

RESEARCH
REPORT
1994

Front cover

'Wet-look' total magnetic intensity map part of the Mudgee (NSW) 1:100,000 topographic sheet (330 to 320 30'S, 1490 50' to 1500 E; 45 km x 55 km). This state-of-the-art imagery, along with radiometrics (imagery incorporating the radioactive elements), greatly facilitates geological mapping because of differing magnetic properties of various rock types. This image is in 'false colour', although colour is directly related to total magnetic intensity. The 'wet look' is produced by an algorithm which provides an 'artificial sun angle', highlighting linear features.

Among zones recognisable in the image are closely spaced, tightly contorted structures in the basement strata of the Hill End Trough (greenish, lower left) and Sydney Basin rocks (yellowish, upper right). Mudgee is just NW of the white patch (top left).

Members of the Earth Environments and Resources group in the Department of Geology are working closely with the New South Wales Geological Survey and the Australian Geological Survey Organisation to remap the Dubbo 1:250,000 geological sheet under the National Geoscience Mapping Accord.

Original data were obtained by AGSO along flight lines approximately 80 metres above ground surface and 400 metres apart; image supplied by NSW Geological Survey. Scale of image 1:250,000.

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UNIVERSITY OF WOLLONGONG

RESEARCH REPORT 1994

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INTRODUCING its Research Management Plan (RMP) in 1989, the University of Wollongong took into account the interdisciplinary nature of many research challenges in the 1990s, signalling its belief that commitment to a concentration of research effort would enable the University to become established as a genuinely international research university. The quality of research undertaken in 1994 demonstrates and substantiates the maturation of initiatives set out in the RMP, also setting the framework for the continued development of this research activity.



Of significance during the year was the establishment of three Research Institutes which draw together research activities with a common theme. Their activities are described in this Report.

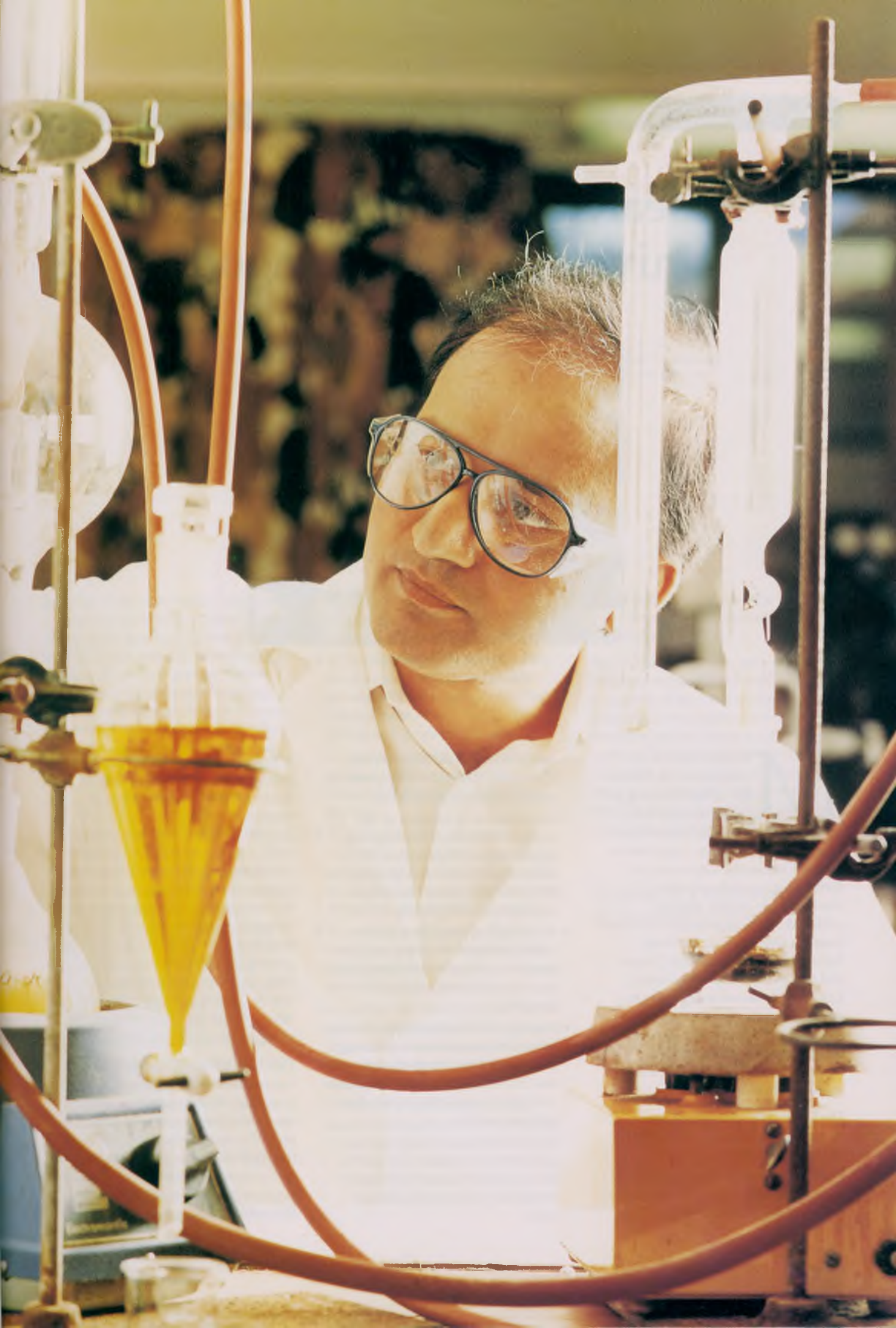
The role of developing research activity through the implementation of the Research Management Plan was given to Professor Bill Lovegrove, appointed Pro Vice-Chancellor (Research) full-time in 1994. By any measure, in all aspects of research activity, that was a highly successful year. Government and industry funds continued to increase including the award of four ARC

Collaborative Grants from five applications, a 50 per cent success rate for APA(I) scholarships, an increase in the number and amount of initial ARC Large Grants and a 60 per cent increase in other grant funds.

Another initiative in 1994 to enhance the research effort through better communication was the introduction of Faculty Research Committees. They were introduced to develop and implement research at a Faculty level and play a major role in encouraging Faculty members to apply for a range of appropriate research grants.

This Report provides an overview of exciting research undertaken at the University of Wollongong in 1994. A series of papers indicating the breadth of research activity within each Research Institute, Program, Group and Development Group and by Individual Researchers is backed up by details of published work by researchers in all categories.

Gerard Sutton
Vice-Chancellor and Principal



Research Management at the University of Wollongong



Professor Lovegrove

MANAGEMENT of research at the University of Wollongong is based on supporting and developing research excellence. A major aim is to foster cooperative research across the University by correlating research activities to produce high-quality results, achieved by the aggregation of related research into *Research Institutes*, *Research Programs*, *Research Groups* and *Research Development Groups*. Enhanced cohesion is expected to utilise research resources more efficiently and provide the impetus for attracting increased external funding. The activities in 1994 are presented in this Report.

The University of Wollongong's Research Management Plan (RMP) has five elements:

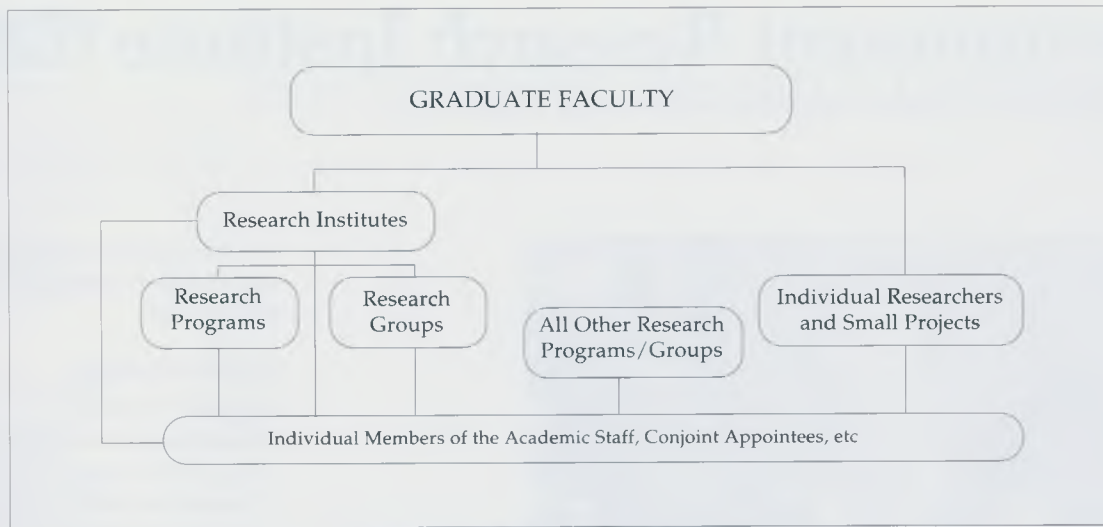
- the principles for the allocation of all intramural resources for research (including grants, scholarships,

equipment and facilities) by the University Research Committee for work that is of high quality;

- the devotion of the bulk of the available resources to sustaining research groupings with well-defined goals, and coordinating the efforts of individual researchers into appropriate groups;
- the grouping of appropriately related *Research Programs* and/or *Research Groups/Development Groups* into broad thematic *Research Institutes*;
- the support of individuals who seek to conduct research or scholarship independently if, in the opinion of the University Research Committee, it is quality work that is best done independently;
- the establishment of appropriate procedures to enable new staff to develop their research efficiently within the framework outlined here.

A *Research Program* represents the grouping into a unit of at least six academic staff who are active researchers working in related areas. In groupings where there are insufficient staff to form a *Research Program* or where there is insufficient research experience within the group to meet the criteria for the establishment of a *Research Program*, a *Research Group* may be formed with the intention of gaining *Research Program* status later. *Research Programs* and *Research Groups* working in broadly related areas may be further aggregated to form *Research Institutes*.

This 1994 Research Report contains information on three *Research Institutes*, 19 *Research Programs*, 16 *Research Groups* and seven *Development Groups*. It is acknowledged in the RMP that there may be individual researchers for whom it is not appropriate to join a *Research Centre* or *Research Group* because the work



Research units at the University of Wollongong

being undertaken is unique and not related to the activities of other staff. Notwithstanding the fact that the RMP is geared towards the bringing together of research activity, provision is made for individual researchers to apply for *Research Project* funds or for *Small Grant* support. Individual researchers may also be members of Research Institutes. The 1994 outputs of such staff are also listed in this Research Report.

