

THE AUSTRALIAN NATIONAL UNIVERSITY

CENTRE FOR MATHEMATICAL ANALYSIS

ANNUAL REPORT, 1982

The Centre for Mathematical Analysis commenced officially on June 1st, 1982 under the Directorship of Professor N.S. Trudinger. The provision of the grant to establish the Centre, under the Commonwealth Program for Promotion of Excellence in Research was announced by the Minister for Education on January 29th, 1982. At this stage the Director had just assumed the Acting Headship of the newly created Department of Mathematics* in the Faculty of Science and consequently became responsible for implementing both the necessary administrative adjustments for the new department and the planning for the new centre. The Acting Headship ceased on April 16th, 1982 and shortly thereafter the Centre was able to commence operation with Professor Trudinger as Director until December 31st, 1984, in the first instance.

Administration

The Director is responsible to the Vice-Chancellor, through the Chairman of the Board of the Faculties, for the administration of the Centre. In planning and executing the academic programme he is assisted by an advisory group comprising Professor R.P. Brent, Department of Computer Science, Faculty of Science, A.N.U., Professor L.M. Simon, Department of Mathematics, Research School of Physical Sciences, A.N.U., Dr. R.S. Anderssen and Dr. F.R. de Hoog, Division of Mathematics and Statistics, C.S.I.R.O., and Professor A.G.R. McIntosh, School of Mathematics and Physics, Macquarie University.

Staffing matters

A secretary, Ms L. Mazanov and a research assistant, Dr. B.R.F. Jefferies were appointed in June, 1982. Dr. K. Ecker took up a one year appointment as a Visiting Fellow in August, with financial support through a scholarship from the Government of West Germany. Dr. S-Å. Gustafson arrived from the Royal Institute of Technology, Stockholm, in November to take up a one year appointment as a Visiting Fellow. Professor A.G.R. McIntosh commenced a two year period of secondment from Macquarie University in December. Dr. G. Williams of the

*The former departments of Pure and Applied Mathematics were amalgamated to form the Department of Mathematics on January 1st, 1982.

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University of Melbourne was appointed as a Research Fellow, jointly with the Department of Mathematics, from January 1st, 1983. The Centre also benefited from several short-term Visiting Fellows from both overseas and other Australian universities. A list of staff, at January 1st, 1983 and official Visiting Fellows in 1982 is attached.

In addition various other mathematicians made brief visits to the Centre and gave colloquia, details of which are indicated in the attached Colloquia programme.

Research Activities

As stated in the report of the Commonwealth Research Centre of Excellence Committee, "the Centre is expected to provide a focus of mathematical research for the study of partial differential equations and their applications to other branches of science and mathematics. With a strong interest in contemporary applicable mathematics the centre will include a component with interests in numerical analysis which will provide an important link with computing science". Accordingly the research of the Centre can roughly be divided into two interwoven areas; (i) theoretical research related to partial differential equations; (ii) computational and related applied mathematics. The research of the Centre is also reflected in that of the members of its advisory group and brief descriptions of their work are also included below.

(i) Theoretical mathematics:

Professor Trudinger was largely occupied during the year with preparation of new material for the second edition of his book: "Elliptic Partial Differential Equation of Second Order" written in collaboration with Professor D. Gilbarg of Stanford University. The first edition had sold out in 1981, although a Chinese translation was published in China in 1981. The main thrust of his research lay in fully non-linear elliptic equations and results were obtained pertaining to the solvability of the Dirichlet problem for such equations under natural structure conditions; (Research report R01).

Professor McIntosh continued his research into problems in operator theory which arise from singular integrals and evolution equations and wrote a paper, with C. Davis (Toronto) and R. Bhatia (Bombay) on perturbation of operators.

Dr. Ecker studied the characterization of isolated singularities of maximal space-like hypersurfaces in Minkowski space.

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Dr. Jefferies developed a general approach to diffusion processes in abstract spaces (see Research report R04).

Professor Simon continued his work on minimal surfaces and was successful in solving a long-standing problem concerning their isolated singularities.

(ii) Computational mathematics:

Dr. Gustafson commenced a research project with Dr. R.S. Anderssen on the analysis of geomagnetic data, and completed preparation of a book entitled "Linear Optimization and Approximation", with K. Glaskoff, (Hamburg).

Professor Brent developed, in collaboration with H.J. Kung, (Carnegie-Mellon University), F.T. Luk and C. Van Loon (Cornell University), systolic algorithms for various algebraic and matrix computations, yielding applications to error correcting codes and signal processing, (see Research Reports R02, R03).

