

Centre for Discrete Mathematics and Computing

in the

Discipline of Mathematics, School of Physical Sciences

and the

School of Information Technology and Electrical Engineering

at

The University of Queensland

2003 Report

June 2004

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CENTRE FOR DISCRETE MATHEMATICS AND COMPUTING

in the
DISCIPLINE of MATHEMATICS, SCHOOL of PHYSICAL SCIENCES
and the
SCHOOL of INFORMATION TECHNOLOGY and ELECTRICAL ENGINEERING
at
THE UNIVERSITY OF QUEENSLAND

Report for 2003

June 2004

0. PREFACE

This Centre was formed at the beginning of 1998 by the merger of the Centre for Combinatorics (in the then Department of Mathematics) with the Algorithms Group (in the then Department of Computer Science and Electrical Engineering). It promotes research in combinatorics and in algorithm design, and supports the Number Theory Web. It acts as national base for an international body, the Institute of Combinatorics and its Applications (ICA), and as regional base for the Combinatorial Mathematics Society of Australasia (Incorporated) (CMSA(Inc)). In association with the Department of Mathematics, University of Auckland, it publishes an international journal, the *Australasian Journal of Combinatorics*, for CMSA(Inc). It is one of sixteen groups listed on the World Combinatorics Exchange <http://www.combinatorics.org/People/index.html>. The Centre periodically hosts conferences and workshops, the most recent being *Working Applications of Discrete Mathematics* in January 2004. This Workshop attracted support from both the Australian Mathematical Sciences Institute and the ICA.

Members of the Centre actively collaborate with overseas research groups in Austria, Belgium, Canada, China, Czech Republic, France, Germany, Iran, Italy, New Zealand, Taiwan, Thailand, Turkey, United Kingdom and United States of America. Within Australia, members of the Centre collaborate with research groups at: the Universities of Sydney, Newcastle, Adelaide, Western Australia and Wollongong; Curtin University of Technology, the University of Technology, Sydney, and the Queensland University of Technology; the Australian National University and Charles Darwin University. The Centre also hosts numerous visitors, including a number of Ethel Raybould research fellows. Postgraduate students within the Centre have the benefit of working with such visitors while they are here, and sometimes of visiting them in their home universities.

Members of the Centre have easy access to the Dorothy Hill Physical Sciences and Engineering Library of The University of Queensland, which houses one of the best collections in Australasia of combinatorial literature. They also have access to computing facilities appropriate to their needs, notably including grid computing on 128 Sun Netra X1 machines.

Although both discrete mathematics and computing are areas of much serious research, they include many problems which are easily stated and understood, and consequently of interest to people with little formal background in the area. Some of these problems are immensely difficult, the four colour theorem and Fermat's last theorem being classic examples. Some are relatively easy to solve, at least in small particular cases, and attract students into the area, and often from there into other areas of mathematics as well. Thus many combinatorial questions feature on the Queensland Association of Mathematics Teachers Problem Solving Competitions, the Australian Mathematics Competitions, and the Mathematical Olympiads. Areas where such questions arise include games and puzzles, scheduling and allocation problems, coding and cryptography, structures of woven textiles, and many problems in graph theory. Staff associated with this Centre have contributed consistently to activities for secondary students, including competitions, ExpoUni displays, Winter Schools, a biennial newsletter (Infinity) and the club allied with it (Club Infinity).

Theoretical interests within the Centre include: designs, finite geometries, networks and graphs; universal algebras and their relation to designs and graphs; number theory; finite fields; combinatorial computing, especially algorithm development relevant to these areas, to linear algebra and to parallel and distributed computing. Applications of particular interest include: experimental design; error-correcting codes and cryptography; techniques for drug design, combinatorial chemistry and DNA sequencing; and the production of scientific software now included in such large systems as MAGMA (based at the University of Sydney), GAP (Scotland), LIDIA and KANT (Germany) and PARI (France).

This report describes the research activities of staff associated with the Centre.

Centre web page: <http://www.maths.uq.edu.au/cdmc/>

1. STAFF ASSOCIATED WITH THE CENTRE

Honorary Professor and Centre Director

Anne Penfold Street, MSc *Melb*, PhD *Ill*, DMath *UW*, FTICA, (*combinatorial designs and applications*).

Honorary Professor

Charles Curtis Lindner¹, BS *Pres, Clinton, S.C*, MS, PhD *Emory*, FTICA, (*combinatorial designs*).

Readers

Peter Adams, BSc (Hons), BComm, PhD, FTICA, (*combinatorial designs, combinatorial computing and applications*).

Elizabeth Jane Billington, MA, DipAdMaths *Oxon*, DipEd, PhD, FTICA, FAustMS, (*combinatorial designs and graph decompositions*).

Diane Margaret Donovan, BA, DipEd *La Trobe*, PhD, FTICA, FAustMS, (*combinatorial designs and computer security schemes*).

George Havas, BA (Hons) *ANU*, PhD *Sydney*, (*algorithm design*).

Queen Elizabeth II Principal Research Fellow (Level D)

Darryn Edward Bryant, BSc, MScSt, PhD, FTICA, (*combinatorial designs, graph theory and DNA sequencing*).

Lecturers

Kevin Eugene Gates, BS *USCGA*, MS, PhD *UWa*, (*algorithm development in linear algebra*).

Barry Denis Jones, MSc *Tas*, PhD *Exe*, MTICA, (*homological algebra and combinatorics*).

Victor Scharaschkin, BSc Hons *Tas*, PhD *Mich*, (*algebraic number theory, arithmetic geometry*).

