.

J.H.M.

MINISTRY OF AGRICULTURE AND FISHERIES

Graeme Winn having moved from Ruakura to the UK, his position has been filled by Hans Hockey. This changes Hans' status from Technician to Scientist, but has no real effect on his work as a statistical consultant. Peter Schaare (Electronics Group) and Martin Upsdell have both received NRAC Fellowships and by coincidence each is going to Nottingham University to take them up. Isabell Gravett, previously Senior Lecturer in Statistics at Lincoln, is the most recent biometrician to be appointed to Ruakura.

Elsewhere there have been no comings or goings among our biometricians, although Geof Jowett will be retiring from his position at Invermay this November, much missed by the rest of us.

We had our annual conference in Dunedin on February 16th and 17th. Some topics of lectures were: Systematic plot designs, optimal sampling from batches of varying size, variance component estimation, jacknifing and bootstrapping, mark-recapture techniques, and modelling in parasitology. There was also a good deal of talk and discussion about computing.

M.J.

UNIVERSITY OF THE SOUTH PACIFIC

Akuila Talasasa returned to the Solomon Islands in April 1981 to take up a position in the Ministry of Education, and Geoff Whittle left in February 1982 to undertake a Ph.D. at the University of Tasmania. Joe Ka has gone on study leave to the Australian National University for Ph.D. studies. Paul Deoki returned from study leave in India and took over as co-ordinator of sub-degree mathematics from Len Raj who went on study leave to England. Paul Deoki spoke on "The Birth of the Mathematical Spirit" to the School of Education Lunchtime Seminar and on "Difficulties Encountered in Mathematics arising from Cultural and Social Influences" to the Tongan Mathematics Association. Kasmulch Morarji gave a paper on "Statistical Training at the University of the South Pacific" to the Fifth Regional Conference of Statisticians in Noumea. Donald Joyce led a discussion on "Computers in the Pacific" in the Sociology Seminar Series and spoke on "The Use of Microcomputers in Teaching Mathematics" at the Second Australasian Mathematical Convention. Ananda Rao gave a talk on "Trouble Shooting in Mathematics" to the Annual Conference of the Fiji Mathematics Association.

Seminars:

Maurice Sion (British Columbia): "History of Integration"
Bill Rosen (Atenisi Institute, Tonga): "Mathematics at the Atenisi Institute"
Bernhard Moiski (Freie Universitat, Berlin): "Code Generation for Arithmetic Expressions"
George Duff (Toronto): "Hyperbolic Differential Equations and Waves"
Ivar Stakgold (Delaware): "Fixed Points and Nonlinear Analysis"
Alan Andrew (Latrobe): "Some Applications of Mathematics in Biology"
Fred Chong (Macquarie): "Mathematics - Communication and Information"
Murray Klamkin (Edmonton): "Teaching Mathematics so as to be (More) Useful"
Ray Zahar (Montreal): "Using Mathematics for Coding and Decoding"

CONSULTANCY AND RESEARCH: Staff have been involved in a variety of consultancies, including preparation of computerized student records, review of mathematics curricula in the Solomon Islands, selection of computing equipment, and statistical analyses. Research projects on cross-cultural studies into mathematical and logical thinking, the use of diagnostic tests in mathematics and the use of microcomputers and calculators in teaching and research are continuing.

COMPUTING: Last year more than 800 students at all levels used our microcomputers as part of their courses. We now have five Commodores and an Apple in our microcomputer laboratory and Extension Services have nine Apples, one in each of the university's regional centres. In November the university took delivery of an ICL2903 computer system, donated to the university by the manufacturer, and Kasmulch Morarji was put in charge of the new computer centre.

COURSES: An undergraduate Diploma in Applied Statistics and Data Processing was introduced last year and has proved very popular. It incorporates a new 200-level course in Data Processing and has a strong practical orientation. Enrolments have increased at all levels: 1981 figures were 1120 at sub-degree level (up 7% from 1979), 555 at first-year level (up 114% from 1979), 130 at second year level (up 60% from 1979) and 100 at third year level (up 216% from 1979). A Masters programme is now underway, with 6 students undertaking courses in computing, numerical analysis, operations research and statistics. Two Summer Schools have been run in Varuatu to allow local students to undertake introductory mathematics courses. An introductory computing course put on as part of the Fiji centre's continuing education programme attracted 60 students and will be offered again this semester.

D.J.

News and Notices

MATHEMATICS COLLOQUIUM

The Seventeenth New Zealand Mathematics Colloquium will be held at the University of Otago from Monday to Wednesday, 17 - 19 May, 1982. Invited addresses will be given by Professors Paul Erdös (an eminent and peripatetic Hungarian), Ivor Francis (Cornell), David Gauld (Auckland), and Thomas Hawkins (Boston). The full programme of about fifty papers will cover a wide range of topics in mathematical research and education.

If you would like to attend write to: The Colloquium Secretaries, Mathematics Department, University of Otago, P.O. Box 56, Dunedin, as soon as possible. All enquiries will be welcomed.

3RD AUSTRALASIAN MATHEMATICS CONVENTION

In May 1981 discussions took place between members of the Council of the NZMS and the Australian Mathematical Society concerning the time and place of the Third Convention. Though it was agreed that the next Convention should take place somewhere in Australia, the Australians have not yet committed themselves to either a time or a place.

Our understanding is that a convention should be held every four years so that the next should be in May 1985. An argument against holding it earlier than that is that it would conflict with ICME5 (the fifth International Conference on Mathematical Education) which will be held in Adelaide in August 1984. It is expected that New Zealanders will be closely involved in both the planning of ICME5 and its attendance.

The NZMS Council has considered this matter at its recent regional meetings and intends to communicate to the Australian Mathematical Society its suggestion that the 3rd Convention be held in Australia (preferably in the southern or eastern part) in May 1985, and that every effort should be made to include all branches of mathematics (pure, applied, statistics, numerical mathematics, education, etc.) by securing the participation of the appropriate Australian controlling bodies. The AMS Council intends to discuss this Convention at their meeting in May and are keen to receive our latest thoughts on this matter before then.

D.B. Gauld, D.J. Smith

NZMS EQUINOXIAL TOPOLOGY WORKSHOP 1982

On Friday, 19 March, 1982, the Department of Mathematics, University of Auckland hosted a mini-symposium in Topology, co-sponsored by the New Zealand Mathematical Society.

The main speaker was Dr. Mark Schroder, University of Waikato, who has recently returned from study leave in Europe. His topic was: "Spaces making continuous convergence and locally uniform convergence coincide". He provided the following abstract -

"In CX, the set of all continuous real-valued functions on the space X, locally uniform convergence is always finer than continuous convergence. They can coincide though, and do so not only for P-spaces, but also for locally compact spaces (when both types of convergence reduce to compact comvergence). What do $c = lu$ spaces (namely, those defined by the title) look like, what do they do, and how can they be characterized?"

Other talks given were -

M.K. Vamanamurthy, "Cardinality of discrete subsets."
Mila Mršević, "On bitopological hyperspaces."
Stuart Scott, "Zero sets, primitive near-rings: questions and some answers."
Ivan Reilly, "Boundedness and finiteness."
Kevin Brougham, "John Conway's clever knot notation."
David Gauld, "Between T_1 and T_2."

I.L.R.

MANUSCRIPTS WANTED

Although the scope of publication activities open to the Society is limited, the Publications Subcommittee is anxious to make contact with authors who feel they may have a manuscript, or at least a potential manuscript, that would be of interest to the Society. The type of material the Subcommittee is looking for might be roughly classified as follows:

(i) shortish expository texts or collections of articles that would be of interest to a rather wider audience than just a section of the Society's members. Examples in this genre might include essays on mathematical education or the history of mathematics: texts on particular topics in the 7th form or 1st year university level that might usefully supplement the currently prescribed texts as these levels (perhaps even replace them). Readers will be aware of the success of the booklets published in 1981 covering the three sections of the 7th form applied mathematics syllabus. Over 4600 copies have been distributed throughout New Zealand in the last year showing clearly the need that exists in our schools for well-written material that is inexpensively produced;

(ii) short monographs of high quality that might be interesting to mathematicians in New Zealand and Australia. The Society could undertake an initial publication of such material, ensure that it was reviewed in overseas journals, and if the results were favourable, possibly negotiate international rights with a major publishing company. Readers will be aware of our first venture of this kind by George Andrews, NZMS Visiting Lecturer in 1979. It has been well received internationally and has produced a small financial return for the Society;

(iii) specialist monographs of particularly high quality that could be sent directly to a firm such as Springer-Verlag and perhaps used to initiate a "New Zealand Mathematical Society Subseries" of their Lecture-Note series:

(iv) occasional large projects which can only be attempted in collaboration with a large commercial publisher, for example the collected works of A.C. Aitken;

For the most part the Society is likely to be restricted in its publication style to materials that can be handled by local University printeries (multilith) or similar scale private printers. Even such a limited format, however, can be useful in providing authors with an initial avenue of publication, and the Society can assist authors both in distributing their material in Australia and in making sure that their work is reviewed and brought to the attention of larger publishing companies. If material came to hand that looked likely to supersede existing 7th form or first year texts, there is a large enough local market to warrant printing on a full-scale commercial basis, irrespective of possible overseas sales.