Drs. Anderssen and De Hoog continued their joint work on the numerical approximation of Sturm-Liouville problems, (Research Report R05) and began preparation for a joint CMA-CSIRO project on solidification.

Conferences and Travel

Professor N.S. Trudinger participated in the Summer Research Institute of the Australian Mathematical Society at Melbourne in January and the Annual General Meeting of the Australian Mathematical Society in Newcastle in May where he delivered an invited lecture and was officially presented with the First Australian Mathematical Society Medal. In August he visited Stanford University and then spent four weeks in Europe where he delivered a series of advanced lectures at Cortona, Italy on recent work in fully nonlinear elliptic equations and gave seminars at the Universities of Paris and Florence. This trip was also used for planning and publicising future CMA activities.

The Centre also supported the participation of Professor Brent at a Workshop on "VLSI and Modern Signal Processing" at Los Angeles, and a Conference on "Numerical Simulation of VLSI Devices" at Boston in November. The Centre was also represented at an International Symposium in Differential Geometry at Durham, U.K., by Dr. P.F. Price of the Department of Mathematics, Research School of Physical Sciences, A.N.U.

Seminar activity

A vigorous colloquium programme was organised with audiences drawn from various ANU departments and the CSIRO. In addition a research seminar on partial differential equations was held in December.

Publications

The Centre initiated two series of publications, Proceedings and Research Reports. The Proceedings are devoted to substantial expository works including conference proceedings while the Research Reports cover research originating from or connected with the Centre. Details of publications are attached as well as references to other staff publications which appeared in 1982.

Future development

Various activities and appointments for 1983 and 1984 were initiated during 1982. There will be further appointments made at the level of postdoctoral and research fellow in 1983 and sojourns by various distinguished overseas mathematicians have also been arranged for this period. As well as further secondments from other Australian institutions, the Centre will also benefit from various mathematicians from both Australia and overseas who will draw at least partial salary support from their home institutions. Judging from enquiries to date, the Centre shows promise of becoming an attractive venue for Australian Outside Studies Programmes.

Academic activities in 1983 will concentrate on partial differential equations techniques in differential geometry and on computational mathematics, while in 1984 the subject of partial differential equations itself will be a principal area of activity.

Facilities

The Centre is located in the Hanna-Neumann building together with the Department of Mathematics with which it shares common facilities. It was realised early in 1982 that the Centre would require additional office space as it would grow beyond the size originally proposed. It was also found that the existing facilities for seminars were inadequate. These obstacles are being overcome through a small extension to the Hanna-Neumann building.

Some computing equipment, including a Tektronix A113 graphics terminal, was ordered in 1982, to provide support for the Centre's computational activities.

Financial statement

A statement of expenditure and commitments in 1982 is attached.

CENTRE FOR MATHEMATICAL ANALYSIS

(i)

STAFF (at 1/1/83)

Director and Professor	N.S. Trudinger, B.Sc.(N.E.), M.S., Ph.D. (Stan.), F.A.A.
Associate Professor	A.G.R. McIntosh, B.Sc.(N.E.), Ph.D.(Calif.)
Research Fellow	G. Williams, B.Sc., Ph.D.(Adel.)
Visiting Fellows [*]	S.-Å. Gustafson, fil.mag.(Lund), fil.dr., docent (Stockholm)
	K. Ecker, Dr.rer.nat. (Heidelberg)
Research Assistant	B.R.F. Jefferies, B.Sc.(Qld.), Ph.D.(Flinders)
Secretary	L.C. Mazanov

VISITING FELLOWS^{*} (1982)

Professor R.B. Melrose, Massachusetts Institute
of Technology

Dr J.H. Michael, University of Adelaide

Professor G.F. Carey, University of Texas

Professor R. Schoen, University of California

Professor D. Fischer-Colbrie, Columbia University

Professor G. Dahlquist, Royal Institute of
Technology, Stockholm

Dr H.B. Thompson, University of Queensland

^{*} Visiting Fellows appointed for periods greater than six months
are shown under staff