Research Fellow

Barbara Marguerite Maenhaut, BMath *UW*, BEd *UWO*, PhD, AFTICA, (*combinatorial designs, graph theory*).

Senior Research Officers

Gregory Gamble², BSc (Computing), BE (Elec), MMath *UNSW*, PhD *UWA*, (*combinatorial algorithms*).

Kenneth Raward Gray³, BA (Hons), DipEd *Macquarie*, PhD, FTICA, (*combinatorial designs and education*).

Nicholas Ahti Hamilton⁴, BSc (Hons), PhD *UWA*, (*finite geometry*).

Abdollah Khodkar⁵, MSc *Sharif*, PhD, (*combinatorial designs*).

Research Officer

Colin Ramsay, BCompSci, BSc (Hons) *NTU*, PhD, (*combinatorial computing and algorithm development*).

Honorary Research Consultants

Keith Robert Matthews, MSc, PhD, (*number theory*).

Graham Hilton Norton, BSc *Cape Town*, PhD *Cornell*, (*applied algebra, algebraic coding theory*).

Peter Arthur Barry Pleasants, MA, PhD *Cantab*, MSc *Wales*, (*number theory, combinatorics, geometry, quasicrystals*).

Sheila Williams, MA, DPhil *Oxon*, FTICA, (*universal algebra and combinatorial designs*).

Honorary Research Adviser

Martin James Sharry⁶, BSc (Hons), PhD, FTICA, (*combinatorial designs and combinatorial computing*).

Visiting Research Staff

Ebadollah S Mahmoodian⁷, BS *Tehran*, MS *Shiraz*, AM, PhD *Pennsylvania*, FTICA, (*combinatorial designs*).

¹Distinguished Professor, Auburn University

²Senior Research Officer (p/t), Research Associate (Curtin University)

³Senior Research Officer (p/t); Consultant in educational assessment and testing, with clients including both Education Queensland and non-state schools.

⁴Senior Research Officer, joint position in the Institute for Molecular Bioscience and the Advanced Computational Modelling Centre

⁵Senior Research Officer (p/t)

⁶Manager - Infrastructure Services Unit, Information Solutions and Technology, Corporatelink, Queensland

⁷Professor of Mathematical Sciences, Sharif University of Technology, Tehran, Iran

2. RESEARCH STUDENTS

This list includes titles of theses and the names of the relevant research supervisors.

Awarded 2003

Andrew D Blinco, (PhD, *Graph decomposition, theta graphs and related graph labelling techniques*, Billington/Adams).

Sara Cauchie, (PhD, University of Gent, *A study of (α, β) -geometries fully embedded in projective spaces*, Hamilton).

Nicholas J Cavenagh, (PhD, *Latin cubes*, Donovan/Billington/Khodkar).

Mark Griffin, (PhD, *The computer simulation of electron paramagnetic resonance spectra employing homotopy*, Gates/G R Hanson/K Burrage).

Andrew Janke, (PhD, *Cognition driven deformation modelling*, Gates/G Galloway).

Annette Masters, (PhD, *Some extensions to support vector machines*, Gates/T Downs (ITEE)).

Awarded 2004

Stephen M Long, (PhD, *Combinatorial methods and applications in drug discovery*, Adams/Tran (Chemistry)/Smythe (IMB)).

Current Research Students

Jenna Appleton, (PhD, *Combinatorial algorithms*, Adams/Bryant).

Melinda Buchanan, (PhD, *Topics on latin squares, edge colourings of graphs and related combinatorial designs*, Bryant/Adams).

Sean Byrnes, (PhD, *Geometric perspectives on noncommutative algebra*, B Jones).

Matthew Dean, (PhD, *Hamilton cycle decompositions of Cayley graphs*, Bryant).

Tristan Freiberg, (MSc, *Rational points on curves of genus > 1* , Scharaschkin).

Daniel Horsley, (PhD, *Topics in Steiner triple systems and related combinatorial designs*, Bryant).

Peter Jenkins, (PhD, *Embedding partial graph designs*, Billington/Adams/Bryant).

James Lefevre, (PhD, *Graph decompositions and trades*, Billington/Adams).

Anthony Rasmussen, (PhD, *High performance computational modelling in molecular reaction dynamics*, S C Smith/Gates).

S M Sheikholeslami, (PhD, Tarbiat Moallem University of Azarbayjan, *Critical sets in dihedral groups*, M A Shahabi, University of Tabriz/Khodkar).

Mary Waterhouse, (PhD, *Graph colourings and emerging applications of combinatorial design theory*, Adams/Bryant).

Current but paused for part of 2003:

Carlo Hamalainen, (PhD, *Critical sets for latin squares and graph colourings*, Donovan/Khodkar).

Karen Grace Harris, (PhD, *Small graph designs and their various properties*, Billington/Donovan).

3. VISITORS

2003

Professor John Cannon (Computational Algebra Group, University of Sydney), January.

Professor Roger Eggleton (Illinois State University), July.

Professor Heather Gavlas (Illinois State University), January.

Professor J W P Hirschfeld (University of Sussex), August–September.

Dr Michael Hoffmann (School of Mathematics and Computer Science, University of Leicester), August.

Professor Lily Khadjavi (Loyola Marymount University, Los Angeles), August.

Professor Rudolf Mathon (University of Toronto), January.

Professor C A Rodger (Auburn University), July, *Raybould Fellow*.

Professor Jennifer Seberry (University of Wollongong), February.

Associate Professor Deborah Street (University of Technology, Sydney), October.