The objectives of the RMP may be summarised as being:

- to develop and exploit fully the research capacity of the University;
- to signal clearly the research strengths of the University by the aggregation of existing compatible strengths/projects within the University into coherent Research Programs and Research Groups, and where appropriate, by incorporating related Research Programs and Research Groups into Research Institutes;
- to facilitate interdisciplinary research, where it is appropriate, so

that Research Programs with a concerted interdisciplinary approach are developed;

- to facilitate whenever possible the work of new (less experienced) members of the academic staff by linking them with Research Programs and Research Groups;
- to encourage the development of postgraduate training related to the Research Programs and Research Groups;
- to allow for the maintenance of individual researchers of quality within the University whose work is not related to any of the Research Programs and Research Groups;
- to provide a sufficiently flexible structure to permit adaptation to changes in the University, external priorities and initiatives;
- to add to the capacity of the University to support research by generating strong external support for the Research Programs and Research Groups;
- to review progressively the Research Management Plan ensuring

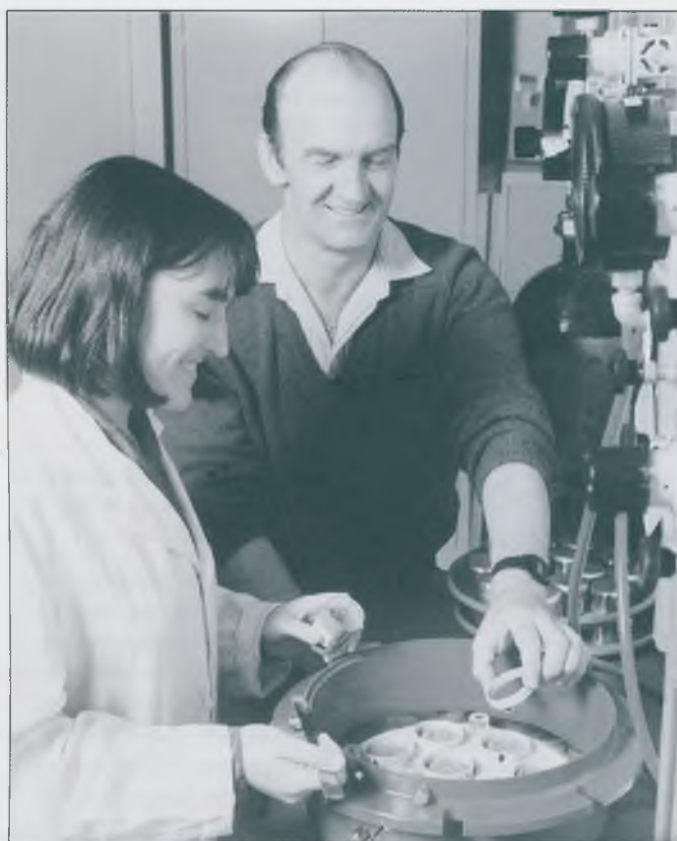
that policies maximise the quality of the research performance of the University.

The original RMP was drawn up in 1988 and implemented from the beginning of the 1989 academic year. It has been continually reviewed since that time and has been modified and updated to meet new demands and initiatives as they occur. I hope you enjoy examining the 1994 outcomes which best demonstrate our management plan in action.

Professor W J Lovegrove
Pro Vice-Chancellor (Research)

Environment Research Institute (ERI)

Co-ordinator: Professor John Morrison (tel 042 21 4377)



Professor John Morrison demonstrates the use of pressure-plate apparatus for soil moisture studies to PhD student Eleanor Hannah

activities, and by presenting a clear and unified picture of these activities to the outside world.

Institute Aims

The Institute aims to:

1. Contribute to the knowledge base and body of trained personnel required to facilitate better management of the environment through the performance of high quality research and teaching in environmental issues;
2. Contribute to the general awareness and understanding of the environment by carrying out appropriate consultancy activities and disseminating results obtained from local and international studies;
3. Increase the capacity of University staff and students to contribute to the long-term sustainable management of the environment.

Institute Strategy

The central strategy of the Institute is to build on and expand the core environmental research activities of the constituent programs and groups and the teaching activities of associated departments.

The *core environmental research activities* include fundamental and applied research on scientific, engineering, health, legal, social and economic issues relating to a better understanding and management of the environment. In addition, the Institute contributes to the *environmental consultancy work* of the University by co-ordinating the establishment of consultancy teams to undertake multidisciplinary projects using the expertise from among the membership, and assisting members in the negotiation and management of consultancy contracts. The Institute also facilitates environmental debate

THE ENVIRONMENT Research Institute (ERI) at the University of Wollongong was established in 1993 to play a vital role in co-ordinating environmental research and consultancy work at the University, and thus make an important contribution to the growing body of expertise and knowledge in this area in Australia.

For over 10 years the University of Wollongong has been carrying out teaching, research and consultancy activities with an emphasis on understanding and management of the world around us and has gained a reputation for innovative teaching

and quality research on environmental issues. The ERI was established to enhance this activity and also to extend the very successful policy of encouraging researchers to work collaboratively to facilitate greater efficiency in the use of resources.

Mission Statement

The mission of the Environment Research Institute is to contribute to the advancement of the academic performance and reputation of the University of Wollongong by enhancing the research, teaching and consultancy work on environmental issues at the University, by encouraging maximum coherence and collaboration in the environmental

and acts as information clearing house by organising regular meetings and seminars, producing a newsletter and acting as a distribution point for information received from government departments, international agencies, etc.

Institute Operation

The Institute encompasses or has close working relationships with the following established University research groupings:

Australian Flora and Fauna Research Program

Bulk Materials Handling and Physical Processing Research Program
Centre for Maritime Policy

Centre for Natural Resources Law and Policy

Environmental Chemistry Research Group
Environmental Health Research Unit

Quaternary Environmental Change Research Program

Tasmanides and Fossil Fuels Research Groups

Technology and Environmental Strategies Research Group

Water Engineering and Geomechanics Research Program

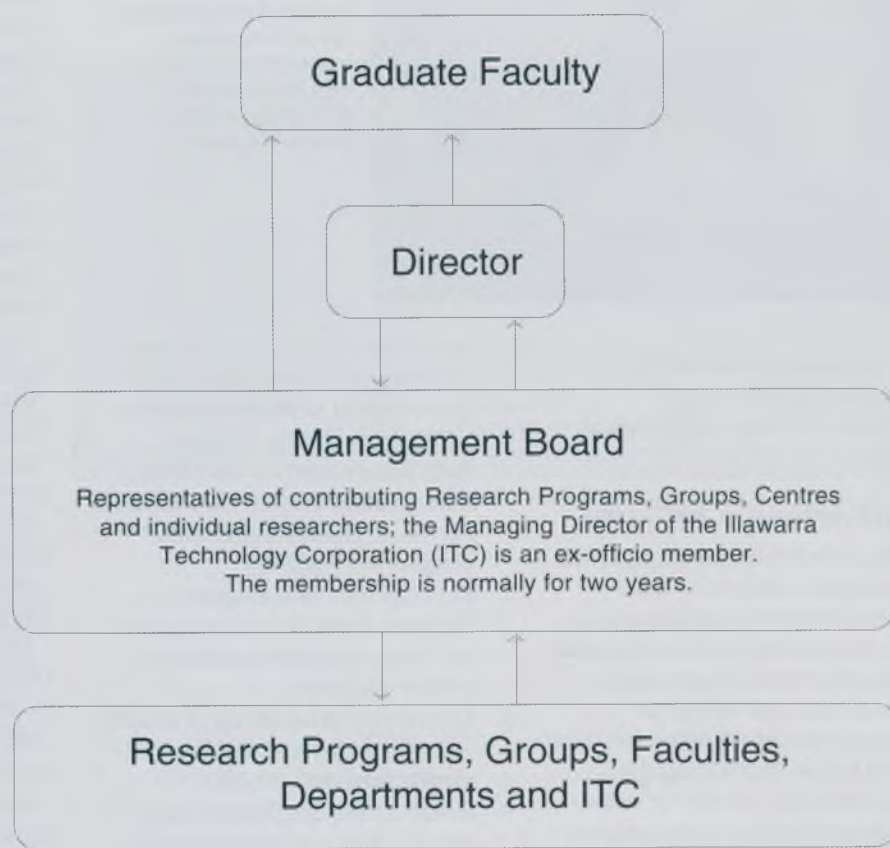
Staff members in Economics, Geography, Mathematics, Philosophy, Physics and Sociology.

A flow chart outlining the ERI structure and place in the University research organisation is given above.

Resources

The Institute has 75 academic staff members, together with postdoctoral fellows and a large number of post-graduate students. In addition, technical and administrative staff

Environment Research Institute



from various sections of the University assist with the work program. The research facilities include a wide range of high performance scientific and engineering equipment housed in various departments within the University, including an interview facility which enables ten interviews to be carried out simultaneously by telephone.

Management Board

The activities of the Institute are directed by a Management Board which has representatives from the major contributing research programs. The Management Board in 1993-4 was:

John Morrison, BHP Professor of Environmental Science (Director)
Dennis Calvert, Professor of Medicine and Public Health
Robin Chowdhury, Associate Professor of Civil Engineering
Jim Falk, Professor of Science and Technology Studies
Martin Tsamenyi, Professor of Law
Brian Ferry, Senior Lecturer in Education
Ann Hodgkinson, Lecturer in Economics
Brian Jones, Associate Professor of Geology
Jim Langridge, Managing Director, Illawarra Technology Corporation
Phillip Laird, Associate Professor of Mathematics



Ian van Tets introduces one of the pygmy possums to its temporary home before relocating it to the Barren Grounds

Arnold McLean, Senior Lecturer in Mechanical Engineering
Rob Whelan, Professor of Biological Sciences.