Persons interested in any publication venture of the above types are warmly invited to contact any one of the current members of the Publications Subcommittee: Graeme Wake, David Vere-Jones (Victoria University of Wellington); David Alcorn, Gary Tee (Auckland University).

Graeme Wake

VIETA: PIONEER OF ALGEBRA
(1540-1603)

Vieta was born at Fontenay in Western France of a legal family and educated for the law at the University of Poitiers; in his early 20's he practised in his native town. His education and interests were however wider than the law and at the age of 24 he became tutor to Catherine de Parthenay, a member of the great aristocratic houses of Lusignan (by birth) and Rohan (by marriage). His religious views are not well documented but it is a plausible guess that his association with the Huguenot Rohans and later with Henri IV put him in the moderate Protestant party. Most of his mature life was spent in the legal and administrative service of the French Crown under Charles IX, Henri III and Henri IV and he did not regard himself as a professional mathematician (whatever that might have meant in the late sixteenth century).

Vieta's early scientific and mathematical interests appear to have been astronomical; only a fragment of his teaching material for Catherine de Parthenay survives and this consists of an introduction to Geography and Astronomy; what else he taught her we don't know. However about this time he began work on an advanced treatise on Astronomy, the *Harmonicon Coeleste*, which has never been published though manuscript copies survive.

As a preliminary to the *Harmonicon* he calculated and published (1579) a set of fundamental trigonometric tables, *Canon Mathematicus seu ad triangula*, which also includes much auxiliary material and a tabular arrangement of rules for solving all cases of plane and spherical triangles. The *Canon* was calculated by the traditional Ptolemaic method as improved by the Islamic astronomers; that is by taking some angle whose sine and cosine are easily-found surds (e.g. 15° or 24°) and repeated application of the formulae.

$$\cos\tfrac{1}{2}\theta = \sqrt{\left(\tfrac{1}{2}+\tfrac{1}{2}\cos\theta\right)} \;;\; \sin\tfrac{1}{2}\theta = \sqrt{\left(\tfrac{1}{2}-\tfrac{1}{2}\cos\theta\right)}. \qquad (A)$$

It is possible that Vieta was led to the study of cubic and higher equations by the hope of more efficient computation based on the division of the arc into three or five or more equal parts leading to equations like

$$x^3 - 3x = 2\cos 3\theta \quad , \quad 3y - y^3 = 2\sin 3\theta \qquad (B)$$

$$x^5 - 5x^3 + 5x = 2\cos 5\theta \quad , \quad 5y - 5y^3 + y^5 = 2\sin 5\theta \; ; \qquad (C)$$

where $x = 2\cos\theta$ $\qquad$ $y = 2\sin\theta$

which besides reaching small angles more rapidly, would enable $\sin 1^\circ$ and $\sin 1'$ to be calculated directly, an advantage since there was only a rudimentary theory of interpolation at this period.

Whether or not this speculation is well founded, Vieta's fame rests mainly on his published work in Algebra and Analytical Trigonometry. He developed this in three ways: he obtained the general formulae for sines and cosines of multiple angles *(Ad angularium sectionum*, edited and published posthumously by Alexander Anderson in 1615); he developed a set of algorithms for the numerical solution of equations, and finally he laid the foundations for the theory of equations.

A faintly comic outcome of this research into multiple angles is the Tale of the Dutch Embassy. A Dutch Embassy to France challenged the king to produce a French geometer capable of solving a problem propounded by Adrianus Romanus (Adriaan van Roomen) "to all the mathematicians of the whole world". The problem can be paraphased thus - f(x) is a given odd polynomial of degree 45; it is required to solve (or better find a geometrical construction for the solution of) the equation

$$f(x) = d.$$

In the challenge, one root was given for each of three values of d and the problem propounded *omnibus mathematicis totius orbis* was to find a root for a given fourth value of d, in modern notation

$$d = \sqrt{\left(\frac{7}{4} - \sqrt{\frac{5}{16}} - \sqrt{\left(\frac{15}{8} - \sqrt{\frac{45}{64}}\right)}\right)}.$$

This is in fact $2\sin 12^\circ$ (I have to thank Dr. D.F. Robinson for help in this bit of detective work). Henri IV summoned Vieta and showed him the problem (which had apparently not reached France at that time), Vieta stepped aside, recognised enough of the form of the equation to guess the nature of the polynomial, recognised also some of the surds in the examples as sines

(or more accurately chords) of simple fractions of a right angle, did a little working in pencil and returned in a few moments with a solution. The next day he produced twenty-two more, thus giving all the positive solutions (it was left to Thomas Harriot (1560-1621) to find the negative roots). Vieta subsequently wrote up his solution in pamphlet form giving a geometrical construction (though one which was barely acceptable at the period in that it involved trisection and **quin**quesection of an angle).

Vieta's other claim to notoriety about this time was his cracking of Philip of Spain's diplomatic cipher. Philip was so sure of the security of his code that he accused the French of using the black arts. Vieta subsequently broke one of the cardinal rules of cryptanalysis - he published his results.

To his learned contemporaries, it is probably that his great claim to fame was his *Apollonius Gallus*. At the end of his reply to van Roomen (1594) Vieta issued a counter-challenge, "to extend but not to torture the wits of the studious", to provide a construction for the Apollonian problem: "Given the radii and centres of three circles, to construct a circle touching all three". Regiomontanus had found a solution algebraically but Vieta asked for a geometrical construction, if one were possible. The best van Roomen could produce involved conic sections which Vieta rejected as "mechanical" not "geometrical". He published his solution under the title *Apollonius Gallus* (1600) in which he gives ruler and compass constructions for all ten of cases of circles touching or passing through three elements (points, lines or circles).

To subsequent generations Vieta is mainly known as the inventor of Algebra or at least of Algebraic notation; this both true and false. It is not true that Vieta's works "can be read like modern mathematics"; his published works are *not* in a modern notation. Harriot's *Praxis* (1631) is clearly on the modern side of this divide. The earlier algebraists (Cardano, Bombelli, Stevin etc.) used words or symbols for the unknown and its powers but their coefficients were numerical; Vieta took the essential step of using a letter (A,E etc.) for the unknown, writing powers of *A* as *A* quad., A cub., A quadquad, etc., and using other letters (B,C,D,...Z) for the coefficients and constant terms. For example:

Si A *cubus* + B 3 *in* A*quad* + D*plano in* A, *aequetur* Z *solido* .

A + B *esto* E. E *cubus* + D*plano* - B*quad*3 *in* E. *aequabitur* Z *solido*

+ D *plano in* B - B*cubo*2,

i.e.

If $A^3 + 3BA^2 + DA = Z$ (D1)

(Note: D and Z are of dimension two, and three respectively),

let $A + B = E$

then $E^3 + (D - 3B^2)E = Z + BD - 2B^3$. (D2)

It is not difficult to see that this notation, though clumsy, is quite flexible and powerful enough to handle identities and to transform equations.

He was able to write down a number of results, some going back to Diophantus (c250AD), in a much more convenient form, e.g.

$$(B^2 + C^2)(D^2 + F^2) = (BD + CF)^2 + (BF - CD)^2$$

a result which can only be handled in words with some difficulty. He also began to collect results on the relations between the roots and coefficients of equations; here he was handicapped by his non-acceptance of negative roots (let alone complex ones).

It will be seen from the example D above that he was interested in transforming equations to remove the second term, this he normally did as a preliminary to solving an equation. His method, which works but is exceedingly tedious to apply, is an ancestor of Horner's method. Vieta regarded a polynomial with leading coefficient unity as a sort of modified power, he called

a^2, a^3, a^5 etc. "pure powers" and $a^2 + ba$, $a^3 - ba$, $a^5 + ba^3 - ca^2 + da$ etc.

"affected powers". He modified the known, long-division type algorithms for the digit-by-digit extraction of roots, for the step-by-step solution of polynomial equations. Those who have carried out the (pure) root-extraction algorithms will know the trial divisors that have to be constructed and tested at each step. Vieta's method for extracting the roots of affected powers uses similar but more complicated trial divisors, which are usually more difficult to guess correctly and more tedious to compute and test.

Vieta's relations with serious mathematicians were friendly and cooperative. He invited van Roomen to visit him in France (and paid his expenses), and the tone of his published reply to van Roomen's challenge, and of the *Apollonius Gallus* are respectful and courteous. His *De Numerosa Potestatum* (1600) was published by Ghetaldi who explains how he came to visit Vieta, and how Vieta had been extremely friendly, making available manuscripts for Ghetaldi to do what he liked with.