Dr Ian Wanless (Oxford University), January.

Planned, 2004

Professor Jennifer Seberry (University of Wollongong), June.

Professor Roger Eggleton (Illinois State University), June.

Professor Dean Hoffman (Auburn University), July, *Raybould Fellow*.

Professor Walter Wallis (Southern Illinois University at Carbondale), July.

Dr Ian Wanless (Australian National University), July.

Professor Peter Cameron (Queen Mary London), July.

Professor Rosemary Bailey (Queen Mary London), July–September.

Professor C. Curtis Lindner (Auburn University), July–August.

Dr Bridget Webb (Open University, UK), August–September.

Professor David Pike (Memorial University, Newfoundland), October–December.

4. RESEARCH INTERESTS

Combinatorial Designs and Graph Theory.

Designs as graph decompositions. Trades in graphs. Graph decompositions and colourings. Metamorphosis of designs, including G -designs. Bipartite and tripartite designs; cycle systems, Hamilton/Waterloo problems.

Triple systems, especially Steiner triple systems. Intersection problems for designs. Blocking sets in designs.

Partitioning families of blocks into collections of disjoint designs, including collections of small planes.

Defining sets of designs and critical sets of Latin squares; trades and Latin interchanges. Defining sets and trades in other combinatorial structures.

Proportionally balanced designs, constructions and properties.

Finite Geometry.

Construction, characterisation and embedding problems associated with geometric structures in finite projective spaces. Links between areas such as polar spaces, finite group theory, structures in projective planes, partial geometries and designs. Construction of distance regular covers of complete graphs using sets in finite projective spaces. Relations between strong Steiner trades and projective planes; m -systems of polar spaces; hyperovals in projective planes.

Applications of discrete mathematics.

DNA sequencing using hybridization methods, Encoding/decoding methods for combinatorial chemistry, optimization of combinatorial chemistry techniques. Drug design. Bioinformatics.

Application of combinatorial designs to authentication schemes, to the construction of access schemes for computer security and to the construction of block ciphers. Classes of designs for the study of plant competition, of scheduling and allocation problems, and of problems in cognitive science.

Combinatorial Designs: relationships with universal algebras.

Relationships between quasigroups and certain types of neighbourhood designs; when the particular quasigroups involved actually form a variety. Minimal distances of group Latin squares. Universal algebra techniques applied to construct new designs. Small 2-perfect designs. Strongly 2-perfect cycle systems and associated quasigroups.

Infinite Combinatorics.

Combinatorial properties of infinite sets.

Algebra and Number Theory.

Ramsey varieties of finite groups, the topological group of p -adic integers, varieties of congruence lattices of groups. Homological algebra and ring theory. Cohomology rings of finite groups. Group representation theory. Formal methods for computing, symbolic computation. Homotopy theory. The Brauer Manin obstruction. The ABC conjecture. Arithmetic geometry. Rational points on varieties.

Combinatorial Computing and Algorithm Design.

Abstract algebraic algorithms. Perfect hashing. Fundamental algorithms for parallel and distributed systems. Finite fields and their applications. Computational combinatorics. Algorithm development for linear algebra. Computing canonical forms of matrices. Extended GCD algorithms.

5. CURRENT FUNDING

Adams

One of 14 Chief Investigators in the Australian Research Council, *Australian Centre for Complex Systems*, Director Professor Peter Lindsay, \$6 000 000, 2003–2006.

Bryant and Adams

With Mr Keith Mitchelson (Australian Genome Research Facility), *Commercial development of a novel DNA sequencing method*, \$250 000, Biotechnology Innovation Fund Grant, 2002–2003.

With Mr Keith Mitchelson (Australian Genome Research Facility), *Mutagenesis and combinatorial algorithms for sequencing problematic genomic regions*, \$450 000, Australian Research Council Discovery Grant, 2002–2006.

Donovan

With Associate Professor Thompson, Professor Burrage (Discipline of Mathematics) and Tarong Energy, *Modelling, simulation and risk analysis in Australian energy markets*, \$197 000, Australian Research Council SPIRT Grant, 2001–2003.

Gates

With Dr G R Hanson (Centre for Magnetic Resonance) and Professor K Burrage, *Development of an interactive computer simulation/visualisation software environment for the analysis of randomly oriented ESEEM and pulsed ENDOR spectra*, \$50 000, Patent Licensing, 1999–2003.

Havas, Bryant, Adams and Street

Emerging applications of advanced computational methods and discrete mathematics, \$290 000, Australian Research Council Discovery project (now rolled into ARC Centre for Complex Systems), 2002–2004.

Scharaschkin

Rational Points and the ABC Conjecture, \$29 000, University of Queensland Early Career Research Grant, 2003.

Street

With Professor J R Seberry (Centre for Computer Security Research, Department of Computer Science, University of Wollongong), *Timed-commitment schemes to smooth Internet bottlenecks, defend against denial of service attacks, and bypass some legal problems of encryption*, \$150 000, Australian Research Council Discovery Grant, 2003–2005.

6. INVITATIONS

The following staff associated with the Centre have given invited talks outside the department during 2003.

Adams

Invited conference talk, *Using graph theory to sequence problematic regions of genomes*, 28ACCMCC, Melbourne, December 2003.

Billington

Invited seminars, *5-cycle decompositions of tripartite graphs* and *Gregarious cycle decompositions*, Auburn University, Alabama, USA, March 2003.

Bryant

Invited seminar, *Cycle decompositions and factorisations*, Illinois State University, December 2003.