Institute Activities 1993-1994

As outlined above, the Institute builds on the research activities of the constituent programs and groups. As a result, many of the Institute research activities are carried out through these groupings, and details of program and group activities are presented below. In addition the Institute initiated a number of activities looking at issues of local, national and international importance. These included:

1. Assessment of the new (1995) Australian Drinking Water Guidelines (a research contract for the National Health and Medical Research Council – \$76,800)
2. National Review of Greenhouse Information and Action Programs (for Department of the Environment, Sports and Territories – \$34,800)
3. Contribution to the preparation of a rehabilitation strategy for the mined out areas on Nauru (for the Australian International Development Assistance Bureau – \$5,500)
4. Sedimentation studies associated with petroleum surveys in Vietnam (for BHP Petroleum).
5. Assessment of community preferences for St Georges Basin/Jervis Bay Regional Effluent Manage-

- ment Scheme (for Public Works Department (NSW) – \$39, 660)
6. Contribution to the development of the South Pacific Regional Pollution Prevention and Waste Management Project (for the South Pacific Regional Environment Programme – \$5,900)
7. Development of management plans for NSW coastal lakes (for the Public Works Department (NSW) – \$12,600)
8. Environmental auditing of landfill operations (for Kolback Environmental Services – \$5,400)
9. Health effects of climate change – climate change and pollen allergens (for the Federal Department of Human Services and Health – \$23,100)
10. Health effects of climate change – development of baseline geographical data on vector-borne disease (for the Federal Department of Human Services and Health – \$24,700)
11. Sustainable transport with Illawarra applications (for Healthy Cities Illawarra - \$3,000)
11. Strengthening of environmental courses at the University of Hanoi (for AIDAB/EPA – \$46,920)
12. Assessment of community preferences for water treatment options and siting in the Illawarra (for Sydney Water Board – \$63, 000).

Seminar Series

The Institute arranged a series of seminars during 1993-4 to facilitate

interdisciplinary discussion of environmental issues. A number of these were organised in collaboration with appropriate departments.

Speakers included:

- Emeritus Professor Cliff Ollier, University of New England
- Professor Joy Zedler, San Diego State University
- Professor Jerry Ongerth, University of Washington, Seattle
- Professor Roger Kitching, Griffith University
- Professor Harry Recher, University of New England
- Professor Howard Worner, Illawarra Technology Corporation
- Mr Ian Carruthers, Marine and Climate Section, DEST
- Dr Ron Groenhout, Economic Management Section, NSW EPA
- Dr Malcolm Mac Garvin, University of Aberdeen
- Mr David Buckingham, Executive Director, DEST
- Dr Judy Messer, National Centre for Appropriate Technology
- Dr Jim Elkins, NOAA, Boulder
- Dr Paolo Ricci, University of California, Berkeley
- Dr John Finnegan, Leader, Coastal Zone Project, CSIRO, Canberra
- Mr Jim Swain, Ciba-Geigy Australia
- Dr Peter Reid, Ansto
- Mr Avis Deepers, University of Wollongong

Strong industry links already exist between ERI members and organisations in the Illawarra/Sydney area and the Institute is keen to expand such co-operation. There is also extensive collaboration with organisations like CSIRO, Ansto, NSW state and local authority bodies, and other universities, both in Australia and overseas. Details are given in the sections below.

Institute members have been and will continue to be widely involved in community environmental activities through membership of local environmental authorities, catchment management committees, natural history groups, and interaction with local council activities.

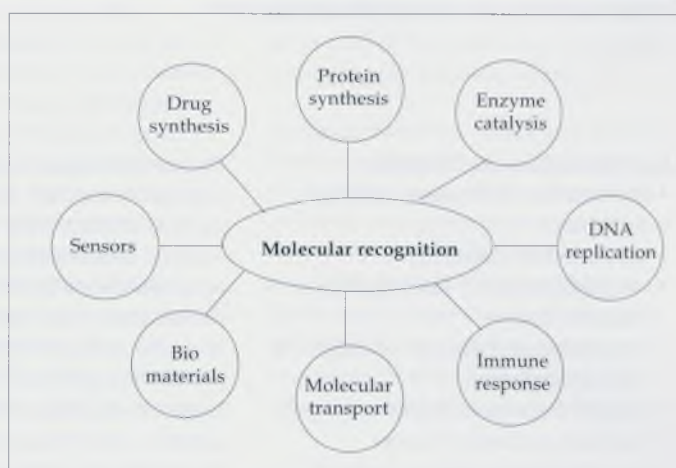
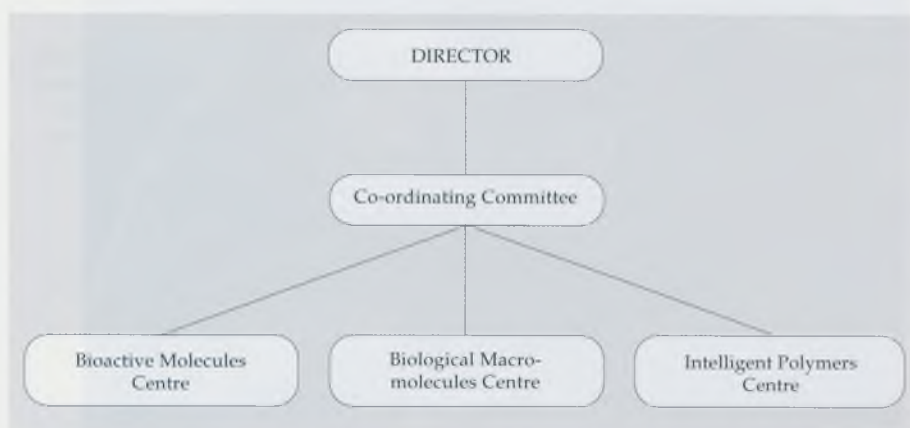
Institute for Molecular Recognition

Co-ordinator: Professor Leon Kane-Maguire (tel 042 21 3509)

THE INSTITUTE for Molecular Recognition (IMR) was officially launched at the University of Wollongong on 30 June 1994 by Professor Michael Pitman, the Chief Scientist to the Prime Minister. It brings together researchers with expertise across chemistry, molecular biology and materials engineering, giving it the capacity to focus on the full spectrum of molecular interactions from small to large macromolecules and their applications in industry and medicine.

The ability of small and large (macro) molecules to recognise and interact with one another lies at the heart of all chemical and biological activity, and has major implications in science and medicine. For example, recognition plays a crucial role in vital processes such as protein synthesis, enzyme catalysis, DNA replication, the immune response, molecular transport and drug action. A striking feature of many of these processes is the very high selectivity between the 'host' and 'guest' molecules. Molecular recognition, in turn, is a key element in research areas such as drug design and synthesis, disease prevention, biomaterials and analytical sensors.

A major challenge in science is therefore determining the factors which control molecular recognition and the exploitation of this knowledge for chemical and biomedical applications.



Institute Objectives

The major aims of the Institute are to:

- nurture multi-disciplinary research in the field of molecular recognition and interaction
- develop focused goals for fundamental research aimed at understanding the basis of these interactions, and their application to industry and medicine
- provide unique postgraduate training bridging the areas of Chemistry, Molecular Biology and Materials Science
- foster strong linkages with industry and government organisations, both in Australia and overseas

- increase awareness in this area through seminar programs and workshops.

Research Areas and Strategy

The research interests of the Institute are concentrated in four major areas, namely:

Macromolecular Structure and Function

- Eye Lens Crystallin Proteins
- Monoclonal Antibodies and Nucleic Acids
- Plant Proteins



Testing the behaviour of an intelligent polymer

Macromolecules and Disease

- Mechanism of Human Cataract Formation
- Vaccine Development
- Amplification for Enzyme-based Immunoassays
- Molecular and Genetic Analysis of Microorganisms
- Role of Receptors in Plasminogen Activation during Cancer
- Free Radicals and Damage to Host Tissue

Drug Synthesis and Ligand-Receptor Interactions

- Synthesis of Bioactive Heterocycles
- Bioactive Natural Products
- Asymmetric Synthesis of Bioactive Molecules
- DNA – Interactive Agents
- Molecular Design of Receptor-specific Pharmaceuticals

Intelligent Polymers

- Intelligent Biomaterials
- Biosensors
- Controlled Drug Release
- Separation Technologies
- Polymer Processing and Mechanical Properties.

The core strategy of the Institute is to enhance the scope and impact of these current strengths by fostering increased collaborative interaction between the various researchers, with the ultimate goal of developing teams with the capacity to address major problems requiring a broad range of research expertise. This should also assist in achieving increased sponsorship through strategic alliances with pharmaceutical, biomedical and biotechnology industries.

The Institute, through the development of these multi-skilled teams, may also provide an effective vehicle for the delivery of innovative multi-disciplinary postgraduate coursework degrees in areas such as molecular engineering.

Institute Resources

The Institute links and integrates the complementary research activities of three existing Research Centres at the University of Wollongong:

- Bioactive Molecules
- Biological Macromolecules
- Intelligent Polymers.



Separating drug precursors by chromatography

Overall, it constitutes an active grouping of over 100 research personnel, including 20 academic staff, 12 post-doctoral Fellows and 50 post-graduate students, providing a bridge between the disciplines of Chemistry, Biology and Material Science.

The Institute is very well equipped for its research role, possessing a wide range of state-of-the-art spectroscopic tools for chemical and biochemical characterisation, including high field NMR (300, 400 and 600 MHz), mass spectrometry (electrospray, FAB, CI and high resolution), FTIR spectroscopy, and circular dichroism. It also possesses excellent protein purification (FPLC) and nucleic acid synthesis facilities, monoclonal antibody and recombinant DNA facilities, tissue culturing and biohazard laboratories, an auto-sampling flow cytometer and advanced computer-aided molecular modelling capabilities, as well as materials testing facilities.

Institute Activities in 1994

Several meetings of all members were held during 1994 to discuss plans and special issues, but the activities were in general directed by the Co-ordinating Committee as outlined in the management structure. The Management Committee is composed

of the Director (Professor L Kane-Maguire), the Co-ordinator of each constituent Centre, the Heads of the Departments of Biological Sciences and Chemistry (or their nominee), and the Dean of Science.

The research activities of the Institute were largely carried out through the three constituent Research Centres identified above. Details of the specific research programs and the publications arising from them are summarised elsewhere under the individual Research Centre Reports. Overall, members of the Institute for Molecular Recognition published some 90 papers in international journals in 1994 and were successful in attracting \$2.75 M in external research funds, including \$1,070,000 from the ARC and \$238,000 from the NHMRC. Our strong commitment to industrially relevant research is shown by Institute members holding eight APRA (Industry) and two Large Collaborative ARC Grants, as well as receiving very substantial direct research funding (*ca.* \$0.5 M) from industry in 1994.

A successful Institute Seminar Series was inaugurated in the second half of 1994, with visits and seminars by leading researchers in the area of molecular recognition, including:

Professor Milton Hearn, Director of the Centre for Process Technology, Monash University,

Associate Professor Robert Vagg, Macquarie University,

Dr Joe Maeji, Head of Chemical Sciences, Chiron Mimotopes Ltd, Melbourne.