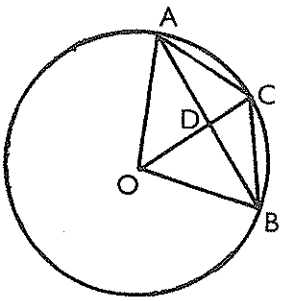
On the other hand there was a prickly side to Vieta, he had the usual renaissance dislike of medieval learning and medieval Latin. He considered medieval Algebra, also called by its practitioners *Ars Magna* or 'Almucabla' to be a confused rehandling of lost techniques of the Ancients, expressed in a barbarous and obscure jargon. He preferred to use the name *Ars Analytice* rather than "Algebra" and revived from Pappus or invented from Greek roots various technical terms such as "Rhetics" meaning algorithms for the solution of equations, "Antithesis" the transfer of terms from one side of an equation to the other, "Hypobibasmus" reduction of the degree of an equation when the constant term is zero (permissible to Vieta who rejected zero roots). These technical terms did not catch on. Another prickly renaissance trait is his tendency to get involved in bad-tempered pamphlet wars, in particular a futile one with Clavius on Calendar reform, a rather more serious one with Scaliger on circle-squaring and in the course of which he produced the first infinite product, which we write as:

$$\frac{2}{\pi} = \sqrt{\frac{1}{2}} \cdot \sqrt{\left(\frac{1}{2}+\frac{1}{2}\sqrt{\frac{1}{2}}\right)} \cdot \sqrt{\left(\frac{1}{2}+\frac{1}{2}\sqrt{\left(\frac{1}{2}+\frac{1}{2}\sqrt{\frac{1}{2}}\right)}\right)} \cdot \text{etc.}$$

Alternatively let $u_1 = \sqrt{\frac{1}{2}}$, $u_{n+1} = \sqrt{\left(\frac{1}{2}+\frac{1}{2}u_n\right)}$

$v_1 = u_1$, $v_{n+1} = v_n \cdot u_{n+1}$,

then $\frac{2}{\pi} = \lim v_n$.



This can be proved very neatly using the following results:

1. In the figure let A C B be an arc of a circle centre O, let AC = CB, and let AB meet OC in D; then the ratio of the triangle ABO to the quadrilateral ACBO is as cos AOC to one.

2. $\text{Cos } \frac{1}{2}\theta = \sqrt{\left(\frac{1}{2}+\frac{1}{2}\cos\theta\right)}$.

It is easy to check, starting from a quadrant, and applying these results n times that

$$\frac{2}{\pi} < v_n \quad \text{and} \quad v_n \to \frac{2}{\pi} .$$

An interesting aspect of renaissance and seventeenth century mathematics was the idea that the ancients had described, in works which had been lost, techniques more advanced than those which had survived. Further, it was possible and worthwhile to reconstruct these lost works. The *Apollonius Gallus* was an attempted reconstruction, based on hints in Pappus, of such a lost work of Apollonius of Perga. Vieta regarded all his work on algebra as the restoration of a lost "Analytic Art". Whether the Ancients possessed this Art is debatable: what is certain is that Vieta introduced a notation, leading to the modern one, and without which the widespread use of algebraic techniques would have been impossible.

J.C.W. De la Bere, Canterbury

AN UNUSUAL VISITOR AT APPLIED MATHEMATICS DIVISION, D.S.I.R.

Now and again, circumstances permit our department to support a visitor for a few months. Such visits can be stimulating and rewarding for all concerned if the visiting scientist, the terms of the appointment and teams he works with, function harmoniously. Applied Maths Division recently supported a visit by Professor R. Leipnik from the University of California, Santa Barbara. On paper, his curriculum vitae was most impressive. Here perhaps was a physicist, statistician, pure and applied mathematician all rolled into one. Surprisingly, what turned up was all these things to the first degree, and more. Roy Leipnik is a walking encyclopedia and incessant conversationalist from 7 in the morning till 12 at night. His forte in mathematics is solving hard problems and some of the tough nuts pulled out of bottom drawers around the laboratory seemed to crack for him in a discouragingly short time. This ability undoubtedly stemmed from his knowledge of the works of the masters. How can you

compete with a man who recalls that Paley or somebody in 1920 had solved a similar problem using certain special techniques and proceeds to find the original material and copy and remodel it to great effect.

During his stay I have pieced together some interesting facets of his scientific career. He was a product of the American depression program to educate talented children from city slums, and on graduating was one of the youngest post graduate scholars appointed at Princeton. Here he met Einstein, Von Neumann and Wigner and developed a wide ranging interest in physics and applied mathematics. He spent many years working for the US Navy as a special problems trouble shooter on the Polaris and Side-winder missile projects. The navy soon discovered they had a scientist with talents ideally suited to writing and evaluating proposals. Recently, he was invited to join the mathematics department at Santa Barbara to redirect the curriculum towards Applied Mathematics. The politics of this appointment and its outcome is a story in itself but in the process he has set up a microcomputer laboratory on the campus with part of its operation involved with educating disadvantaged minority groups in the use of these machines for various business purposes.

It is not surprising then with this background that he found himself discussing similar possibilities with the Maori Affairs Department and looking at the problems and possibilities for manufacturing our own local microcomputers for educational purposes with techniques at Wellington Polytechnic.

He left us to work with Professor Green at the University of Adelaide on problems of plasma physics. This subject has to be the key to one of the great unsolved problems of the twentieth century. How do you build a plasma machine to generate thermonuclear power? Perhaps Professor Roy Leipnik will have something specific to say on this question before he leaves for Santa Barbara next year.

Alex McNabb

WHAT CAN WE DO FOR THE MATHEMATICALLY GIFTED SCHOOL STUDENT?

Many members of the Society will have heard something of David Tan, who by his age should now be studying for School Certificate, but is in fact taking Mathematics Honours Part 2 at Canterbury University. This has come about because of a confluence of special circumstances, but David, although certainly very gifted, is not an isolated case. There must each year be two or three students in New Zealand who could do what he has done, and many more who are clearly capable of progressing, at least in mathematics, much faster than the organisation of our school system permits.

Such students are often ahead of their teachers, and may be asking questions that their teachers do not have the knowledge to answer. It seems a pity if they are to be discouraged from mathematics by lack of stimulus. Some, like David Tan, are fortunate enough to come in contact with University staff, or others who can lead them further. It seems to me to be worth the effort to try to find such students, or at least to have someone to whom their teachers can refer them, and also to have some kind of framework, very flexible, within which they can be helped. This will not often mean an education as accelerated as that given to David Tan.

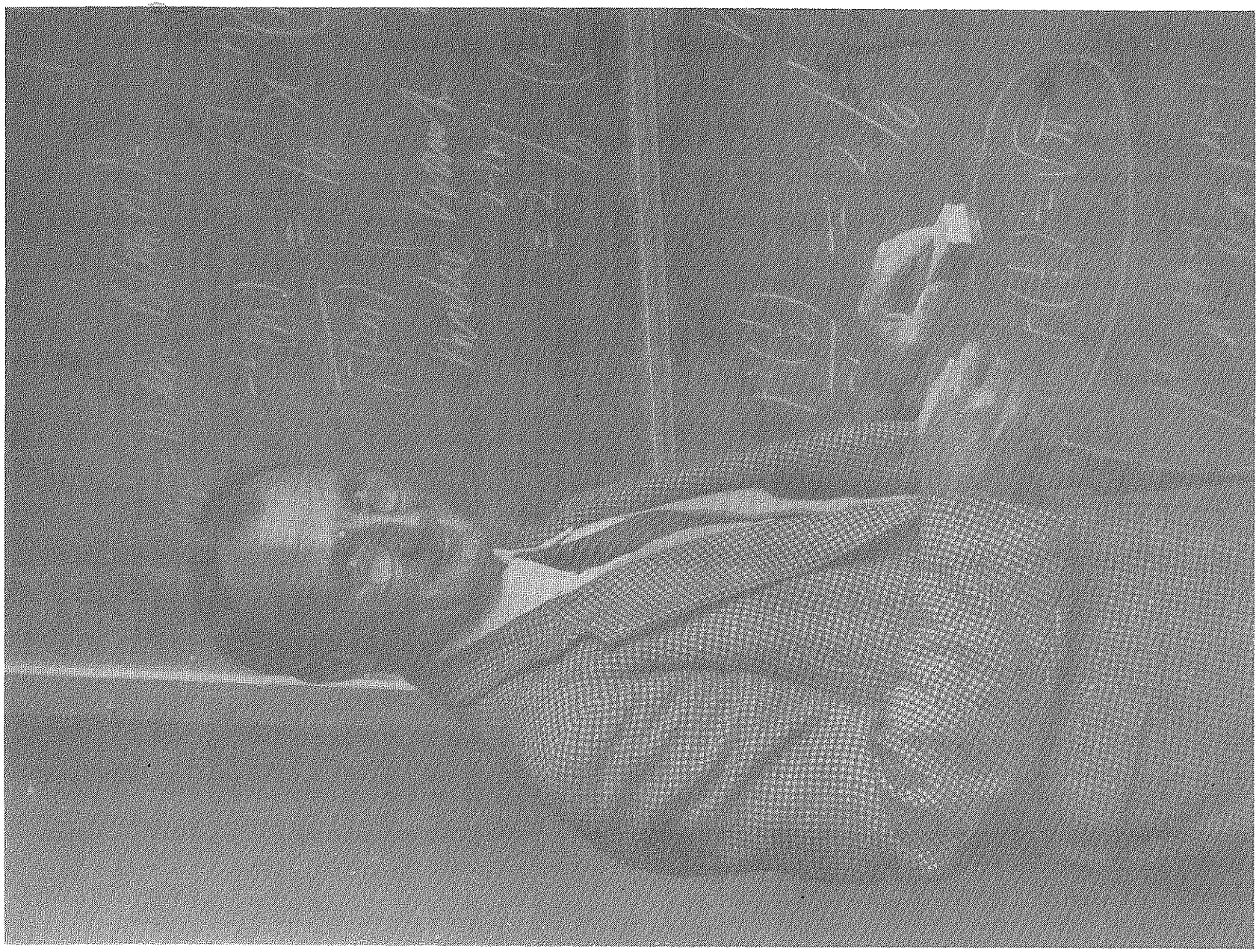
What happens already? The Canterbury Mathematical Association runs a Senior Competition for sixth and seventh formers, now a national event. This has certainly detected some students of the kind I am thinking of, but is generally too late in their school career. There is also no provision for continued contact.