Gray

Invited speaker, *Proportionally balanced designs*, Open University Winter Combinatorics Meeting, January 2004.

Havas

Invited speaker, Computing, The Australasian Theory Symposium (CATS2003), Adelaide, Feb 2003.

Invited lecturer, Groups and Computation, The Ohio State University, Columbus, Ohio, USA, Mar 2003.

Invited lecturer, NETCA Instructional Workshop on Computational Algebra, Centre for Interdisciplinary Research in Computational Algebra, University of St Andrews, Scotland, Sep 2003.

Invited lecturer, Computational Group Theory Conference at CCNY, New York, Sep 2003.

Seminar speaker, University of Auckland Mathematics Department, Oct 2003.

Seminar speaker, University of St Andrews, Scotland, Nov 2003.

Invited lecturer, Università degli Studi di Trento, Italy, Nov 2003.

Khodkar

Two invited talks, *An investigation of 2-critical sets in Latin squares* and *On a generalization of the Oberwolfach problem*, Sharif University of Technology, Iran, July 2003.

Invited speaker, *An investigation of 2-critical sets in Latin squares*, Sultan Qaboos University, Oman, July 2003.

Maenhaut

Invited seminar, *Cube factorisations of complete graphs*, Illinois State University, December 2003.

Street

Invited speaker, *Proportionally balanced designs*, Department of Pure Mathematics, Open University, United Kingdom, June 2003.

Special speaker, *Defining sets in combinatorics: a survey*, Nineteenth British Combinatorial Conference, Bangor, Wales, June/July, 2003.

Invited speaker, *Proportionally balanced designs*, Conference on Recent Advances in Statistical Designs and Related Combinatorics (in honour of Stratis Kounias), University of Athens, July, 2003.

7. EDITORIAL WORK

In association with the Department of Mathematics, University of Auckland, the Centre publishes the *Australasian Journal of Combinatorics*, an international journal, for the Combinatorial Mathematics Society of Australasia (Incorporated). Billington is Editor-in-Chief, Dr C Paul Bonnington (Auckland) is Managing Editor and Adams is Financial Manager. Bryant, Donovan, Professor Peter Gibbons (Auckland), Havas, B Jones and S Williams are Associate Editors, and Street is one of two Honorary Editors. Of the 20 members of the Editorial Board, nine work within Australia and New Zealand, and the remaining 11 form an international network of combinatorialists in Canada, Germany, Greece, Sultanate of Oman, Slovakia, United Kingdom and United States of America. See also Section 9, under 'Edited journal'.

The Centre also publishes a Research Report Series, edited by Donovan.

Matthews maintains a World Wide Web site called The Number Theory Web. The site provides links to nearly 500 number theorists' home pages throughout the world, centres, book descriptions, surveys, recent theses, conference information and libraries with good holdings in the number theory field.

CMAT and CALC are exact arithmetic matrix and number theory packages developed by Matthews for use mainly in teaching. For more information see the WWW address <http://www.maths.uq.edu.au/~krm/> Hamilton maintains a web site on recent theses in geometry. See Section 9, under 'Web Sites'.

The following staff associated with the Centre have served in other editorial capacities during 2003.

Billington is an Associate Editor of the *Bulletin of the Australian Mathematical Society* and a member of the Editorial Boards of *Utilitas Mathematica* and *Journal of Combinatorial Mathematics and Combinatorial Computing*. She reviews for *Mathematical Reviews* and referees for *Journal of Combinatorial Designs*, *Ars Combinatoria*, *Discrete Mathematics*, *Bulletin of the Institute of Combinatorics and its Applications*, *Journal of Graph Theory* and *Journal of Algebraic Combinatorics*.

Donovan is a member of the Editorial Board of *Ars Combinatoria*. She referees for the *Bulletin* and the *Gazette* of the Australian Mathematical Society, and for *Discrete Mathematics*, *European Journal of Combinatorics*, *Journal of Combinatorial Mathematics and Combinatorial Computing* and *Utilitas Mathematica*.

Hamilton referees for *European Journal of Combinatorics*, *Designs, Codes and Cryptography*, *Utilitas Mathematica*, *Australasian Journal of Combinatorics* and the *Bulletin of the Australian Mathematical Society*.

B Jones is an Associate Editor of the *Bulletin of the Australian Mathematical Society*.

Khodkar referees for *Ars Combinatoria*, *Australasian Journal of Combinatorics*, *Discrete Mathematics* and *Utilitas Mathematica*.

Norton reviews for *Zentralblatt* and referees for *IEEE Transactions on Information Theory*, *Discrete Mathematics*, *Mathematica Applicandae*, *Applicable Algebra in Engineering, Computing and Communications*, *Journal of Symbolic Computation*.

Pleasants referees for *American Mathematical Monthly*, *Australasian Journal of Combinatorics*, *Bulletin of the Australian Mathematical Society* and *Theoretical Computer Science*. He is also reporting on a book for Springer-Verlag New York, who are considering it for publication.

Street is a member of the editorial boards of *Ars Combinatoria*, *Ars Textrina*, *Bulletin of the Institute of Combinatorics and its Applications* and *Scientia Iranica*. She also referees for *Discrete Mathematics*, *Journal of Combinatorial Mathematics and Combinatorial Computing* and *Utilitas Mathematica*.

S Williams reviews for *Zentralblatt* and *Mathematical Reviews*, and referees for the *Bulletin of the Australian Mathematical Society*.

8. COLLABORATION

The following staff members have collaborated in research with people outside the Centre for Discrete Mathematics and Computing during 2003. The list includes the names and affiliations of all collaborators. Inter-disciplinary collaboration is indicated by an asterisk.