The Institute also co-sponsored the Cell and Molecular Evening Seminar Series in the Department of Biological Sciences as well as some Seminars in Chemistry.

Two well-attended Workshops were also held during the above visits on areas of general interest to Institute members, namely 'Proteins at Interfaces' (led by Professor M Hearn) and 'Chirality in Chemistry and Biology' (led by Associate Professor R Vagg).

Characterising proteins using electrospray spectrometry



As part of its strategy of nurturing cross-disciplinary research, the Institute provided seed-funding to allow the initiation of several promising projects involving collaboration between molecular biologists and protein chemists. A major proposal was also developed through the Institute, together with members of the recently formed Metabolic Research Centre, for an ARC Key Centre for Teaching and Research for Medicinal Biochemistry. This was ranked in the top 18 of 96 applications submitted Australia-wide. Although

not finally successful, the developments outlined in the proposal will form part of the Institute's on-going research and teaching strategies.

Institute members continued during 1994 to further develop their already strong links and collaboration with industry and government organisations such as ANSTO. The Institute provided limited travel support to assist these important activities, and will significantly increase such programs in 1995 with the aim of enhancing industry sponsorship.

Molecular recognition between two compounds



The Institute of Telecommunications Research

Co-ordinator: Professor Hugh Bradlow (tel 042 21 5919)



Professor Hugh Bradlow

THE INSTITUTE of Telecommunications Research (TITR) at the University of Wollongong is focused on providing the technological and human infrastructure that will enable Australia to capitalise on change in the telecommunications industry. In particular, TITR offers a multi-disciplinary approach to telecommunications R&D and training, with particular emphasis on the disciplines of telecommunication networks and services. This focus allows TITR to provide an orientation of particular benefit to Australia, in that significant advances do not necessitate huge investments.

TITR, in conjunction with the Centre for Information Technology Research (CITR), has a strong commitment to partnership and collaboration with industry. CITR, which is part of the Illawarra Technology Corporation (the University of Wollongong's commercial arm), has been undertaking industry-funded research and

development since 1989. CITR operates on a fully commercial basis and performs project management for the work of the Institute. CITR has undertaken a total of \$15m worth of contracts to date with organisations such as Telecom Australia, OTC, Optus, Canon Nokia, Ericsson, Alcatel, NorTel, AWA, SITA and DSTO.

The Institute for Telecommunications Research is co-located in the Illawarra Technology Centre (on the campus of the University of Wollongong) with the NorTel Technology Centre, Telecom Australia's Advanced Applications Centre and Telstar Systems (a systems development subsidiary of Telecom Australia). This cluster of expertise has become a focus for world-class research in telecommunications.

The Institute for Telecommunications Research brings together a number of existing research centres and groups within the University of Wollongong, namely:

- The Switched Networks Research Centre (SNRC)
- The Telecommunications Software Research Centre (TSRC)
- The Center for Computer Security Research (CCSR)
- Wireless technology group
- Speech and image processing research groups
- Applied Statistics research group
- Educational Interactive Multimedia unit.

It is important to note that while each of the research groups described above involves a specific discipline, the Institute achieves synergy be-

tween these groups by focusing on problems where the solution requires the application of a wide range of skills. Examples are provided below in the research highlights of the Institute.

Research Highlights

Developing the information super-highway

The Institute initiated a program of work to address the provision of interactive multimedia services over broadband networks for application in education. The program of work is being funded by Telecom Australia through their renewal of the contract for the Telecommunications Software Research Centre in 1994. News Ltd have also promised support through access to their media archives. This work program is a good example of the synergy achieved by the establishment of the Institute. The development of applications for the 'information superhighway' requires the ability to manipulate coded information and to switch it at high speeds while providing the end-users with secure and intuitive access. The solution of these problems will require expertise in high speed switching systems and protocols (ATM and Broadband-ISDN), telecommunication software systems, computer and communications security and signal processing and coding. The work program accordingly involves contributions from the Switched Networks Research Centre, the Telecommunications Software Research Centre, Center for Computer Security Research and the Interactive Multimedia Unit in Education.

The aim of the research being conducted by TITR is to develop an 'information superhighway' which combines the freedom and openness of the Internet, while at the same time offering the management, security and protection that is expected of a telecommunications network. This 'best of both worlds' approach will yield a system that will provide opportunities for small Australian content providers and technology developers, and at the same time protect their Intellectual Property. A key part of the research strategy involves the use of Telecom Australia's Wollongong Optical Fibre Trial as a 'live laboratory' for the testing of new services with real customers. The Optical Fibre Trial currently connects 200 homes, businesses and schools and will enable the distribution of interactive broadband services.

The research program involves developing multimedia protocols, software tools and applications with a specific emphasis on the provision of applications for education. At the same time the research encompasses the security issues relating to multimedia and interactive networked information. The systems to manage services and connectivity are also addressed as part of the work program and build on the work previously performed by the Telecommunications Software Research Centre on the Telecommunications Information Network Architecture (TINA).

Securing the superhighway

The provision of networked information and software creates numerous security problems – users need to be authenticated, data and transmissions must be kept private, intruders must be prevented from entering unauthorised areas, etc. The Centre for Computer Security Research has been addressing a number of problems relevant to these issues.

In particular it has been looking at the design of secure cryptographic algorithms for authentication, encryp-

tion and hashing. Researchers have shown how to use so-called bent functions to construct S-boxes with requested cryptographic properties.

Research has also been conducted on the Kuperee server which is used to provide authentication services in a distributed system. Unlike previous server-based solutions, Kuperee employs a public key cryptosystem which provides authentication through the intermediary of the server, while retaining the ability for clients to perform one-to-one authentications themselves. Currently the research effort is directed towards using replication of the server to increase performance while reducing the risks associated with attacks to the servers. Other work covered by the Centre for Computer Security Research has addressed security threats within mobile computing environments; the theory of authentication codes and automated verification of cryptographic protocols; and the analysis of hashing algorithms and the design of group-oriented cryptosystems.

Designing the Internet of the future

The Internet, which connects many

millions of people worldwide, has grown up as a collection of independent co-operating networks. While this format has worked well for the academic and research community, the technological basis of the network (specifically the IP protocol and network structure) is deemed inadequate for the future network growth and the increasingly commercial requirements of the 'Net'. Accordingly research groups worldwide are addressing the network structures that will support the style of service that has become associated with the Internet – specifically transaction based services (such as e-mail) and interactive information services (such as the World Wide Web).

The Institute for Telecommunications Research is using its existing expertise in Broadband ISDN and ATM (Asynchronous Transfer Mode) technology to pursue research projects related to the future network architectures. In particular, it is generally anticipated that the network technology will rapidly migrate to ATM networks which are capable of supporting all traffic types and can be used for both local and wide area networks. ATM networks, while they have reached a



Multimedia developers Stephen Rojan and Karen Taylor

significant level of maturity, are still evolving and their use for these types of application leaves many problems to be addressed.

In particular, the efficient use of ATM networks for bursty traffic (which is typical of the transactional data services being considered) requires effective mechanisms to control congestion. ATM relies on statistical multiplexing of multiple traffic streams on to shared resources such as transmission links and switches. Congestion control is most needed in those situations where the peak traffic demand for a given service is a large fraction (more than a few percent) of the total resource availability. This is as true for large enterprise LANs providing bandwidth-intensive multimedia services as for the lower bandwidth tails of the network which are often all that is available for customer access. The Switched Networks Research Centre is currently developing a special adjunct to an ATM switch (called the Resource Adjunct Processor or RAP) which will optimise the performance of ATM switches and links in the presence of high demand multimedia applications. The RAP, which can be used with any ATM switch, prevents the well known congestion problem of cell loss multiplication and is capable of implementing the congestion control algorithms currently being standardised within the ATM Forum.

While the RAP addresses current issues, the Switched Networks Research Centre (SNRC) has also identified the opportunity for further improvements to congestion control in the future. It has been recognised in research laboratories around the world that the traffic that is generated on Local Area Networks (and hence the Internet) is fractal, or self-similar, in nature and thus displays a high degree of correlation. SNRC's research has shown that the traffic correlations can be predicted up to a few hundred milliseconds. This is of the same order as the propagation delay experienced by signals which traverse large networks such as the

Internet. Due to this delay, it has been extremely difficult to control congestion in high speed ATM networks. The discovery that the traffic level is predictable up to hundreds of milliseconds is a significant result as it will potentially enable congestion control devices such as the RAP to predict the onset of congestion and to take corrective action to prevent it. This will lead to significantly more reliable and efficient networks.

In addition to the resource and traffic management issues, the provision of Internet services over ATM creates significant protocol design problems, particularly when interconnection with 'legacy' networks must be taken into account. While most people anticipate a strong trend towards all-ATM networks, the reality is that most networks today use current LAN and Router technology. It is thus vital to design the protocol stack of the future to work effectively over an all-ATM network, but still be capable of inter-working with 'legacy' networks. Current approaches have tended to focus on the latter problem and consequently adopt an incremental approach to Internet design. The Switched Networks Research Centre has proposed, and is investigating, an alternative approach which we have termed TCP/ATM, whereby the current IP protocol layer is eliminated entirely with a view to the fact that it is redundant in an all-ATM network and thus would create unnecessary administrative and management complications. It is proposed to achieve inter-working with legacy IP networks through the use of special gateways which will perform protocol and address translation. Key issues that are currently being investigated are the address translation, routing and signalling to make such inter-working possible. In addition, the functionality that would be performed by the gateway and the resulting performance constraints are also being addressed.

Speech compression and recognition
The provision of advanced new

services over the telephone often is considerably enhanced if the user can talk to the computer as opposed to typing in digits. The Institute has been undertaking research, funded by Telstra Corporation, for the development of a Connected Digit Recognition system to be used over the telephone network. A system with a 13 word vocabulary (the digits 0-9, Oh, double and triple) was developed which achieved a high level of accuracy irrespective of the speaker (the string recognition rate has been proved to be greater than 96% and the word level accuracy is greater than 98%).