June 2	Professor L.C. Evans (University of Maryland) "Control theory and nonlinear partial differential equations"
June 9	Professor J.A. Liggett (Cornell University) "The boundary integral method and its application"
June 16	Professor R.B. Melrose (M.I.T.) "Drumheads, geodesics and the inverse spectral problem"
June 30	Dr L.N. Trefethen (Stanford University) "Stability of finite difference models and group velocity of dispersive waves"
July 21	Professor S. Pruess (University of New Mexico) "Local polynomial representations for collocating ordinary differential equations"
July 28	Professor A.S. Wightman (Princeton University) "Perturbation series in quantum theory"
August 9	Dr Franklin Luk (Cornell University) "Procrustes rotation to a partially specified target"
August 11	Professor F. Stummel (J.W. Goethe-Universitat, Frankfurt) "Perturbation of domains in elliptic boundary value problems"
August 16	Professor G.F. Carey (TICOM, University of Texas at Austin) "Finite element methods for Navier Stokes problems"
September 1	Dr D. Fischer-Colbrie (Columbia University) "Complete minimal surfaces in three-manifolds"
September 8	Professor P. Anselone (Oregon State, Corvallis) "Operator approximation theory and applications to differential and integral equations"
September 15	Professor R.M. Schoen (University of California at Berkeley) "On the harmonic mapping problem"
October 6	Professor L.M. Simon (Institute of Advanced Studies, ANU) "Asymptotics for non-linear evolution equations with application to geometric problems"
November 17	Professor Germund G. Dahlquist (Royal Institute of Technology, Stockholm and Stanford University) "Multiplier techniques for the analysis of the stability of multistep methods for non-linear differential and integral equations"
December 10	Professor George Leitmann (University of California) "Stabilization of uncertain linear systems by means of estimated state feedback"
December 29	Professor John Ball (Heriot-Watt University, Edinburgh) "Singular minimizers in the calculus of variations"

OFFICIAL PUBLICATIONS 1982

PROCEEDINGS

- Vol. 1 Miniconference on Partial Differential Equations
Edited by P.F. Price, L.M. Simon, N.S. Trudinger
- Vol. 2 Basic Theory of One-Parameter Semigroups, D.W. Robinson

RESEARCH REPORTS

- RO1 Fully nonlinear, uniformly elliptic equations under
natural structure conditions, N.S. Trudinger
- RO2 A systolic architecture for the singular value
decomposition, R.P. Brent and F.T. Luk
- RO3 A systolic architecture for almost linear-time
solution of the symmetric eigenvalue problem,
R.P. Brent and F.T. Luk
- RO4 Semigroups and diffusion processes I, by B. Jefferies
- RO5 On the correction of finite difference eigenvalue
approximations for Sturm-Liouville problems
with general boundary conditions, R.S. Anderssen
and F.R. de Hoog

STAFF PUBLICATIONS 1982

1. ECKER, K., Estimates for evolutionary surfaces of prescribed mean curvature, *Math. Zeid.* Vol. 180 (1982), 179-182.
2. GUSTAFSON, S.-Å., Time series analysis of geomagnetic data in electric conductivity modelling for the earth, Nordisk Symposium i Anvendt Statistik og Edb, Denmark's Institute of Technology, 1982.
3. MCINTOSH, A.G.R., On representing closed accretive sesquilinear forms as $(A^{1/2}u, A^{*1/2}v)$, Nonlinear partial differential equations and their applications, Collège de France Seminar, Vol. III, Research Notes in Mathematics, 70 (1982) 252-267, Pitman.
4. L'intégral de Cauchy définit un opérateur borné sur L^2 pour les courbes lipschitziennes, Annals of Mathematics, Vol. 116 (1982), 361-387, with R. Coifman and Y. Meyer.
5. The Hilbert transform on lipschitz curves, Miniconference on Partial Differential Equations, Proceedings of the Centre for Mathematical Analysis, Vol. 1 (1982), 26-69 Australian National University.
6. TRUDINGER, N.S., Harnack inequalities for nonuniformly elliptical divergence structure equations, Inventiones Math. Vol. 64, (1981), 517-531.
7. Elliptic equations in non-divergence form, Proceedings of the Centre for Mathematical Analysis, Vol. 1, Miniconference on Partial Differential Equations, 1-16 (1982).

CENTRE FOR MATHEMATICAL ANALYSIS
EXPENDITURE AND COMMITMENTS, 1982

Salaries	\$48,743.60
Salary related expenses	7,793.19
Equipment	45,342.30
Other (including capital work)	77,574.24
Movement expenses (including non-salaried Visiting Fellows)	20,277.35
Sundries	<u>269.32</u>
TOTAL	<u><u>\$200,000.00</u></u>