Adams

Professor K Basford*, *School of Land and Food, The University of Queensland.*
 Professor Saad I El-Zanati, *Department of Mathematics, Illinois State University.*
 Dr A Galbraith*, *The Prince Charles Hospital.*
 Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University.*
 Professor C C Lindner, *Department of Discrete and Statistical Sciences, Auburn University.*
 Dr D C McGiffen*, *The Prince Charles Hospital.*
 Professor G J McLachlan, *Discipline of Mathematics, The University of Queensland.*
 Professor C A Rodger, *Department of Discrete and Statistical Sciences, Auburn University.*
 Professor C Vanden Eynden, *Illinois State University.*

Billington.

Professor Saad I El-Zanati, *Department of Mathematics, Illinois State University.*
 Professor Hung-Lin Fu, *National Chiao-Tung University, Hsin-Chu, Taiwan.*
 Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University.*
 Professor C C Lindner, *Department of Discrete and Statistical Sciences, Auburn University.*
 Professor E S Mahmoodian, *Department of Mathematical Sciences, Sharif University of Technology, Tehran, Iran.*
 Dr D A Pike, *Department of Mathematics, Memorial University, St Johns, Newfoundland.*
 Professor Gaetano Quattrocchi, *Department of Mathematics, University of Catania, Italy.*
 Professor C A Rodger, *Department of Discrete and Statistical Sciences, Auburn University.*

Bryant

Dr B J Battersby*, *Department of Chemistry, The University of Queensland.*
 Dr Duncan Cochrane, *Australian Genome Research Facility.*
 Professor Saad I El-Zanati, *Department of Mathematics, Illinois State University.*
 Professor Hung-Lin Fu, *National Chiao-Tung University, Hsin-Chu, Taiwan.*
 Dr Heather Gavlas, *Department of Mathematics, Illinois State University.*
 Professor Mike Grannell, *Department of Pure Mathematics, The Open University.*
 Professor Terry Griggs, *Department of Pure Mathematics, The Open University.*
 Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University.*
 Ms Gita Lala, *Australian Genome Research Facility.*
 Professor C C Lindner, *Department of Discrete and Statistical Sciences, Auburn University.*
 Dr Alan Ling, *Department of Mathematics, University of Vermont.*
 Dr Keith Mitchelson, *Australian Genome Research Facility.*
 Professor C A Rodger, *Department of Discrete and Statistical Sciences, Auburn University.*
 Dr M Smythe*, *Centre for Drug Design and Development, The University of Queensland.*
 Dr T Tran*, *Centre for Drug Design and Development, The University of Queensland.*
 Dr M Trau*, *Discipline of Chemistry, The University of Queensland.*
 Professor C Vanden Eynden, *Department of Mathematics, Illinois State University.*

Donovan

Dr Nicholas Cavenagh, *Charles University, Czech Republic.*
 Dr Joan Cooper*, *Department of Information and Communication Technology, University of Wollongong.*
 Dr E P Dawson*, *Information Security Research Centre, Queensland University of Technology.*
 Professor Aleš Drápal, *Charles University, Czech Republic.*
 Dr Rebecca A H Gower, *Numbercraft, Oxford.*
 Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University.*
 Professor Saad I El-Zanati, *Department of Mathematics, Illinois State University.*
 Professor E S Mahmoodian, *Department of Mathematical Sciences, Sharif University of Technology, Tehran, Iran.*
 Professor C E Praeger, *Department of Mathematics, University of Western Australia.*

Professor Jennifer Seberry*, *Department of Computer Science, University of Wollongong.*
 Dr Somporn Sutinuntopas, *Department of Mathematics, Ramkhamhaeng University, Bangkok, Thailand.*
 Professor John van Rees, *Department of Computer Science, The University of Manitoba.*
 Professor C Vanden Eynden, *Department of Mathematics, Illinois State University.*

Gamble

Professor R Mathon*, *Department of Computer Science, University of Toronto.*
 Professor C E Praeger, *Department of Mathematics, University of Western Australia.*
 Professor Jennifer Seberry*, *Department of Computer Science, University of Wollongong.*

Hamilton

Dr A Blockhuis, *Department of Mathematics, Technische Universiteit Eindhoven and Vrije Universiteit Amsterdam.*
 Prof K Burrage, *Advanced Computational Modelling Centre, The University of Queensland.*
 Dr S Cauchie, *Vakgroep Zuivere Wiskunde en Computeralgebra, Universiteit Gent.*
 Professor F De Clerck*, *Vakgroep Zuivere Wiskunde en Computeralgebra, Universiteit Gent.*
 Dr T Huber, *Computational Biology and Bioinformatics Environment, The University of Queensland.*
 Professor R Mathon*, *Department of Computer Science, University of Toronto.*
 Dr C M O'Keefe*, *Vakgroep Zuivere Wiskunde en Computeralgebra, Universiteit Gent.*
 Dr T Penttila, *Department of Mathematics, University of Western Australia.*
 Dr I Pinneri, *Dipartimento di Matematica, Universita degli Studi di Roma 'La Sapienza'.*
 Dr C Quinn, *Department of Pure Mathematics, University of Adelaide.*
 Prof M Ragan, *Institute for Molecular Biosciences, The University of Queensland.*
 Professor M J de Resmini, *Dipartimento di Matematica, Universita degli Studi di Roma 'La Sapienza'.*
 Dr S D Stoichev*, *Department of Computer Science, Technical University, Bulgaria.*
 Professor V D Tonchev, *Department of Mathematical Science, Michigan Technological University.*
 Dr H Wilbrink, *Department of Mathematics, Technische Universiteit Eindhoven.*