In addition to being able to recognise speech it is important to have the ability to compress it — this enables speech to be transmitted efficiently across bandwidth constrained channels such as those provided by mobile and satellite systems, or to be stored efficiently on a computer's disk. The Institute has been conducting research into speech coding which has been concentrated in two areas:

- (i) A team funded through the Federal Government's GIRD scheme has been developing low-rate IMBE coders for Inmarsat and integrated coders for Vodafone.
- (ii) Longer-term research work has been conducted on a new technique known as Prototype Waveform coding. The primary aims of the research are to reduce the codec complexity and to achieve consistent coding quality for a wide variety of speakers. This work (funded through a small ARC grant) has led to the implementation of a new class of coders operating at approximately 2.4kb/s.

Image coding

The Institute has been undertaking image coding research which has concentrated on coding techniques for reducing the enormous bandwidths normally required for image and video communications. Work is underway to develop transform coding

techniques which will meet internationally specified requirements.

Two research thrusts are being undertaken: sub-band / wavelet coding of images and vector quantisation (VQ). A generic quantisation and encoding method suitable for any sub-band analysis has been developed. This generic quantisation and encoding method is a generalisation of the JPEG baseline sequential coder.

A novel method of exploiting the inter-block correlation inherent in partitioned images has been developed for use in vector quantisation based image encoders. The improvement afforded by this technique at low bit rates (less than 0.4 bit per pixel) is about 3dB (peak signal to noise ratio (PSNR)) on the average. The method has been successfully applied to image adaptive VQ, universal codebook VQ and tree structured VQ. Further work is being carried out in its application to image sequences.

The problem of enhancing noisy images arising from medical imaging is also being addressed by the image coding group. The use of non-linear filtering techniques is being studied in this regard.

International and other collaborations

TITR has been establishing international collaborations with universities around the globe. The list includes:

- Stellenbosch University in South Africa – collaboration involving network performance modelling and distributed programming

environments is being addressed

- Simon Fraser University in Canada – collaboration is continuing on the interactive multimedia applications in education
- Queen's University in Canada – collaboration on computer and communications security
- University of Athens and Technical University of Athens in Greece – collaboration on computer and communications security.

Recognition and publicity

Grants received

The following ARC grants were received:

Professor J Seberry (with the University of Queensland), Large ARC Grant \$170,000: Access schemes using combinatorial designs.

Associate Professor J Pieprzyk and Dr R Safavi-Naini, Large ARC Grant \$160,000: Group-oriented cryptography.

Professor G Anido and Professor H Bradlow, Collaborative ARC Grant \$540,000: Design, analysis and implementation of an ATM virtual-ring LAN.

In addition, CITR secured the following commercial R&D contracts which involved members of the Institute:

Dr Peter White, Vodafone Australia Pty Ltd, \$980,000: Polarisation diversity antennas.

Professor G Anido and Professor H Bradlow, Vodafone Australia Pty Ltd, \$650,000: Network modelling software.

Professor H Bradlow, Dr P Beadle, Professor G Anido, Dr R Safavi-Naini, Telecom Australia, \$900,000: Telecom-

munications Software Research Centre.

Dr Peter White, Canon Inc, \$143,000: Wireless local area networks.

The total value of the new grant income awarded in 1994 was \$3.53 million.

Conference committees

- The Centre for Computer Security Research organised Asiacypt '94 Conference in Wollongong. More than 120 participants from all over the world attended. Professor Jennifer Seberry was General Chair of the Organising Committee and Associate Professor J Pieprzyk was Program Chair.
- Professor Hugh Bradlow was on the Organising Committee of the ATNAC '94 Conference.

Invited speakers

Professors Anido, Bradlow and Seberry presented invited papers at a number of conferences during the year, as did Ms Robin Lindley (a total of eight papers).

Journal editors

- Professor Gary Anido was appointed editor of a special issue of the Telecommunications Journal of Australia to be released in 1995
- Professor Jennifer Seberry was appointed to the editorial board of the Springer-Verlag journal entitled *Journal of Universal Computing* (to be published on CD-ROM)
- Dr Rei Safavi-Naini was appointed to the Editorial Board of Computer Security Reviews.

*Major increase in equipment infrastructure a stimulus to research
Surface engineering, iron and steel processing and
interface engineering the areas of most marked growth*

Advanced Materials and Surface Engineering

Co-ordinator: Professor Druce Dunne (tel 042 21 3012)

THE YEAR saw rapid growth of the Advanced Materials and Surface Engineering Research Program and the formulation of plans for regrouping activities in 1995 to facilitate the development of interdisciplinary interaction within an Institute.

There was a major increase in the available equipment infrastructure through successful applications for funding from internal and external sources. In particular, the Infrastructure Equipment and Facilities Program (formerly Mechanism C) provided funding for wear-testing equipment (\$100k; Samandi, Chandra and Spinks); a 28 GHz gyrotron microwave system (\$455k; Siores, Paoloni, Rozgonyi, Dunne and Samandi) and a scanning probe microscope (\$277k; Spinks, Dunne). In addition, the CRC for Materials Welding and Joining granted capital equipment funds to purchase micro-

wave and surface engineering equipment (\$110k; Samandi) and a contact-angle goniometer (\$38k; Spinks) and provided the lever for a NSW State Government grant of \$200k for a high-quench-rate dilatometer (Dunne).

Further IEFPP success by Professor Dou – \$300k for equipment to serve the interests of the super-conductivity and electronic materials centre – will also have general applicability to continuing materials research activities.

The CRC for Materials Welding and Joining has been a major stimulus for the research activities of the Program, with total funding for projects and equipment during 1994 in the vicinity of \$800k. Driven by ARC, CRC and industrial funding, the Program moved forward strongly in the project areas of rapid solidification and nanocrystalline materials; surface engineering; iron and steel processing; microwave processing of materials; extractive metallurgy; and interface engineering.

The three areas in which the most marked growth has occurred are surface engineering, iron and steel processing and interface engineering and it is planned that these areas will be key activities in the rationalisation of materials research within two Institutes now being developed.

Since 1988, when the Advanced

Materials and Surface Engineering Program was established, state-of-the-art plasma processing and tribological laboratories for surface engineering research have been established. A strong team has been formed, led by Dr Masoud Samandi and currently consisting of 14 academic and research staff and research students. Research activity embraces a balanced portfolio of strategic and applied research of direct relevance and importance to manufacturing industry. The plasma processing and tribological laboratories are unique assets in Australia, on a par with

A postgraduate student in the Department of Materials Engineering, Mr Prosjenit Basu is at work on the contact-angle goniometer



Members

Associate Professor T Chandra,
Associate Professor G Delamore,
Professor N Kennon, Ms S
Nightingale, Dr M Samandi,
Dr G Brooks, Dr G Spinks

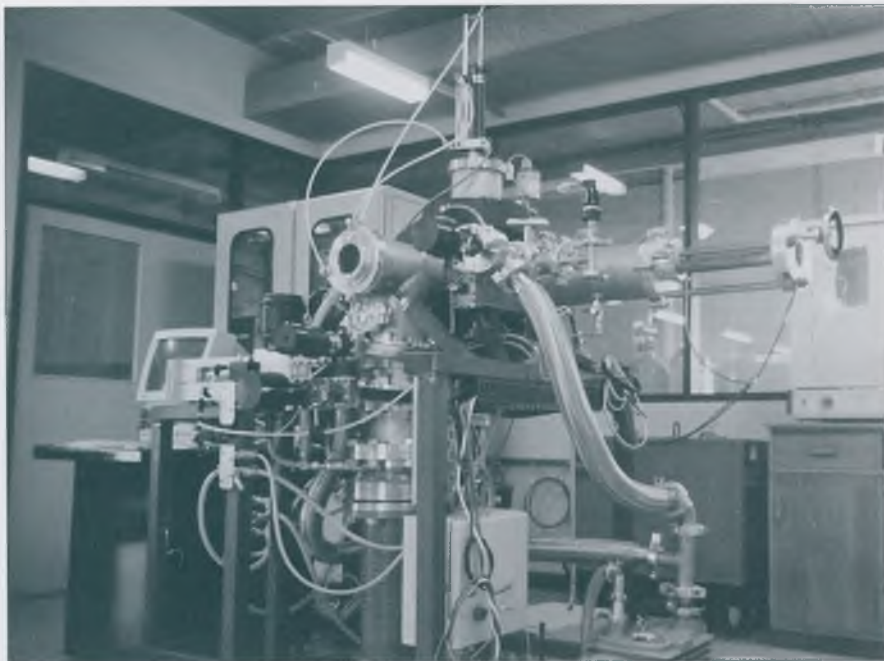
the best available in the world, and provide an excellent platform from which to launch multi-disciplinary research both inside and outside the University.

The surface engineering research program is strongly supported by industry, particularly BHP and other local firms. Strategic links with BHP, especially the Sheet and Coil Products Division, have been significantly strengthened by the development of joint research projects to exploit the advantages of surface engineering both as an enabling technology and, perhaps more importantly, as a core technology. The relationship with BHP, both directly and through the CRC for Materials Welding and Joining, has been pivotal in attracting research funds, quality students and access to sophisticated analytical facilities.

Associate Professor Chandra and Professor Dunne have a strong commitment to the iron and steel processing area, which involves 13 academic staff, post-doctoral fellows and postgraduate students. Hot rolling, one of the main topics being addressed by this research group, is a complex thermomechanical processing operation, involving deformation and softening of the steel at elevated temperatures in a schedule of rolling reduction passes referred to as the roughing, intermediate and finishing stages.

Pass reduction, interpass hold time, plate temperature, composition and structure interact to determine the hot rollability. Structure developed during finishing and on cooling determines the mechanical properties exhibited by the steel at ambient temperatures. Use of appropriate processing conditions is all-important in determining steel quality and the cost-effectiveness of the hot rolling process.

Projects within this stream involve either laboratory hot rolling investigations or hot rolling simulation using uniaxial hot compression testing to



This highly complex Filtered Arc Deposition System (FADS) was designed, constructed and commissioned, under the direction of Dr Masoud Samandi, by the technical staff of the Department of Materials Engineering. FADS utilises a vacuum arc for deposition of a range of advanced coatings such as refractory metals, transition metal nitrides and carbides and alloy coatings

clarify the effect of rolling variables. This activity is well supported by a hot uniaxial compression testing machine, a recently commissioned 100-tonne Hille hot and cold rolling mill and the high quench rate dilatometer. The main projects in this group are funded by the CRC for Materials Welding and Joining, ARC-Collaborative and APA-Industry grants with BHP Slab and Plate Products Division and Bisalloy Steels as the industrial collaborators.