The Wellington Mathematical Association has for some years run a special school, lasting about three days, in the May or August holidays, for about forty sixth and seventh form students. Having been involved with this twice, I know that this has some value.

But what I have in mind would be longer term contact with a mathematician. Probably it would start earlier in the school, and would continue through the years. Such contact would in most cases necessarily be by post. So I call the idea a Correspondence Club. It would have perhaps half a dozen 'mentors', mostly University Staff, with a central coordinator, and exchanging material, but with a very free hand on what they do in correspondence with the members with which they are in contact. Each mentor might have five or six members, perhaps at different stages of their school career. Mentors would send material to members, not just Olympiad type problems, but to lead them through areas of mathematics of mutual interest, often those not taught at school (or university?), and perhaps more importantly, answer questions put to them by their correspondents. If possible it should be the members who choose the direction and pace.

I have arranged with the Colloquium Secretaries to lead a session on this matter at Dunedin in May. I would like then to hear your comments and, if enough people are interested, to make the contacts which will enable the Club to be set up. Society members not going to the Colloquium may like to write to me.

David Robinson, Canterbury



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EMERITUS PROFESSOR J.T. CAMPBELL

"In arithmetic there were numbers and one couldn't do much about them, but with algebra ... let x be ... . Now that is something different, I have a say in this matter!"

So reminisces Emeritus Professor J.T. Campbell about the arousal of his interest in mathematics during his first term as a pupil at Gisborne High School, an interest that was to be developed, sustained and propagated through student years at Otago and Edinburgh Universities, through 34 years as a staff member of the Mathematics Department at Victoria University College in Wellington, subsequently Victoria University of Wellington, the final 17 years as Professor of Mathematics and Head of Department, and strongly into the present of his retirement years.

Campbell was born in 1906 at Kilmacolm, Scotland, a village on the Clyde, 40 miles west of Glasgow. His father, a Highlander and his mother, a Lowlander, emigrated to Gisborne in 1913 with James, their only child. Despite an early set back through his Scottish tongue being regarded as an inadequate vehicle for proper English Campbell prospered in school studies, successfully gaining a university entrance scholarship in 1924, in his sixth form year. It was results in English, Latin and French that secured him the 'lucky' position near the bottom of the ranked list. Results in Mathematics and Science were not so good although, in the case of Science, this may be explained by the fact that in that final year he planned his own Science programme, including experiments, as formal teaching stopped at form five.

From Gisborne to Knox College, Dunedin, and Otago University in 1925. It was here that Campbell came under the influence of Professor R.J.T. Bell, one of two persons who exercised a formative and significant influence on his person and career, mathematically and otherwise. Campbell describes Bell as *"the best teacher of mathematics I have known."* During Campbell's first years as a student Bell was the only staff member in the Mathematics Department, lecturing five days a week, each day from 8.00 am to 1.00 pm. Bell himself was a Glasgow man and Campbell recalls his comment that if anything made his move to New Zealand worthwhile it was that he was able to launch A.C. Aitken on his mathematical career.

It was Professor A.C. Aitken who, likewise, was to exercise a major influence on Campbell's mathematical career. In 1928 Campbell completed his M.A. with First Class Honours in Mathematics. For a year or more he stayed on at Otago as a holder of the Ross Fellowship, a kind of residential tutorship at Knox College. Campbell used the time to broaden his background in mathematics. The mathematics course he had completed had covered some of the fundamentals of real analysis but little of complex analysis, apart from the algebra of complex numbers. He recalls of that time, *"Chrystal's two volume algebra provided plenty to think about."* In 1930 Campbell took up the post-graduate scholarship he had won in Arts. Bell advised him against Cambridge (.. *wisely, knowing me."*), suggested Edinburgh, and put him in touch with Aitken. *"I became Aitken's first research student, and I could not have been more fortunate."*

Under Aitken's supervision Campbell began working in matrix algebra but then shifted for his thesis work to a topic with a statistical flavour. Aitken, with his exemplary care of research students, judged that in this newer field there was a better chance of fresh results. At the end of the 1931/1932 academic year Campbell's Ph.D. thesis was accepted. It developed results about Charlier's Series of Type B (Charlier's Type A Series are Hermite Polynomials), subsequently published in articles in the Proceedings of the Edinburgh Mathematical Society.

Campbell stayed on at Edinburgh for a short time as an assistant lecturer, but his strong wish was to return to New Zealand, if possible, to a university post. So, in hope of being an applicant for a vacancy, when one arose, Campbell returned to New Zealand in the third term of 1933 to an appointment at Nelson College as an assistant housemaster and teacher. Early in 1934 Professor D.M.Y. Somerville of Victoria University College died and F.F. Miles, the one lecturer in the department was appointed to succeed him. The vacant lectureship was advertised and Campbell duly appointed. So began his association with Victoria University College and Victoria University which continued

until his retirement in 1968, broken only by some four years service with the Royal New Zealand Naval Volunteer Reserve during the Second World War.

Prior to returning to New Zealand Campbell had made brief working visits to the Nautical Almanac Office at Greenwich, where L.J. Comrie, an Aucklander, was in charge. Here he gained his first acquaintance with numerical analysis. Another such visit found him at Rothamstead Agricultural Research Station, where R.A. Fisher was then resident statistician, with J. Wishart as his assistant. Of more personal significance was his marriage in 1934 to Margaret Wilson of Nelson - an outcome of a meeting at the Canterbury Capping Ball earlier that year.

From the time of his appointment at Victoria in 1935 Campbell made the teaching of Mathematics his first priority, He comments of himself: *"I have no claim to have been a creative mathematician. The subject has always fascinated me, and still does, but the main drive has been teaching I believe."* None the less he made a useful contribution to the development of statistics as a professional activity in New Zealand during the middle and late 1930's. He helped staff of Massey Agricultural College with the design and analysis of their experiments. He helped A.H. Ward (now Sir Arthur Ward), then newly appointed as Statistical Officer to the recently formed New Zealand Dairy Board, with the analysis of data relating to the sire improvement scheme for dairy herds and other projects. About this time it was proposed that Campbell take up a joint appointment with the Department of Scientific and Industrial Research as the nucleus for the formation of a statistical section within the department. In the event this did not come about, but Campbell's interest and involvement in this early development led to later association between Victoria and the Applied Mathematics Division of the D.S.I.R., when this was established following the Second World War. During his war service Campbell was attached to the Signals Section of the Naval Reserve and contributed to the solution of various problems. In later years he was one of the prime movers in the formation of the N.Z. Statistical Association.

But it was students and the teaching of mathematics that claimed Campbell's first love and it is the influence he exercised on successive generations of students that establishes him as one of the significant personalities of New Zealand mathematics. No doubt his lecturing style would be criticised by today's educational technocrats - his blackboard writing was often illegible and in the excitement of mathematical ideas worth sharing and insights to be imparted, his speech often over-ran itself. But it was the enthusiasm for mathematics that created the real presence of Campbell's lecture room and made it a living experience for so many. One former colleague writes: *"His great forte was "enthusiasm", which the humbler student remembered long years after the technical details were forgotten. The sheer physical vigour of his lecturing with material prepared in fine detail! The clouds of chalk, the repeated trips, blackboard to bench, full face to the class, the roving eye to catch a bewildered student, the quick 'ad lib' with alternative explanations to ease (or increase) that bewilderment."* Another former student and colleague recalls: *"I never remember him less than enthusiastic in front of a class. His patience in encouraging students into the subject was limitless; he was always happy to converse and debate or explain after the lecture, and his study offered the opportunity not only of continuing discussions on current material but of delving into the history and philosophy of mathematics from any viewpoint. He is a true evangelist: through him one connects with mathematics."*

Enthusiasm for mathematics, yes, always sustained by a wide and thorough reading of current mathematical books and publications, but, over the years, it was a deep-seated interest in the students under his care that became Campbell's distinguishing characteristic. Indeed in retirement he was able to say that important as the subject had been to him through the years yet, increasingly, it had been the means by which he had been able to sustain his relationship with students, and these relationships he valued most of all. In a lighter vein it is claimed by some that he was able to detect a growing romance between students before even the principals had given it conscious recognition. There is no doubt that through having no family of his own Campbell brought to his relationship with senior students and younger staff members a richness of interest and encouragement that has been a significant factor in the lives of many of them.