Havas

Professor J-Y Cai, *SUNY Buffalo.*
 Dr C M Campbell*, *St Andrews University.*
 Professor G Cooperman, *Northeastern University.*
 Professor Z J Czech, *Silesia University.*
 Dr X G Fang*, *Beijing University.*
 Dr S Feisel, *Paderborn University.*
 Professor J von zur Gathen, *Paderborn University.*
 Dr H W Gollan*, *Essen University.*
 Professor D G Hoffman*, *Auburn University.*
 Dr D F Holt*, *University of Warwick.*
 Assistant Professor Alexander Hulpke, *Department of Mathematics, Colorado State University.*
 Dr W Liang, *Australian National University.*
 Dr S A Linton, *St Andrews University.*
 Dr B Mans, *Macquarie University.*
 Dr A Nerurkar, *SUNY Buffalo.*
 Professor M F Newman*, *Australian National University.*
 Dr A C Niemeyer*, *University of Western Australia.*
 Dr E A O'Brien*, *University of Auckland.*
 Professor C E Praeger, *Department of Mathematics, University of Western Australia.*
 Dr S E Rees*, *University of Newcastle (UK).*
 Professor E F Robertson*, *St Andrews University.*
 Professor J-P Seifert, *Frankfurt University.*
 Professor X Shen, *University of Missouri.*
 Dr I Shparlinski, *Macquarie University.*
 Professor C C Sims*, *Rutgers University.*
 Dr L H Soicher*, *University of London.*
 Professor M R Vaughan-Lee*, *Oxford University.*
 Dr C Wagner, *Siegen University.*
 Professor J Wang*, *Beijing University.*
 Professor R A Wilson*, *Birmingham University.*

Khodkar

Professor E S Mahmoodian, *Department of Mathematical Sciences, Sharif University of Technology, Tehran, Iran.*

Dr M A Shahabi, *Department of Mathematics, University of Tabriz, Tabriz, Iran.*

Professor Saad I El-Zanati, *Department of Mathematics, Illinois State University.*

Professor C Vanden Eynden, *Department of Mathematics, Illinois State University.*

Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University.*

Professor Hung-Lin Fu, *National Chiao-Tung University, Hsin-Chu, Taiwan.*

Professors Chin-Mei Fu, *Department of Mathematics, Tamkang University, Taiwan.*

Dr S. Sutinuntopas, *Ramkhamhaeng University, Bangkok, Thailand.*

Professor John van Rees, *Department of Computer Science, The University of Manitoba.*

Maenhaut

Professor C Vanden Eynden, *Department of Mathematics, Illinois State University, USA.*

Professor Saad I El-Zanati, *Department of Mathematics, Illinois State University, USA.*

Professor M J Grannell, *Open University, Milton Keynes, United Kingdom.*

Professor T S Griggs, *Open University, Milton Keynes, United Kingdom.*

Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University, USA.*

Dr K A S Quinn, *Pure Mathematics Department, Open University, United Kingdom.*

Professor Jennifer Seberry, *Department of Computer Science, University of Wollongong.*

Professor R G Stanton, *Department of Computer Science, University of Manitoba, Canada.*

Dr I M Wanless, *Christ Church College, Oxford University, United Kingdom (now at ANU, Canberra).*

Dr B S Webb, *Pure Mathematics Department, Open University, United Kingdom.*

Matthews

Dr T H Jackson, *Department of Mathematics, University of York, United Kingdom.*

Norton

Professor T D Blackmore, *University of Loughborough, United Kingdom.*

Professor A Salagean, *University of Loughborough, United Kingdom.*

Pleasants

Dr H Ardal, *Department of Mathematics, Boğaziçi University, Istanbul.*

Professor M Baake, *Mathematics Institute, Greifswald University.*

Professor T C Brown, *Department of Mathematics, Simon Fraser University.*

Professor V Fournée*, *CNRS, Ecole des Mines, Nancy.*

Professor C J Jenks*, *Ames Laboratory, Iowa State University.*

Dr G Kasner*, *Theoretical Physics Institute, Magdeburg University.*

Dr J C Lagarias, *AT&T Laboratories, Florham Park.*

Professor J Ledieu*, *Surface Science Research Centre, University of Liverpool.*

Professor R McGrath*, *Surface Science Research Centre, University of Liverpool.*

Mr H Ray, *Department of Mathematics and Statistics, Curtin University of Technology.*

Dr J Simpson, *Department of Mathematics and Statistics, Curtin University of Technology.*

Dr Z Papadopolos*, *Theoretical Physics Institute, Tübingen University.*

Ramsay

Dr I T Roberts*, *Department of Mathematics, Northern Territory University.*

Scharaschkin

Dr Lily Khadjavi, *Loyola Marymount University, Los Angeles.*

Dr Wayne Raskind, *University of Southern California.*

Sharry

Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University.*

Professor C C Lindner, *Department of Discrete and Statistical Sciences, Auburn University.*

Street.