Interface engineering is a general term which addresses the properties of the transition zone between joined or connected materials. A major research effort is being mounted on the interphase zone in polymer-metal systems, under the direction of Dr Geoff Spinks. In this case, the metal substrate is connected to a polymer layer by adsorption or curing. The interface has been shown to be critical to the performance of many industrially important polymer-metal systems, including structural adhesive joints, reinforced composites and

coated substrates. This research has particular relevance to areas such as the use of adhesives for structural bonding of metals and the adherence and stability of paint coatings on sheet metals.

Interface engineering research is being supported through both CRC-funded projects and collaboration with BHP Sheet and Coil Products Division, which has a strategic interest in the adhesive bonding and paint finishing of coated sheet steels.

Another outgrowth of the Program during 1995, stimulated by interaction with the Illawarra Technology Centre (ITC), has been the development of a melt processing/extractive metallurgy interest involving Dr Geoff Brooks, Professor Howard Worner and Sharon Nightingale. Research areas being developed include modelling of extractive processes, waste destruction by molten bath smelting, iron and steelmaking by DC arc furnace and wear and erosion of industrial refractories.

*High-performance local and wide-area networks
Multimedia communications and collaborative workplaces
Image coding, speech coding and speech recognition*

Advanced Telecommunications

Co-ordinator: Professor Gary Anido (tel 042 21 3065)

THE ADVANCED Telecommunications Research Program is focused on technology that will enable tomorrow's systems to be effective in terms of both cost and performance. The Program has nine academic staff members involved in four main research themes: transmission and switching technologies, multimedia communications; speech compression and recognition; and image and video coding and processing.

The Program had a highly successful year. External support was strong with \$1,350,00 in new funding being won in 1994. This represents some \$770,000 in external funding, together with \$603,200 of competitive funding from the Australian Research Council (ARC) and ATERB. In addition, a Large ARC Collaborative Grant of \$540,000 was awarded for 1995 involving BNR (Australia) as the industrial project collaborator. A total

of ten refereed journal papers, 12 international conference papers and 15 national conference papers were published. Fourteen PhD and eight ME (Hons) research students are engaged in telecommunications research activities, supervised by members of the Program. Since 1989, nine PhD and 18 Honours Masters students have graduated from the Program.

To encourage further collaborative telecommunications research across the University, an Institute of Telecommunications Research was established in early 1994. Based on the Advanced Telecommunications Research Program, this incorporates some of the activities of the Telecommunications Software Research Centre and the Computer and Communications Security Centre. Its vision is the development of the network and customer-premises technologies needed to support advanced telecommunications applications.

Telecom Australia Centre of Excellence

The Advanced Telecommunications Research Program was formally established in May 1990 as a Telecom Australia Centre of Excellence with over a million dollars of funding. In March 1992 the Program's funding base was expanded with a half-million-dollar grant from Ericsson Australia. In 1993 a \$650,000 research

contract with AWA was finalised and this supports two leading-edge projects in high-performance local-area network design. A \$160,000 research agreement with the Defence Science and Technology Organisation (DSTO) was established towards the end of 1993 to study the use of Asynchronous Transfer Mode (ATM) technologies for defence purposes. In 1994 the Large ARC Collaborative Grant mentioned earlier, the competitive grants from ATERB and an industrial contract with Vodafone were won on the basis of projects being undertaken by researchers in the Program.

These grants and research contracts have enabled the Program to establish a laboratory in which inter-operability studies involving emerging networking technologies may be undertaken. The Program performs research into the design and performance of advanced telecommunications networks and services such as ISDN, Broadband ISDN and Intelligent Networks. An important research topic currently being investigated by the Program is the use of a technique known as Intelligent Burst Multiplexing for handling high-speed bursty data in ATM networks. Currently, the Program includes ten research students, one postdoctoral researcher, and four academic staff.

The Program is now seen as Australia's premier site for advanced networks research work (*The Australian*,

Members

Professor Hugh Bradlow, Associate Professor Joe Chicharo, Associate Professor Frank Paoloni, Dr Phillip Ogunbona, Dr Peter Beadle, Dr Ara Samouliien, Dr Ian Burnett, Mr Tony Eysers, Mr David Atkinson, Mr David Rowe, Mr John Kostogiannis

Researchers from left are Associate Professor Frank Paoloni, Dr Philip Ogunbona, Associate Professor Joe Chicaro, Professor Gary Anido (Director), Mr David Atkinso and Dr Peter Beadle



11 October 1993). This reputation has been enhanced as a result of the Program's recent acquisition of a Syn-Optics ATM Switch. As such, the Program is the first site in the Southern Hemisphere to have an ATM Research Laboratory capable of undertaking internetworking experiments with multi-vendor ATM switches. Within the Program's ATM Laboratory researchers are currently developing high bandwidth distributed information servers capable of supporting multimedia education and information services for distribution over the emerging Information Superhighway. The prototype services and servers are expected to be field tested in 1995 via Telecom Australia's Optical Fibre Network which was deployed in Wollongong in 1993.

The work of the research team has received wide national and international recognition. The Program hosted the 1993 Australian Conference on Telecommunications Software and the 1993 Australian Broadband

Switching and Services Symposium. The Program forms the backbone of the new Institute for Telecommunications Research.

Researchers: G J Anido and H S Bradlow (Directors), P Beadle, J Chicharo, D Atkinson, B Banh, M Butler (UTS), S Duigud, E Dutkiewicz, A Eyers, I Kerekes, J Lawrence and P Vial

Multimedia communications

Multimedia communications research activities include the development of suitable architectures for Customer Premises Equipment (CPE) to suit multimedia applications over broadband networks, and the implications of such applications on the performance of broadband networks. The multimedia applications being studied and developed as part of these activities are shared (or collaborative) document preparation environments and multimedia databases (such as imaging databases).

The multimedia work being under-

taken was responsible for the winning of a \$120,000 research contract from the Defence Science and Technology Organisation (DSTO) to study multimedia technologies for defence purposes. A competitive grant from ATERB was also won. In July of this year the Program hosted the Third Australian Multi-Media Communications Applications and Technology Workshop.

Over the next five years telecommunications services will make increasing use of video and imagery. The trend towards multimedia applications, graphical computer-aided design systems, high-resolution desktop publishing and so on will make the development of efficient visual and image-data-compression techniques imperative.

Researchers: P Beadle, W Musangeya and J Judge

Voice coding

Voice coding activities have focused on the development of low bit rate coders for use in mobile communications systems, spread spectrum techniques for mobile radio systems and the design and analysis of intelligent speech and a novel Digital Audio Power Amplifier based on the use of DSP techniques. Funding for the low rate-coding activities has come from a \$300,000 GIRD grant, won in 1994 in conjunction with the University of South Australia.

Coding of wideband audio signals is an area of great interest, particularly with the possibility for transmission via networks such as ISDN. The research activity has mainly been concerned with the Optimum Coding in Frequency coder (OCF) and the forthcoming international ISO/IEC standard MPEG/Audio, both utilising psychoacoustic weighting to mask the noise.

Researchers: I Burnett, D Rowe, P Secker, J Kostoganiannis and J Whitehall

Image coding

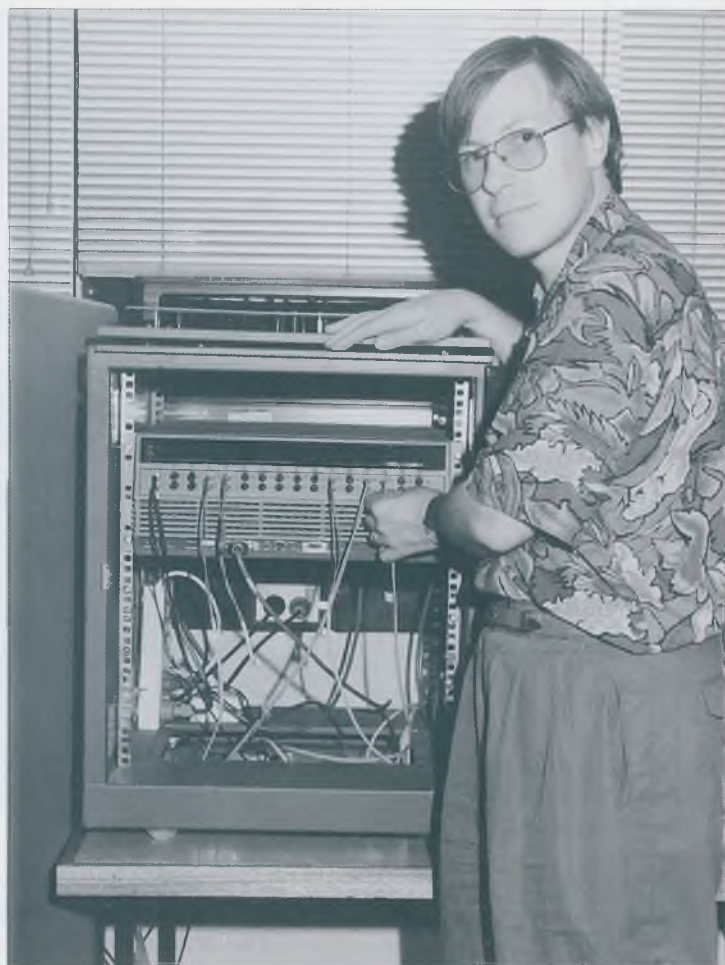
The image coding research has concentrated on coding techniques for reducing the enormous bandwidths normally required for image and video communications. Work is under way to develop transform coding techniques which will meet internationally specified requirements.

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has been successfully applied to image adaptive VQ, universal codebook VQ and tree-structured VQ. Further work is being carried out in its application to image sequences.

The problem of enhancing noisy images arising from medical imaging is also being addressed by the image coding group. The use of non-linear filtering techniques is being studied.

Researchers: F J Paoloni, P Ogunbona and J F Chicharo



Seen here with Australia's first ATM switch is Peter Beadle

Research projects with industry

The Advanced Telecommunications Research Program has been working closely with industry. Co-operative projects include:

- Mobile network optimisation sponsored by Vodafone.
- Research contracts with Telecom for switched networks and image coding.
- ISDN signalling network research sponsored by Ericsson Australia.
- High-speed local-area network design for AWA Communications.
- ATM and multimedia technologies for DSTO.
- GIRD grants for speech coding and transmission.
- Image processing and reconstruction with BHP Engineering.