Appointed to the Chair of Mathematics in 1952 at Victoria University College, he served as Head of a rapidly growing department, four establishment positions in 1952, some 20 or so in 1968, including a second chair, in applied mathematics. As with his relationships with students, so also, those with his staff were characterised by care for their well-being, encouragement and stimulation of their mathematical interests and whole-hearted support for their career progress. With-all there was a formality in personal relationships. Campbell was congenitally unable to address even the closest of his colleagues directly by their personal name. But it is typical of the man that one of the reasons he gave for his retirement some years before he had reached 65 years of age was that he was no longer happy to be running a department in which it was not possible to keep regular but informal contact with his staff members. The requirement of keeping staff members informed and in contact through written memoranda was the denial of a style of administration that he had practised successfully for many years.

Campbell's period as Head of Department and Professor saw the growth and development of mathematics departments in New Zealand from their close teaching and examining links within the college structure of the University of New Zealand to the independence of the several universities as they are today. He was cautious in course developments, although, as soon as opportunity allowed in the late 1940's he introduced a masters paper in matrix algebra. Given his interests, it is surprising that degree courses in statistics were not established at Victoria until the middle 1960's, although he had taught non-degree courses from before the war. Difficulties in recruiting staff over these years was undoubtedly one factor, but not the only one. In an article written in 1947 Campbell sets out his attitude then to mathematical developments at university level. He writes: *"... in fact, I consider that Stage I Mathematics should aim principally at presenting mathematics to the student as one of the great developments of the human intellect. ... if this view is accepted, then we shall have at most two years for the majority of Science students in which to make them mathematically literate. This time will be fully occupied with what is usually regarded as 'pure' mathematics and would allow of few excursions into the field of applied or quantitative mathematics. I consider that any attempt to increase the extent of such excursions would act detrimentally on the standard of work attained, and this we can ill afford." "Where then the applicable mathematics? I would suggest that, in the main, it is best treated as a post-graduate study. This belief is fully confirmed by overseas experience."* (Mathematics in Research in N.Z., the N.Z. Science Congress, 1947)

During the 1960's, especially, Campbell appointed to his staff several former students, some of whom had gained graduate qualifications from overseas universities. While sometimes criticised for this on the grounds of building a department too inbred with Victoria graduates, there is no doubt that it was personal loyalty to Campbell that was a large factor in inclining these graduates to accept positions back at Victoria, when other opportunities were so easily come by in those days. One strong ambition Campbell had regarding his staff was the appointment of women members. In this he was successful with several appointments.

In later years in his university position Campbell played a respected role as a senior professor in the wider life of the University. But it is characteristic of the man that in the final two or three years of his work he withdrew from intensive involvement in wider committee work in order to concentrate on his work in the Mathematics Department, including most of all his teaching activities.

Combined with Campbell's commitment to teaching at the university level was his strong interest in mathematics teaching in primary and second schools and his desire to see those engaged in teaching at these different levels supporting each other in commonality of mathematical interest. An early attempt before the Second World War to bring this about was not successful, but renewed attempts in the 1950's led to the revitalisation of the Wellington Mathematical Association, of which Campbell is now a life member in acknowledgement of his pioneering and continuing work in its growth and development.

Another successful initiative during those years was his own participation, and the enabling of the participation of other university teachers, in the programmes of the Teachers Refresher Courses organised through the

Department of Education. In these and other ways Campbell gave practical expression to his concern that universities and schools should come together in mathematics teaching.

Campbell came to retirement at the end of 1968 a little earlier than need be, but with a firm conviction that it was time for others to succeed him. His wife, Margaret, had at that time completed the second of two very effective terms as a member of the Wellington City Council. They shifted to Nelson where Campbell embarked on a new teaching career at the Nelson College for Girls. Again, how characteristic of him that he should write as follows of that experience: *"Two experiences of this period stand out in my memory. One was a 3A class - I have never been worked so hard as by that group - what enthusiasm and questioning. The other was a bursary class of four girls, one dropped out during the year. It was Mechanics and Statistics for bursary. The three girls, Vicki Mabin, Meryl Wastney and Anne Dean have gone on to careers in Applied Mathematics. Vicki Mabin recently completed a Ph.D. in Statistics in England and is back working in the A.M.D., Meryl Wastney went to Lincoln College and is now embarked in post-graduate work in the U.S.A."*

Mathematics requires those who are gifted and able to create its concepts and theorems and propagate them through the world-wide network of publications. Equally it requires those with Campbell's gifts to create mathematics as a living experience in the minds of those who seek from it understanding. Those many of us who have benefited from the exercise of that gift record our gratitude. One covets for all students of mathematics the experience of such a teacher.

Wilf Malcolm

Book Review

OPTIMIZATION TECHNIQUES: An Introduction, by L.R. Foulds.
Springer-Verlag, 1981. XI, 502p,72 figs.
Cloth DM 84, (c.NZ$65) ISBN 3-540-90586-3

In the words of the author, the major objective of this book is to provide an introduction to the main optimization techniques which are at present in use. The book is aimed at final year undergraduates or first year graduates in mathematics, engineering, business or the physical or social sciences. Only slight mathematical knowledge is assumed and the appendices on basic calculus and linear algebra should prove useful to the less mathematically based students.

Material covered includes linear programming, integer programming, network analysis, dynamics programming, classical theory, calculus of variations and nonlinear programming. As might be expected in *an introduction* the major emphasis is placed on linear problems. For example nearly 200 pages are devoted to linear programming and applications, whereas nonlinear programming occupies only 60 pages.

In the first half of the book material is carefully developed and the student is guided through well chosen examples illustrating the underlying principles and practical aspects of optimization. An excellent feature of the book is the numerous exercises set at the end of each chapter. The student who works through all these will know the subject very well indeed, but for those who prefer to have their work done for them, there are about 100 pages of solutions to selected exercises.

The worst chapter in the book is that on nonlinear programming. Here too much emphasis is placed on inefficient algorithms. Illustrative examples which were so prominent in earlier chapters are sadly missing. Excluding the special techniques of quadratic programming and geometric programming only 12 pages are used to introduce algorithms for optimizing general nonlinear functions with nonlinear constraints.

A number of typographical errors were noted but perhaps no more than is usual in a first edition, and many of these are unlikely to cause confusion. However, there are one or two more serious errors in Chapter 8.

In my view the book would be substantially improved if Chapter 8 were rewritten or even omitted. However, it would be unfair to be too critical on the basis of one chapter. The content and presentation of the first six chapters alone would make a very suitable text for an introductory course on optimization techniques.

I.D. Coope

Conferences

*** 1982 ***

May 5-7 (San Francisco, California)
Fourteenth Annual ACM Symposium on the Theory of Computing
Details from Walter A. Burkhard, Publicity Chairman, SIGACT-82 Symposium, University of California, San Diego, La Jolla, California 92093, U.S.A.

May 10-12 (Armidale, N.S.W.)
Simulation Society of Australia 5th Biennial Conference
Details from Dr. I.H. Fisher, SSA Conference 1982, Department of Resource Engineering, University of New England, Armidale, N.S.W. 2351, Australia.

May 10-14 (Newcastle)
Twenty-sixth Annual Meeting of the Australian Mathematical Society
Details from Dr. J.G. Couper, Secretary, A.M.S. Meeting, Department of Mathematics, The University of Newcastle, N.S.W. 2308, Australia.

May 13-14 (Montréal)
Optimisation Days 1982
Details from Jacques Ferland, Centre de Recherche sur les Transports, Université de Montréal, P.O. Box 6128, Station "A", Montréal, Québec, Canada H3C 3J7.

May 16-28 (Algarve, Portugal)
NATO Advanced Study Institute on Nonlinear Stochastic Problems
Details from J.M.F. Moura, Caps Complexo, Instituto Superior Tecnico, Ave. Rovisco Pais, P-1000 Lisbon, Portugal.

May 17-19 (Dunedin)
Seventeenth New Zealand Mathematics Colloquium
Details from Colloquium Secretaries, Department of Mathematics, University of Otago, P.O. Box 56, Dunedin, New Zealand.

May 17-19 (Washington, D.C.)
Fourth Symposium on Mathematical Programming with Data Perturbations
Details from Anthony V. Fiacco, Lloyd Heck Marvin Centre, The George Washington University, 800 21st Street, N.W., Washington, D.C. 20052, U.S.A.

May 17 - June 5 (Quezon City, Philippines)
Second Franco-Southeast Asian Mathematical Conference
Details from The Secretariat, Second Franco-Southeast Asian Mathematical Conference, Mathematics Department, University of the Philippines, Diliman, Quezon City, Philippines.

May 24-28 (Valencia)
International Forecasting Conference
Details from Oliver Anderson, IFC Spain, 9 Ingham Grove, Lenton Gardens, Nottingham NG7 2LQ, England.

June 6-11 (Edmonton, Canada)
Conference on Approximation Theory
Details from Approximation Theory Conference, C/o S.D. Riemenschneider, Department of Mathematics, University of Alberta, Edmonton, Alberta, Canada T6G 2G1.