Professor Chin-Mei Fu, *Tamkang University, Tamsui, Taipei Shien, Taiwan.*

Professor Hung-Lin Fu, *National Chiao-Tung University, Hsin-Chu, Taiwan.*

Professor D G Hoffman, *Department of Discrete and Statistical Sciences, Auburn University.*

Professor C C Lindner, *Department of Discrete and Statistical Sciences, Auburn University.*

Professor E S Mahmoodian, *Department of Mathematical Sciences, Sharif University of Technology, Tehran, Iran.*

Professor R Mathon*, *Department of Computer Science, University of Toronto.*

Professor Jennifer Seberry*, *Department of Computer Science, University of Wollongong.*

Professor R G Stanton*, *Department of Computer Science, The University of Manitoba.*

Associate Professor Deborah J Street, *Department of Mathematical Sciences, University of Technology, Sydney.*

9. HONOURS AND AWARDS

The Institute of Combinatorics and its Applications, an international body, was set up in 1990, based in Canada, with Professor W T Tutte as president and Professor R G Stanton as Registrar. Street is one of the two Australians invited to become Founding Fellows of the ICA and served as its President from 1996–2002; Billington, Donovan and S Williams are Foundation Fellows; Adams, Bryant, K Gray, Hamilton and Sharry are Fellows; Maenhaut, Moran and Nester are Associate Fellows; B Jones is a Member. Billington was on the ICA Council until 2001.

The ICA awards Kirkman Medals, recognising outstanding achievement by combinatorialists in the early stages of their careers; Adams, Bryant and Hamilton are Kirkman Medallists.

Bryant holds a QEII Fellowship, 2002–2006.

10. THE CENTRE AND THE WIDER COMMUNITY

Staff associated with this Centre have been involved in the following outreach programs.

National and International Activities.

Australian Mathematics Competition Problems Committee: S Williams served as a member of this committee, which develops questions to challenge and extend young mathematicians.

QAMT (Queensland Association of Mathematics Teachers) Problem Solving Competition: This is an annual competition with over 3000 students participating each year. Donovan is involved with setting it.

University and Cross-Faculty Activities.

Enhanced Studies Program: Donovan (2003) co-ordinates the delivery of MATH1061 to Enhanced Studies Students. MATH1061 is an introductory discrete mathematics course which exposes Year 12 students to both the theory and application of discrete mathematics.

EXPO Uni: Centre members have developed and staffed numerous exhibits which stress the importance of discrete mathematics; for example, displays on secret key distribution schemes and error detection techniques for barcodes.

Biological and Chemical Sciences Faculty Science Days: This recent initiative is part of the Bright Minds program. In October 2003, Year 12 students attended special sessions on campus. Donovan was the co-ordinator of the mathematics sessions, which were delivered by two talented mathematics graduate students. It is planned to run such sessions four times per year.

Engineering, Physical Science and Architecture Faculty Activities.

EPSA School Liaison Program: A number of Centre staff and students have delivered talks on applications of discrete mathematics and on career prospects to high school students.

Brainwaves Festival (National Science Week): Donovan has been responsible for organising interactive displays which have attracted much interest. Adams has delivered well-received talks to large audiences. Once again these activities are based around applications of discrete mathematics.

School of Physical Sciences Activities.

Infinity: This is a biennial newsletter which is edited by Donovan, with two members of this department, namely, Cathy Holmes and Helen Grey. Mailed to every high school in Queensland, it provides a link between the University and the broader community and has had great success in developing strong ongoing communications between interested individuals and University staff.

Club Infinity: Currently this club has around 400 members. It provides a means for the University to communicate directly with mathematically-minded community members, including school students. It is also an excellent vehicle for advertising University events. Club members receive a welcome pack, copies of *Infinity*, and individual invitations to club events, such as public lectures. See the website <http://www.maths.uq.edu.au/~infinity/>

11. PUBLICATIONS AND WEB SITES

The names of authors, associated with the Centre while the work was carried out, appear in upper case.

Refereed papers in journals and chapters in books, 2003.