*Complementary methodologies: cognitive psychology,
psychophysiology and field studies
'A blend of expertise'*

Applied Cognitive Sciences

Co-ordinators: Professor William Lovegrove (tel 042 21 3903) and Dr Steven Avons (tel 042 21 3156)

THE AIMS of the Applied Cognitive Sciences Research Program are to develop pure research in cognitive psychology and psychophysiology, and to combine these two approaches to facilitate the development of more effective applications of psychology within these areas. The Program represents a blend of expertise in at least three complementary methodologies (Cognitive Psychology, Psychophysiology and Field Studies) across several content areas. Perhaps the most rewarding aspect of the Program's activities in 1994 was the successful completion of higher degrees by students working with the staff of the Program. Elizabeth Conlon, Stephen Dawson, Amirkh-ibani Kholiamani and Mohammad Vaezmousavi all completed PhDs and Jim McKee completed his MSc (Hons).

Associate Professor Anshel has been examining the coping process in sport. In particular, he is generating inventories concerning coping style and appraisal style in the athlete's

response to various acute stressors experienced during competition. The implication of this work is the ability to predict the athletes' preferred ways of interpreting and reacting to acute stress, then develop more effective stress management strategies that combat poor coping skills and enhance performance. Both adult and child versions of these inventories are being developed. Improving the coping skills of child athletes will not only reduce stress but lead to reduced dropout rates in youth sport.

Dr S Avons left the University to take a position at the University of Essex. Dr S Roodenrys joined the Program from York University. His major research interest is in the area of working memory and he is particularly interested in aspects of verbal short-term recall tasks and the possibility of linking the research in this field to that of speech perception and production. He received small ARC funding for 1995 for a project in this area looking at the influence of long-term phonological representations on short-term recall tasks. He also has an interest in research on executive aspects of working memory, in normal subjects and children with a range of psychological disorders. He will work with Professor Lovegrove and Dr Wragg on both dyslexia and attention deficit hyperactivity disorders (ADHD).

The work of Professor Lovegrove and his students on various aspects of

dyslexia has continued to attract world attention. Professor Lovegrove presented an invited address to the combined meeting of the New York Orton Society and the National Dyslexia Research Foundation. With Karen Pepper, he has continued his ARC-funded research on the possible remedial implications of their previous finding that while normal readers read best when text is presented in a whole line format, this is the condition which is most difficult for dyslexics. Kristen Pammer has worked with him on a project aimed at determining the neural basis of the effect of wavelength on reading disability. He, Dr S Avons, Agnes Au and Christopher Wragg have continued to collect data on an ARC-funded project investigating the hypothesis that dyslexics may have problems processing rapidly presented stimuli in both vision and audition. This extends their previous work on visual information processing. In addition it provides a theoretical framework which may help reconcile much previous and apparently unrelated work on vision and phonological processing in dyslexia.

During 1994 the Cognitive Neuroscience Laboratory received substantial funding through a major ARC Infrastructure grant to Professor Barry and a colleague at Westmead Hospital (University of Sydney). This will eventually allow the laboratory to run simultaneously two subject booths, each equipped to collect up to 24

Members

Associate Professor Mark Anshel, Professor Robert Barry, Dr Eugene Chekaluk, Dr Elizabeth Conlon, Dr Allison Fox, Dr Steven Roodenrys, Dr Jeffrey Wragg



Ms Alison Fox and PhD student Brian Corless with an EEG recording of human brain activity

channels of EEG and event-related potentials, and up to another eight channels of physiological data from a human subject. The time-locked nature of the recorded data will allow a significant extension of the range of psychophysiological investigations of cognitive processing.

Professor Barry continued his development of a theory relating such physiological indices to the processes involved in information processing in both normals and psychiatric groups, and this has been taken up by a number of research students. For example, at Westmead Hospital, Ashmi Sawant continued her MA (Hons) research, under his supervision, linking electrodermal and EEG measures of state in simple habituation paradigms. Kerrie Wilde continued her PhD research investigating children's cardiac and electrodermal functioning in an outdoor adventure context at Broken Bay Sport and Recreation Centre. Mohammad Vaezmousavi completed his PhD thesis on the event-related potential correlates of skilled performance of the type involved in such activities as pistol-shooting.

Another infrastructure grant was obtained from the university for the whole Research Group. This aimed to foster the integration of psychophysiological measures, as used by Professor Barry and Dr Allison Fox, and available in the developing Cognitive Neuroscience Laboratory, into the research activities of others in the group. The major thrust of this

support will be software development to bring the different paradigms used by different researchers together. An immediate outcome of this was the linking of Professor Lovegrove and Dr Wragg with Professor Barry and Dr Fox in a new project on Attention Deficit Disorders (ADHD). This brings Professor Lovegrove's background in visual disorders and reading and Dr Wragg's interests in diagnosis and remediation of children's learning difficulties together with Professor Barry's and Dr Fox's expertise in the physiological aspects of cognitive functioning. It is expected that this project will develop during 1995 to the stage where external funding can be sought for a substantial program of research in this area.

Other collaborative research links have been recently established to extend the research of other members of the program to include psychophysiological measures. Dr Fox, Dr Roodenrys and Ms Pena have developed a project to examine electrophysiological correlates of reading skill. Dr Roodenrys, Dr Fox and Ms Murphy are also collaborating on a project which will examine event-related potential indices of working memory. Professor Barry, Dr Fox, Dr Heaven and Mr Bruggeman are working on a project examining psychophysiological indices of personality attributes.

Dr Allison Fox, as well as being awarded her PhD entitled 'Working memory: Validation of event-related potential indices and their application

to social drinkers', continued her collaboration with the National Drug and Alcohol Research Centre as Honorary Research Fellow and contributed to a symposium organised by NDARC which was part of the recent Australian Psychology Society Conference held at Wollongong in September. A video of the symposium 'Psychological consequences of drug use' is available through the Australian Psychological Society test library. The data reported indicate that there are two distinct types of cognitive impairments in patients seeking treatment for alcohol dependence, namely an organisational impairment and a visuo-spatial impairment and discussed the implications of these findings to understanding the etiology of cognitive deficits as well as to the development of appropriate cognitive remediation programs. Her research with heavy social drinkers from the community suggests that there may be subtle changes to complex memory organisation which can be detected using sensitive psychophysiological techniques. Current research projects include investigating the nature of organisational impairments in heavy social drinkers with Ms Bresnahan, development of a cognitive retraining program in severely dependent problem drinkers with Ms Sim at Kedesh House, examination of ERP correlates of visual attention with Mr Lethbridge and visual evoked potential correlates of the sustained/transient system with Professor Lovegrove and Ms Thomas.

Modelling as a powerful tool for understanding past experience, unravelling current trends and designing a better economic future

Applied Economic Modelling

Co-ordinator: Associate Professor Tran Van Hoa (tel 042 21 3659)

THE PROMOTION of world trade and economic growth has been a primary objective of the majority of highly developed and newly developing countries in the past few years. More prominent activities in this area which are well known to most people through the mass media are the GATT negotiations and APEC forums. Unknown to most people, however, is perhaps the fact that these international negotiations and multi-country forums are based on trade and economic forecasts as well as on favourable development scenarios – made by economic modellers from existing data and past experience – to help policy-makers identify trends and directions in world economies.

The University's Applied Economic Modelling Research Program started in 1991 under the co-ordination of Associate Professor Tran Van Hoa in the Department of Economics. It has

concentrated on two objectives: to develop economic, econometric and statistical modelling methodologies, and to explore ways and areas in which these methodologies can be used in practical and applied economic studies to assist policy makers in both developed and developing economies.

During 1994, the Research Program's members worked on nine projects covering a wide range of economics research, training and consulting activity in several major countries. The activity includes modelling foreign investment in Vietnam and training in applied economic modelling for Vietnamese officials (Tran Van Hoa); modelling the impact of financial and trade liberalisation and resource production on the macro-economy (Harvie, Tran Van Hoa, and others); foreign investment and trade flows in East Asian and Asia-Pacific countries (Suh); trade in labour services (Chowdhury); pass-through analysis for small countries such as Australia (Webber); savings, investment, productivity and growth (Chaudhri and Wilson); investigation into the persistence of the usury doctrine (Lee); and modelling the perennial crop sector, pricing policies in the rice sector and efficiency in the Sri Lankan stock market (Perera). A separate project on the general theory of estimation and forecasting and its application to important economic causal relationships was carried out by Associate Professor Tran Van Hoa.

Foreign investment and economics training in Vietnam

Associate Professor Tran Van Hoa started economics research and training work on the Asian economies early in the 1980s. Since then he has directed his investigation into countries such as Thailand and Vietnam. Currently he is looking at the impact of energy consumption on economic development and, with the support from the Ministry of Industry and the Economic Modelling and Forecasting Program at Chulalongkorn University in Thailand, at the issue of sectoral growth in the non-oil industry there. Preliminary results were presented at a Ministry of Industry workshop in Chiangmai, Thailand, in October.

Tran Van Hoa is also chief investigator in an ARC collaborative research grant to work with the Research Institute for Foreign Economic Relations, Ministry of Trade, in Vietnam during the triennium 1995-1997. His activities also include training Vietnamese officials in the use of economic policy tools (for example, applied economic modelling and information technology applications) of Western economies and participation in the Harvard Committee on Economics Education and Research in Vietnam Program at the National Economics University in Hanoi, to assist Vietnam in its modernisation process from a command to a free-market or mixed economy.

Members

Associate Professor D P Chaudhri, Dr K Chowdhury, Ms M Chowdhury (PhD Student), Dr C Harvie, Dr B Lee, Dr N Perera, Ms B Sootsukon (PhD Student), Dr C C Suh, Associate Professor Tran Van Hoa, Dr A Webber, Mr E Wilson

Associate Professor Tran Van Hoa represented Wollongong University at the workshop on marketing education in Vietnam organised by DEET at Macquarie University. Thirtythree of Australia's 36 universities were represented at this workshop. Early in 1994, he was nominated by the Australian Academies of the Social Sciences and the Humanities to make a fact-finding tour of Vietnam to promote academic and cultural activity. During 1994, Tran Van Hoa visited, by invitation, the CEPPI, Prime Minister's Office, France, to establish an Asia-Pacific link network, and to evaluate the international trade databank CHELEM developed by the CEPPI for the EEC.

Modelling other economies in the Asia Pacific

Dr Harvie has been researching and publishing widely in the area of energy policy modelling for Australia, Indonesia and the UK. Currently he is collaborating with Tran Van Hoa to investigate the effects of financial and trade liberation (as well as privatisation) and its sequencing upon the macro-economy, especially in the context of Australia and major developing economies in the region – notably Vietnam and China. Dr Suh, an expert on the Korean economy, is compiling data to build a general econometric model to determine the major determinants of foreign investment and its flows in the Asia-Pacific region. Dr Chowdhury is investigating trade in labour services in Bangladesh, a small and low-income country in the sense of the World Bank ranking, and evaluating its effects on the macro-economy.