June 8-11 (New Haven, Connecticut)
Conference in Modern Analysis and Probability (in honour of Shizuo Kakutani)
Details from R. Beals, Mathematics Department, Box 2155 Yale Station, New Haven, Connecticut 06520, U.S.A.

June 14-18 (Arlington, Texas)
Fifth International Conference on Trends in Theory and Practice of Nonlinear Differential Equations
Details from V. Lakshmikantham, Department of Mathematics, The University of Texas at Arlington, Box 19408, Arlington, Texas 76019, U.S.A.

June 16-18 (Dublin)
Second International Conference on Boundary and Interior Layers - Computational and Asymptotic Methods
Details from BAIL Conference, 39 Trinity College, Dublin 2, Ireland.

June 21-25 (Les Arcs, France)
IEEE International Symposium on Information Theory
Details from Bernard Picinbono, Laboratoire des Signaux & Systemes, École Superieure d'Électricité, Plateau de Moulon, F91190, Gif-sur-Yvette, France.

June 21-25 (Ithaca, New York)
Ninth U.S. National Congress of Applied Mechanics
Details from Y.H. Pao, Department of Theoretical and Applied Mechanics, Thurston Hall, Cornell University, Ithaca, New York 14853, U.S.A.

June 28-30 (Kansas City, Missouri)
1982 National Educational Computing Conference
Details from E. Michael Staman, NECC-2 General Chairman, Campus Computing Services, University of Missouri-Columbia, 305 Jesse Hall, Columbia, Missouri 65211, U.S.A.

June 28 - July 2 (Houghton, Michigan)	*Differential Geometric Control Theory* Details from R. Millman, Department of Mathematical and Computer Sciences, Michigan Technological University, Houghton, Michigan 49931, U.S.A.
June 28 - July 2 (Clermont-Ferrant, France)	*Eleventh Conference on Stochastic Processes and their Applications* Details from P.L. Hennequin, Université de Clermont-Ferrand II, Complexe Universitaire des Cezeaux, Département de Mathematiques Appliquées, B.P. n. 45, 63170 Aubière, France.
June 28 - July 3 (Las Palmas, Canary Islands)	*Second World Conference on Mathematics at the Service of Man* Details from Second World Conference on Mathematics at the Service of Man, Universidad Politécnica de Las Palmas, Casa de Colón, Herrerias 1, Las Palmas de Gran Canaria, Canary Islands, Spain.
July 25 - August 7 (Oxford)	*Joint NATO/London Mathematical Society Advanced Study Institute on Systems of Nonlinear Partial Differential Equations* Details from J.M. Ball, Department of Mathematics, Heriot-Watt University, Riccarton, Currie, Edinburgh EH14 4AS, Scotland.
July 26-30 (Sao Paulo, Brazil)	*International Seminar on Functional Analysis, Holomorphy and Approximation Theory* Details from Jorge Mujica, Institute of Mathematics, Statistics and Computer Science, State University of Campinas, Caixa Postale 1170, 13100 Campinas, Sao Paulo, Brazil.
August (Beijing, China)	*International Conference on Finite Element Methods* Details from Conference Secretary, International Conference on Finite Element Methods, Department of Civil Engineering, University of Hong Kong, Hong Kong.
August 3-10 (Czechoslovakia)	*Meeting on Binary Systems and Ring Theoretic Methods in Universal Algebra* Details from J. Ježek, Department of Algebra, Charles University, Sokolovská 83, 18600 Praha 8, Czechoslovakia.
August 8-13 (Montreal)	*Tenth IMACS World Congress on Systems Simulation and Scientific Computation* Details from S. Sankar, Tenth IMACS Congress Chairman, Department of Mechanical Engineering, H 929-12, Concordia University, 1455 Maisonneuve Boulevard West, Montreal, Canada H3G 1M8.
August 9-13 (Sheffield)	*First International Conference on Teaching of Statistics* Details from ICOTS Secretary, Department of Probability and Statistics, The University, Sheffield 853 7RH, England.
August 11-19 (Warsaw)	*International Congress of Mathematicians* Details from Czeslaw Olech, Institute of Mathematics, Polish Academy of Sciences, Sniadesckich 8, P.O. Box 137, 00-950 Warszawa, Poland.
August 19-21 (Cincinnati)	*3rd American Time Series Meeting (8th ITSM)* Details from Oliver Anderson, 9 Ingham Grove, Lenton Gardens, Nottingham NG7 2LQ, England.
August 19-27 (Blazejewko, Poland)	*Eighth Conference on Analytic Functions* Details from Julian Lawrynowicz, Instytut Matematyczny PAN, Oddzial W Lodzi, ul. Kilinskiego 86, PL-90-012 Lodz, Poland.
August 23-27 (Bonn)	*XI International Symposium on Mathematical Programming* Details from Math. Progr. Secretariat, c/- Institute for Operations Research, Nassestrasse 2, D-5300 Bonn 1, West Germany.
August 23-27 (Melbourne)	*Sixth Australian Statistical Conference* Details from Ian R. Gordan, Conference Secretary, Department of Statistics, University of Melbourne, Parkville, Victoria 3052, Australia.
August 23-27 (Adelaide)	*Tenth Australian Conference on Combinatorial Mathematics* Details from Dr. L.R.A. Casse, Department of Mathematics, University of Adelaide, North Terrace, Adelaide, South Australia 5001, Australia.
August 23-28 (Würzburg, West Germany)	*Equadiff 82* Details from H.W. Knobloch, Equadiff 82, Mathematisches Institut, Universität Würzburg, D8700 Würzburg, Federal Republic of Germany.

August 30 - September 3 (Gdansk, Poland)	*Eleventh International Symposium on Mathematical Foundations of Computer Science* Details from Witold Lipski Jr., MFCS '82, Institute of Computer Science, Polish Academy of Sciences, P.O. Box 22, 00-901 Warsaw PKiN, Poland.
October - November (Chiangmai, Thailand)	*Workshop on Teaching of Graduate and Undergraduate Mathematics* Details from Mark Tamthai, Department of Mathematics, Chulalongkorn University, Bangkok 5, Thailand.

M.R.C.

TENTH AUSTRALIAN CONFERENCE ON COMBINATORIAL MATHEMATICS

The Tenth Australian Conference on Combinatorial Mathematics will be conducted by the Combinatorial Mathematics Society of Australasia at the University of Adelaide, Australia, from Monday, 23 August, to Friday, 27 August, 1982. The fourth Annual General Meeting of the C.M.S.A. will be held at the conference. Registration will take place on the Sunday evening and on the Monday morning before the formal programme begins.

Invited Addresses: Not all details are available. Among those who have agreed to give a one-hour invited talk are:

Dr. D. Keedwell, University of Surrey, U.K.
Dr. J. Hirschfeld, University of Sussex, U.K.

We hope also to have invited talks from the following:

Professor J.A. Thas, University of Ghent, Belgium.
Professor A. Barlotti, University of Bologna, Italy.
Professor C.C. Lindner, Auburn University, U.S.A.
Professor N. Pullman, Queen's University, Canada.
Professor R. Stanton, University of Manitoba, Canada.

There will also be some expository lectures.

Contributed Papers: Papers are welcome in all areas of pure and applied combinatorics. Contributed talks will be allowed thirty minutes each, five minutes of which is usually for discussion. For further information, please write to Dr. L.R.A. Casse, Department of Pure Mathematics, University of Adelaide, Box 498, G.P.O., Adelaide, S.A. 5001, Australia, by June 30, 1982.

PROPOSAL FOR AN INTERNATIONAL SYMPOSIUM

The National Committee for Theoretical and Applied Mechanics is considering a proposal to seek the sponsorship of the International Union for Theoretical and Applied Mechanics for an international symposium in New Zealand on Single- and Multi-Phase Fluid Flow through Heterogeneous Permeable Materials.

Many naturally occurring porous materials tend to be more heterogeneous than commonly assumed in theoretical studies. Many, for example, are cracked or fractured or have holes of varying sizes within their connective channel system. Others tend to be layered, the permeability varying from one layer to the next. Some fraction of the fluid flowing through such materials will thus move much further or much more quickly than the remainder. The pattern of flow may thus be markedly distorted from that predicted from homogeneous permeable media theory. The channelling may also affect the pressure and pressure change distribution through the media. In situations in which the fluid is in some way tagged (as by its chemistry or its temperature) or in which a second phase or constituent is present (as in water-steam, water-oil, oil-gas, water-air systems) the heterogeneous nature of the porous media is now recognised as playing a significant role in the distribution of the constituents and the variation of this (and related properties) with time. Over recent years these effects have been recognised by scientists involved in geothermal reservoir analysis, the study of water movement through soils and in the study of flows of oil and gas reservoirs. Considerable effort is being put into these areas and it is thus appropriate to bring these scientists together (along with others from other research areas working on some aspect of this problem) to discuss study techniques, and experimental and theoretical results.

Comments are welcomed, and should be directed to Dr. Ian Donaldson, Physics and Engineering Laboratory, Lower Hutt.