- Peter ADAMS, Richard BEAN and A KHODKAR, *A census of critical sets in the Latin squares of order at most six*, *Ars Combinatoria* **68**, 203–223.
- Peter ADAMS, Elizabeth J BILLINGTON and E S Mahmoodian, *The simultaneous metamorphosis of small-wheel systems*, *Journal of Combinatorial Mathematics and Combinatorial Computing* **44**, 209–223.
- Peter ADAMS, Roger Eggleton, James MacDougall and E S Mahmoodian, *Corrections to Steinbach's posets of graphs (orders 5, 6, 7)*, *Bulletin of the Institute of Combinatorics and its Applications* **27**, 29–34.
- Peter ADAMS, Darryn E BRYANT, C Vanden Eynden, Barbara MAENHAUT and Saad El-Zanati, *Least common multiples of cubes*, *Bulletin of the Institute of Combinatorics and its Applications* **38**, 45–49.
- Peter ADAMS, Darryn E BRYANT, Heather Gavlas and Saad El-Zanati, *Factorisations of the complete graph into C_5 -factors and 1-factors*, *Graphs and Combinatorics* **19**, 289–296.
- Elizabeth J BILLINGTON, *Combinatorial trades: a survey of recent results*, Chapter 3 in *Designs 2002: Further Computational and Constructive Design Theory* (ed W.D. Wallis), Kluwer Academic Press, Massachusetts, USA pp. 47–67.
- Elizabeth J BILLINGTON and Karen A Dancer, *The metamorphosis of designs with block size four: a survey and the final case*, *Congressus Numerantium* **164**, 129–151.
- Elizabeth J BILLINGTON and D G Hoffman, *Decomposition of complete tripartite graphs into gregarious 4-cycles*, *Discrete Mathematics* **261**, 87–111.
- Andrew BLINCO, *Decompositions of complete graphs into theta graphs with fewer than ten edges*, *Utilitas Mathematica* **64**, 197–212.
- Darryn E BRYANT, Heather Gavlas and Alan Chi Hung Ling, *Skolem-type difference sets for cycle systems*, *Electronic Journal of Combinatorics* **10**, 12pp.
- Darryn E BRYANT, Mike Grannell, Terry Griggs and Barbara MAENHAUT, *On the volume of 4-cycle trades*, *Graphs and Combinatorics* **19**, 53–63.
- Darryn E BRYANT, Mike Grannell and Terry Griggs, *Large sets of large sets of Steiner triple systems of order 9*, *Utilitas Mathematica* **64**, 115–118.
- Darryn E BRYANT and Barbara MAENHAUT, *Common multiples of complete graphs*, *Proceedings of the London Mathematical Society* **86**, 302–326.
- Colin Campbell, George HAVAS, Alexander Hulpke and Edmund F Robertson, *Efficient simple groups*, *Communications in Algebra* **31** (10), 5191–5197.
- Nicholas CAVENAGH, *Decompositions of complete tripartite graphs into triangles with an edge attached*, *Utilitas Mathematica* **63**, 197–211.
- Nicholas CAVENAGH, *Latin trade algorithms and the smallest critical set in a Latin square*, *Journal of Automata, Languages and Combinatorics* **8**(4), 567–578.
- Nicholas J CAVENAGH and A KHODKAR, *Balanced critical sets in Latin squares*, *Utilitas Mathematica* **64**, 229–249.
- Diane DONOVAN and A KHODKAR, *Product constructions for critical sets in latin squares*, *Journal of Combinatorial Mathematics and Combinatorial Computing* **46**, 227–254.
- Diane DONOVAN, Abdollah KHODKAR and Anne Penfold STREET, *Doubling and tripling constructions for defining sets in Steiner triple systems*, *Graphs and Combinatorics* **19**, 65–89.
- Diane DONOVAN, Abdollah KHODKAR and Anne Penfold STREET, *On minimal defining sets in $AG(d, 3)$* , in *Designs 2002: Further Computational and Constructive Design Theory* (ed W D Wallis), 103–131, Chapter 6, Kluwer Academic Press, Massachusetts, USA.
- Diane DONOVAN, Ebadollah S Mahmoodian, Colin RAMSAY and Anne Penfold STREET, *Defining sets in combinatorics: a survey*, In *Surveys in Combinatorics 2003* (ed C D Wensley), London Mathematical Society Lecture Note Series 307, Cambridge University Press, 115–174.
- Mike Grannell, Terry Griggs, Barbara MAENHAUT, Kathleen Quinn and Ralph Stanton, *More on exact bicoverings of 12 points*, *Ars Combinatoria* **69**, 197–213.
- Brenton D Gray, Rudolf Mathon, Tony Moran and Anne Penfold STREET, *the spectrum of minimal defining sets of some Steiner systems*, *Discrete Mathematics* (Special issue in honour of Alex Rosa) **261**, 277–284.

- Ken GRAY and Anne Penfold STREET, *Constructing a class of proportionally balanced designs*, in Designs 2002: Further Computational and Constructive Design Theory (ed W D Wallis), 207–225, Chapter 8, Kluwer Academic Press, Massachusetts, USA.
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- J C Lagarias and Peter PLEASANTS, *Repetitive Delone sets and quasicrystals*, Ergodic Theory and Dynamical Systems **23**, 831–867.
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- Peter ADAMS, Darryn E BRYANT, Stephen Long, Mark Smythe and Tran Trung Tran, *Virtual drug discovery using graph theory*, Bulletin of the Institute of Combinatorics and its Applications **40**, 100–106.
- Peter ADAMS, Darryn E BRYANT and Barbara MAENHAUT, *Common multiples of complete graphs and a 4-cycle*, Discrete Mathematics **275**, 289–297.
- Peter ADAMS, Darryn E BRYANT and Barbara MAENHAUT, *Cube factorisations of complete graphs*, Journal of Combinatorial Designs (to appear).
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- Richard BEAN and Diane Donovan, *Closing a gap in the spectrum of critical sets*, Australasian Journal of Combinatorics.
- Elizabeth J BILLINGTON, *The extended metamorphosis of a complete bipartite design into a cycle system*, Discrete Mathematics (Special issue in honour of Curt Lindner) **284**, 63–70.
- Elizabeth J BILLINGTON, C C Lindner and A Rosa, *Lambda-fold complete graph decompositions into perfect four-triangle configurations*, Australasian Journal of Combinatorics (to appear).
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- Darryn E BRYANT and Chris Rodger, *On the completion of latin rectangles to symmetric latin squares*, Journal of the Australian Mathematical Society **76**, 109–124.
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- Jonathan M KEITH, Duncan A E Cochran, Gita H Lala, Peter ADAMS, Darryn BRYANT and Keith R Mitchelson, *Unlocking hidden genomic sequence*, Nucleic Acids Research **32**, e35, 9pp.
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- A KHODKAR and W de Launey, *On the range of influences in back-circulant latin squares*, Discrete Mathematics (to appear).
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- Rudolf Mathon, Anne Penfold STREET and Greg GAMBLE, *Classification of partitions of the set of all triples on ten points into copies of Fano and affine planes*, Discrete Mathematics (Special issue in honour of Jennifer Seberry) (to appear).
- Colin RAMSAY, *The IQ-Block: an interesting polyomino puzzle*, Journal of Recreational Mathematics.
- Mary WATERHOUSE, *Some 2-coloured 4-cycle decompositions*, Journal of Combinatorial Mathematics and Combinatorial Computing (to appear).
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