A REACTION TO PROFESSOR VERE-JONES' ARTICLE: "UNIVERSITY ENTRANCE MATHEMATICS: WHERE NEXT?"

While Yossarian was still at cadet school he found himself, one day, sitting with the ingenuous Clevinger high in the reviewing stands, looking down at the parade-ground where one of the instructors, Lieutenant Scheisskopf, was raging at some of the cadets.

"Lieutenant Scheisskopf tore his hair and gnashed his teeth. His rubbery cheeks shook with gusts of anguish. His problem was a squadron of aviation cadets with low morale who marched atrociously in the parade competition that took place every Sunday afternoon. Their morale was low because they did not want to march in parades every Sunday afternoon and because Lieutenant Scheisskopf had appointed cadet officers from their ranks instead of permitting them to elect their own.

'I *want* someone to tell me,' Lieutenant Scheisskopf beseeched them all prayerfully. 'If any of it is my fault, I *want* to be told.'

'He *wants* someone to tell him,' Clevinger said.
'He wants everyone to keep still, idiot,' Yossarian answered.
'Didn't you hear him?' Clevinger argued.
'I heard him,' Yossarian replied. 'I heard him say very loudly and very distinctly that he wants every one of us to keep our mouths shut if we know what's good for us.'

'I won't punish you,' Lieutenant Scheisskopf swore.

'He says he won't punish me,' said Clevinger.

'He'll castrate you,' said Yossarian.

'I swear I won't punish you,' said Lieutenant Scheisskopf. 'I'll be grateful to the man who tells me the truth.'

'He'll hate you,' said Yossarian. 'To his dying day he'll hate you.'"

When I first read Professor Vere-Jones' article on the problems facing the University Entrance Board's Mathematics Steering Committee, my reaction to his request for advice was more like Yossarian's than Clevinger's but after a month or so I put my better instincts aside and decided to write this letter. Surely the New Zealand University clobbering machine is not yet as strong as that of the US Airforce! As the topic of University Entrance mathematics is of such great importance, particularly to those who study it, I thought I would take a chance.

I want to comment on three aspects of Professor Vere-Jones' article "University Entrance Mathematics: where next?" which appeared in the Newsletter, number 22.

1. *"The University representatives (on the Steering Committee) ... expressed concern that ... standards were already declining."*

Among the general populace it is accepted wisdom that the weather is getting worse, that moral standards are declining and that time goes faster as you get older; the equivalent wisdom among University lecturers is that students are not what they used to be, particularly new students. Well, my experience suggests that this is simply not the case and even a cursory look at University Entrance exam papers over the years indicate that the opposite may well be true. Here are some exam questions that I have picked out to illustrate this.

1929: Given that 1 foot = 30.480 cms; 1 lb = 453.953 gms; and that 1 cubic cm of water weighs 1 gm, find (i) the difference, to the nearest ounce, between the weight of 1 cubic foot of water and 1,000 ounces, and (ii) the difference, to the nearest pound, between the weight of 1 cubic yard of water and 3/4 ton.

1939: A piece of metal is in the shape of a solid right circular cylinder of radius 1½ inches and length 2 feet. The metal is completely used up in making wire of uniform circular section and of length one mile. Find the diameter of the wire to the nearest ten thousandth of an inch.

1949: Express as a product of linear factors $(a^2+b^2-c^2-d^2)^2 - 4(ab-cd)^2$.

1959: The number of apples that can be bought for a certain sum is reduced by 60 if the price of each apple is increased by ½d., and it is increased by 100 if the price is reduced by ½d. Find the price and the number of apples.

1969: If $p = (v+1)(2-3v)^2$ find the value of $\frac{dp}{dv}$ when $v = 1$.

1979: Find the value of $\int_{-2}^{2} (x+2)\,dx$.

Although it hardly seems necessary to gild the lily, here are some questions from the matriculation exam of 1884.

Define multiplication and find the value of 36204×53, explaining the process.

Prove that $a-(b+c-d) = a+d-b-c$.

If $a = 1$, $b = 2$, $c = 3$ find the value of $2a+4b-3c$. Who said that the New Mathematics is new?

In 1929 a complete paper for UE was headed:

ARITHMETIC (FOR GIRLS WHO ARE NOT TAKING MATHEMATICS)

Maybe arithmetic was not a part of mathematics in those days! One of the questions asked in it was:

> In a piece of fine linen as many threads run lengthwise as crosswise and in each case there are 180 parallel threads to the inch. How many miles of thread are used in weaving a square yard of such linen?

I don't want to claim that this rather haphazard selection of questions proves anything; but I do want to suggest that they throw doubt on one of the basic tenets of the University representatives on the Steering Committee.

2. *"In broad terms, the teachers on the Committee felt that it was essential to move to a syllabus more in keeping with the interests and capabilities of the pupils actually confronting them in the classroom, while the University representatives pointed to the statutory rôle of the examination in determining a suitable level for University entrance."*

In my opinion the deadlock between the two groups which this difference has led to should be resolved by the University representatives deferring to the teachers. It seems to me that the teachers are in the right and I have a number of reasons for this.

Firstly there is the plight of those who actually fail their UE. According to Professor Vere-Jones the pass rate in UE in 1979 was 58.5%. Transferring this rate for the whole exam to mathematics (for want of anything more accurate), it appears that 11,160 pupils set out at the beginning of the year to study sixth form mathematics and were told at the end that they had failed. Or was it the course of study that failed them? Would it not have been better for them to have studied a course more in keeping with their interest and capabilities? And if they had succeeded in such a course, why shouldn't they come on to University to study mathematics? Today we react with incredulity to the thought of a UE paper in arithmetic for girls not taking mathematics, but at least the people responsible for that 1929 paper were making a genuine effort, according to their own lights, to meet a need that they saw. Why should we not do the same?

Secondly, it is worth asking how many of the 26,893 who took UE Mathematics will actually study mathematics at a University? My guess is about 2,500, say 10%. I see nothing wrong in a sixth form course which prepares these pupils for University, but I see no reason why a course suitable for them should be the only choice for the other 24,393.

Thirdly, I do not believe that more diversity in school mathematics courses would set problems for Universities that cannot be overcome with only a little effort. In fact it is a myth that the present intake into Universities has a homogeneous background in mathematics. At present, anyone with UE in any subjects at all can come to the University and there enrol for Mathematics courses: it is just that we choose to base our mainstream courses on the assumption that our students have had a successful seventh form year and we tend to shunt the others into deadend first year courses or not provide anything at all for them. In my opinion the diversity of backgrounds of our students should already be met by a diversity of courses.

All this brings up the question of just who are the so-called University "representatives" who maintain these views on the Steering Committee?; in what sense do they represent us?; are they elected, appointed or are new members simply nominated by the previous members in the true spirit of University Committees? Come to think of it, Professor Vere-Jones' description of the way that the meetings proceed probably provides the answers to these questions.

3. *"The notion of proof ... is the very feature ... that explains the universality of mathematics and the spreading influence of quantitative methods over all branches of science and industry."*

If I had to list twenty important aspects of mathematics, the notion of proof would be one of them, but it certainly wouldn't be pre-eminent. However, it is not the nature of mathematics as a whole that concerns us here; rather it is the aspects of mathematics relevant to the sixth form. To my mind the pupil's study ought to have three aims:

(1) The mastery of some (small?) part of mathematics.

(2) The development of their imagination through their mathematical intuition.

(3) Training in replacing intractable problems by simpler tractable ones.

As far as I am concerned, the best thing a first year student at the University can have in his background is lots of experience with genuine mathematical things. No matter what they are, I know I can then build on it and get him competent in calculus and linear algebra in two or three years.

As someone who has tried to teach some idea of proof in a semi-formal fashion, I can only report that it doesn't work. Students who can find their way through very complicated mathematics, involving a proof in its own way, may have difficulty with a "proof". They need to have experience in describing the mathematics that they already understand: then notions of proof will develop on their own. Anyway, how many of the 26,893 who sat UE Mathematics will ever pursue their Mathematics to the extent that they really need to produce a proof? Somewhere between the 3 and the 93 I suppose, and probably closer to the former.

In this rather long letter I have commented on three points in Professor Vere-Jones' article. It would have been nice to have been more constructive and to go into more details, but in a University system where Professors get 100,000 votes and Associate-Professors get 10,000 there is probably little point. If there are only a few comments coming from the others to whom this article is addressed, it may be for the same reason.

One of the reasons that I have taken the time to write this, despite misgivings about its effectiveness, is a concern for the future of our mathematics teaching. I recently went to an evening meeting of the Auckland Mathematics Association in which the topic was mathematics in the classroom, but the topic of conversation at the supper afterwards was computers. One possible scenario for the future is computing taking a dominant position in the schools and universities with mathematics being relegated into a position similar to that which is now occupied by classical mechanics or philosophy with its practitioners insisting on teaching their own version of their discipline, with the inertia of the system supporting them, but being increasingly ignored by everyone else who can find no relevance in the ϵ's, δ's and associative laws beloved of the mathematicians. The irony is that if present trends continue, this withering of our discipline may be the best thing for our students; the mathematically talented of the future can then concentrate on computer science and medicine.

All this may look as though I have nothing but criticism for Professor Vere-Jones' article. As this is not the case, let me close with three of his sentiments with which I have sympathy.

1. "I am also becoming increasingly sceptical about the importance of syllabus *content*."
2. "Could we even *abolish* such sound institutions as the Entrance Board, subject convenors and all?"
3. "A minimum formal syllabus, giving the teachers maximum scope to develop their own examples, special topics, applications and cross-links would come closest to my personal ideal."

Peter Lorimer

Problems

Readers are invited to send problems for this section. Some indication should be given of how a problem has arisen and whether a complete solution is known and attribution of sources should be provided for problems that are not original. Attempts at solutions should be sent to the setter or to the Editor.

Problem 7. A combinatorial exercise

Prove: $\sum_{i=0}^{r} (-1)^i \, {}^{n}C_{i} \, {}^{n-m-i}C_{n-m-r} = (-1)^r \, {}^{m-1+r}C_{m-1}$

Tevita 'O. Helu, Nukuâlofa, Tonga

* * * * *

John Harper draws our attention to the result

$$\int_0^1 \frac{x^4(1-x)^4}{1+x^2}\,dx = \frac{22}{7} - \pi \ , \quad \text{and hence} \quad \frac{1}{1260} < \frac{22}{7} - \pi < \frac{1}{630} \ .$$

Has anyone anything comparable?

Secretarial

ANNUAL GENERAL MEETING

The Eighth Annual General Meeting of the New Zealand Mathematical Society will be held on Tuesday, 18 May 1982, at Otago University. Items to be included on the agenda should be sent to the Secretary as soon as possible.

An item of business at that meeting will be the Election of Officers. As of 23 March, 1982 no nominations have been received for Incoming Vice-President. The following nominations and biographical notes have been received for Council.

Dr. I.D. Coope (University of Canterbury): Ian Coope gained his Ph.D. from Leeds University in 1977. He was Research Fellow in numerical analysis at Dundee University from 1976 to 1979 and has been a lecturer in mathematics at Canterbury University since 1979. In 1980/81 he was assistant editor of the NZMS Newsletter and has been acting editor from January 1982. He is an Associate Fellow of the Institute of Mathematics and its Applications. His main interests are in optimization and related areas in numerical analysis.

Dr. P.D. Hill (University of Waikato): Peter Hill gained his M.Sc. from Auckland in 1971 and his Ph.D. from Glasgow in 1976. He is a Fellow of the Statistical Society. He was a junior lecturer at Auckland from 1972 to 1973 and has been a lecturer at Waikato since 1976. His main interests are in medical statistics, and current interests also include kernel density estimation and optimal design of regression experiments.

Dr. K.H. Russell (Victoria University of Wellington): Ken Russell is 1% Kiwi (a transplanted kidney), and the rest is dinkum Aussie; opinions vary as to which of these components is the better. He is not interested in discussing under-arm bowling. He gained a B.A. in Statistics and Mathematics at Macquarie University (Sydney), and then a Master of Statistics and a Ph.D. in Statistics at The University of New South Wales. In 1977 and 1978, he was a temporary lecturer in Statistics at U.N.S.W., and in the second of these years served as Secretary of the NSW Branch of the Statistical Society of Australia. Since 1979 he has been a lecturer in Statistics with the Mathematics Department at Victoria University of Wellington. His principal research interest is the design and analysis of experiments.

RSNZ FELLOWSHIP

The NZMS Council would like to remind members of the success in 1980 of its nomination of Professor J.C. Butcher as Fellow of the Royal Society of New Zealand and invites members to submit ideas for nominees for the coming year.

NATIONAL COMMITTEE FOR MATHEMATICS

Members are invited to make suggestions for nominations to the two positions on this committee which fall vacant this year. RSNZ rules specify that actual nominations are to be made by Member Bodies (rather than by members of Member Bodies) or by RSNZ Fellows.

The current committee is Professor B.A. Woods (Convenor), Professor J.J. Deely, Professor D.B. Gauld, Mr. K.E. Jury, Dr. M.G. Roberts, Dr. G.M. Thornley. Professor Deely and Dr. Thornley are retiring this year but are eligible for re-nomination.

NEW MEMBERS

The following new members have been received:

Professor Gordon Hookings, Department of Mathematics, University of Auckland, Auckland.
Professor I.F. Collins, Department of Theor. & Appl. Mechanics, University of Auckland, Auckland.
Mr. Stefan W.E. Nachtsheim, New Mexico Petroleum Center, Socono, New Mexico 87801, U.S.A.
Mr. Hamish Spencer, 95 Onewa Road, Northcote 9, Auckland.
Mr. Peter Knight, 11 Remu Road, Wellington, 5.
Mr. J.W. Giffin, Economics Department, University of Canterbury, Christchurch.
Mr. Neil Ralph Cox, Ruakura Agric. Research Centre, Private Bag, Hamilton.
Dr. Roderick D. Ball, Department of Mathematics, Purdue University, West Lafayette, Indiana, U.S.A. 47907.

The Society records with regret the deaths of the following members:

Professor H.G. Forder (see obituary in Newsletter No. 22)
Professor A.S.B. Holland, born 4 June 1930, died 5 August, 1981.

Crossword

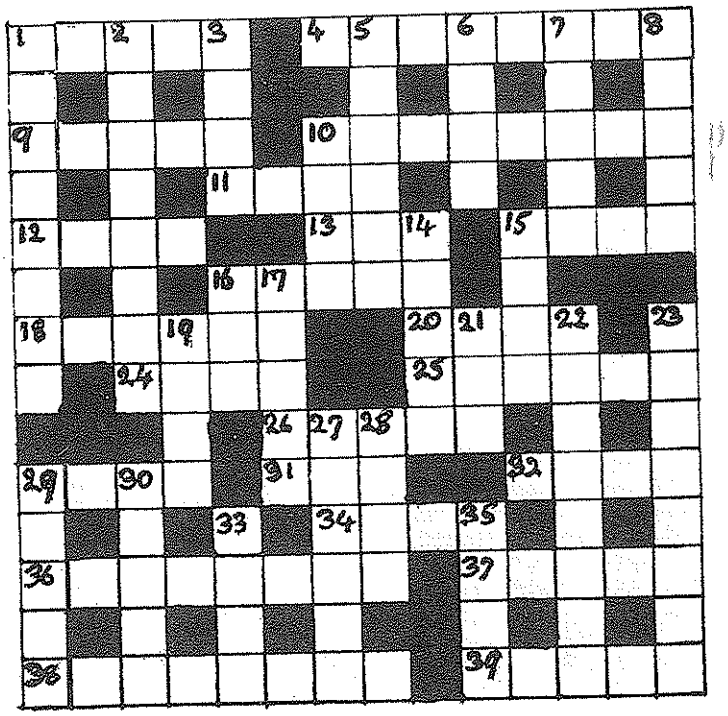
SLIGHTLY DOTTY

Across:

1. ? (5)
4. . (4,4)
9. Ornamental embedding (5)
10. See 38a
11. All single; Bill to pay (4)
12. Protective land point (4)
13. Consume (3)
15. See 16a
16 and 15a -·-· ··· -·· · (5,4)
18. Fixed ungulate (6)
20. Mismanaged tour (4)
24. Dispatch from Southend (4)
25. Communication (6)
26. With these 10 would not be 38 (5)
29. Large and no more (4)
31. River city? (3)
32. Abbreviated angling (4)
34. With Di remove the garment (4)
36. ¨ (8)
37. Low joint (5)
38 and 10a ⁘ (8,8)
39. The within of the with it group (5)

Down:

1. ⁘ (8)
2. ... (8)
3. Repetitive toy (4)
5. Descriptive of substitution (4,2)
6. Instrument of Richard III's opening (4)
7. Silver nosed watcher (5)
8. A step into sticker (5)
10. Ever turn (4)
14. Reset and succint (5)
15 and 19d (8)
16. About half of humanity (3)
17. Stranger with fewer 2's (5)
19. See 15d
21. Short musical output (3)
22. ∴ (8)
23 and 27d  (3,5,6)
27. See 23d
28. Turns at the game (4)
29. Geometrical spokes (5)
30. Personal belief (5)
33. 'Take me to your swan?' (4)
35. Oft hailed (Thankyou 11) (4)



N^{o} 6 by Matt Varnish

CROSSWORD N^{o}5 SOLUTION

Büvös Kocka = Magic Cube

Across: 2. Mesh, 7. Rotor, 8. Rubik, 9. Vaunt, 10. Blue, 11. Argue, 14. Sprang, 16. Red, 18. Approximately, 19. Don, 21. Finito, 24. Sides, 26. Cell, 27. Hunch, 29. Henna, 30. Orbit, 31. Edge.

Down: 1. World, 2. Moves, 3. Era, 4. Hungarian Cube, 5. Purr, 6. Pique, 11. Aghast, 12. Green, 13. Edgy, 15. Proofs, 17. Spend, 18. Aids, 20. Oiled, 22. Ochre, 23. Plain, 25. Erno, 28. Cog.

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However correspondence should normally be sent direct to the Secretary, Dr. D.G. Smith, Department of Mathematics, University of Auckland.

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