Dr Webber is concentrating on modelling trade value responses to the exchange rate, using mainly Australian data. These responses are measured both in the long run and in a dynamic sense and include endogenous import, non-rural export, values, volumes and pass-through. Associate Professor Chaudhri and Mr Wilson continue their work on



Co-ordinator of the Program is Associate Professor Tran Van Hoa

modelling and then testing, using Australian data, some important causal relationships between investment and domestic savings, productivity and investment growths, with or without neoclassical endogenous growth 'drivers', and overseas borrowing and domestic investment.

Dr Perera's research projects are directed towards an analysis of macro-economic problems in the LDCs, in particular Asian countries, using econometric models developed for those countries. The areas he investigates are the perennial crop sector in the LDCs, pricing policy in the rice sector, and efficiency in the Sri Lankan stock market.

Are the banks too greedy?

Dr Lee is investigating an important current issue in financial studies, the enormous profits currently being made by banks and the wide differential between the deposit and lending rates: are the banks too greedy? The investigation utilises usury doctrine and the part played by economic theory in it. The findings from this study will have significant impact on

the thinking and operation of the banking industry.

Development of new and useful econometric methodologies

Associate Professor Tran Van Hoa is continuing his research into the fundamentals of his internationally known new and improved 2SHI (two-stage hierarchical information) methodology in the general theory of estimation and forecasting, and also into its applications to important micro and macro-economic problems. Using an error correction functional form (which has been developed by the London School of Economics and whose use is almost imperative in all current modelling research in Europe) for private consumption and aggregate demand for money in Australia, the 2SHI estimators were found to be far superior in terms of forecasting mean squared errors to all popular existing statistical approaches used in econometrics. The findings were reported at the Second Meeting of the International Society for Bayesian Analysis (ISBA), organised by Chicago University, in Toronto, Canada, in August.

*Rolling mill technology – automatic expert system
Turbulent flow, bubble dynamics, fuzzy logic
Intelligent manufacturing systems*

Applied Mechanics and Advanced Manufacturing

Co-ordinator: Associate Professor A Kiet Tieu (tel 042 21 3061)

The Research Program, involving 13 member researchers, six associate members and 18 PhD/ME students, has been collaborating with local and national industries – among these BHP Steel SPPD and Coated Products Division, BHP Research, BHP Engineering, MM Metals and Pacific Power. In 1994 the program attracted over \$220,000 from ARC large grant, ARC Collaborative and APRA (Industry) and \$320,000 from industry. Members were active in publication with two authored books, 36 journal contributions, 56 conference papers and two reports.

Rolling mill technology

A K Tieu and students: S Wang, PhD, G D'Alessio, PhD, X Yao, PhD, S Luo, ME

In the ARC collaborative project 'Automatic Expert System in Hot Strip Rolling', the system can intelligently integrate multiple-sensor

information with practical knowledge and experts' intelligence and key process variables upstream of the rolling mill and machine condition in order to optimise the quality of the strip leaving the finishing mill.

The dynamics and control of rolling processes, tribology at the strip-roll interface and vibration on rolling mills are important factors influencing strip quality. Lubrication, friction and wear at the interface can affect the dynamics of the strip and the quality of hot and cold rolled strip. With the assistance of BHP Steel SPPD, Stuart Oiltech company, Henry and Jones manufacturing shop and others, the Hille experimental rolling mill has been upgraded (at a cost of \$115,000) with a tension control system which consists of a coiler, uncoiler, and a high-speed datalogger capturing all the key process variables such as rolling force and torque speeds.

Computer modelling of slab casting will quantify the benefits of different cooling techniques, how the heat transfer affects the roll profile and hence the thickness profile of the slabs. BHP Steel SPPD and CPD are collaborating in these projects.

Tribology

A K Tieu and student: M MacKenzie, ME
The ARC project 'Superlaminar Flow in Hydrodynamic Bearings' examines

the effects of turbulent flow in hydrodynamic journal bearings. Sophisticated laser doppler anemometers have been developed to measure velocities in small gaps in the vicinity of 130 microns, a world first. A 2-D anemometer is currently being tested.

Bubble dynamics: cavitation and underwater explosions

W K Soh, J Best; students M Shervani, PhD, A Karimi, PhD

The study of bubble dynamics is aimed at understanding the physics of a pulsating cavity in a liquid. The phenomenon relates to cavitation problems and damage in hydraulic machinery, and to the mechanisms of damage resulting from underwater explosions. Experimental, theoretical and computational research have already led to formulation of descriptions of the thermodynamics processes, with good comparison between theory and experiment.

Natural convection in enclosures using scale models

P Cooper

The 'Natural Convection Laboratory' has been equipped with state-of-the-art particle tracking technology for measuring fluid flows in scale models of real life situations. Theoretical developments have continued (through collaboration with research-

Members

Professor M West, Professor G Arndt, Dr W K Soh, Dr A Basu, Dr P Cooper, Dr G J Montagner, Dr X D Fang, Dr D Saini, Dr T Chandra, Dr R Rudziejewski, Associate Professor V Stewart, Mr R Dwight

Flanked by colleagues, Co-ordinator of the Applied Mechanics and Advanced Manufacturing Program Associate Professor Kiet Tieu (fifth from left) and Mr Wally Cardillo (fourth from right and in the final year of his thesis in electrical engineering), form a background to the rolling mill fitted with Mr Cardillo's experimental tension control system



ers at the University of Cambridge, Department of Applied Mathematics and Theoretical Physics) that now allow the thermal stratification found in naturally ventilated buildings containing point sources of heat to be simply predicted.

Solar air conditioning project

P Cooper and J G Montagner

Using a commercial absorption refrigeration machine powered by the sun through solar hot water heaters a demonstration solar air conditioning plant has been commissioned. In 1995 the system performance will be monitored and improvements researched with a view to improving the cost-effectiveness of the technology.

Jet ejector development project

P Cooper

The objective is to develop an air conditioning system based on the VJRS (Vapour Jet Refrigeration System) that is cost-effective and that can be powered by waste heat. Currently Dr Cooper and PhD student Hassan Sharifi Bidgoli are engaged in the optimisation of the ejector through experimental work and Computational Fluid Dynamics (CFD) modelling.

Computational mechanics of materials

M P West, A K Tieu, A Basu

Advanced non-linear finite element method (FEM)(such as ABAQUS package) and 3-D Modelling (PATRAN) software have been acquired for the Mechanical Engineering Department. This project seeks to develop FEM analyses of material forming problems and of biomechanics applications.

Flexible robotics manipulators

A Basu, X D Fang, students: M H Korayem (PhD completed), Y Fang (ME completed), C Schwartz, BE

Contributions of this work are chiefly in the area of dynamics of flexible manipulators using Lagrangian equations of motion and a PC-based symbolic language Mathematica.

Biomechanics

A Basu, F Risi, BE, and C Ballantine-Jones, BE

Work during the year was carried out to develop mathematical and Finite Element Modelling of the Musculo-skeletal System. This modelling technique will be enhanced with information provided by an ultrasonic

scanning technique and magnetic resonance imaging in 1996 from the Canberra Australian Institute of Sports.

Welding and joining of materials

Members have been actively involved with the Co-operative Research Centre (CRC) for Materials Welding and Joining. In this area, several projects are currently undertaken:

Characterisation of gas metal arc welding

A Basu, I S Kim, PhD and S Moosavian, ME

The following areas have been considered:

- (i) Development of theoretical and experimental models to characterise Gas Metal Arc Welding (GMAW) process in finding empirical relations between input and output parameters.
- (ii) Application of infrared thermography to measure temperature distribution and isotherm radii.
- (iii) Development of transient heat transfer model coupled with the Navier-Stokes equations to simulate the heat flow and fluid flow in the Weld pool GMAW process and

use of the PHOENICS package to calculate temperature distribution, velocity profile and weld bead geometry.

Microwave welding and joining

A Basu, D Do Rego, PhD, J Spackman, BE
A plasma jet device consists of a microwave chamber in which gas in a ceramic pipe is ionised by a plasma arc. Two significant results are achieved: (1) a stable plasma source, and (2) an efficient cavity. Work in this area is expected to continue throughout 1995.

Metal transfer and droplet formation in gas metal arc welding

M P West, W K Soh, D P Saini, J Lowke (CSIRO), S Simpson (Univ of Sydney); students L Sanders, PhD, H Ratto, ME
This project has developed a MIG welding experimental facility in the Manufacturing Research Laboratory to monitor metal transfer processes via high speed film, electrical input signals and arc acoustic signature. The experimental visual images and electrical signals will be used to verify physical predictions of weld droplet formation. Weld process models will be developed for use in control algorithms for autonomous welding systems.

Fuzzy logic and expert system

X D Fang, student: S Shivathaya, PhD, visiting fellow: Y Zhang
Dr X D Fang has successfully developed a new algorithm for machine condition monitoring by introducing the concept of Fuzzy Feature-State Matrix for signal synthesis with the support of a knowledge-based expert system. Other research activities include the development of an applied fuzzy logic control strategy for a drilling machine, robot providing more research facilities for postgraduate research, and fuzzy set for optimal assignment of metallurgical grade in BHP steel production.

CAD/CAM integration

M P West, D P Saini

Work has started with this project to explore concepts for open-systems integration of computer and machine-tool architectures. The objectives are to (i) Develop state-of-the-art CAD/CAM facilities for the Manufacturing Research Laboratory (MRL); (ii) Explore digital/servo interface issues for the MRL robots; (iii) Develop concepts for standardised integration of multiple production elements under 486-PC host computer control.

Effect of microstructure on machinability and surface quality of copper in HSLA steel

T Chandra

A study has been carried out to investigate the effect of heat treatment conditions on the machining properties of copper-bearing HSLA steel. It has established a link between the microstructure and mechanical properties of heat-treated alloy. Machinability and surface quality of the material at different conditions are being evaluated.

Advanced diagnosis system for machine condition monitoring and process control

D Saini

Both the machine and process conditions are important factors in maintaining high productivity and quality of manufactured products. Monitoring the process and machine condition by A.E. technique has been observed to have high sensitivity towards changes in the cutting process due to flank wear of the tool.

Intelligent manufacturing systems

G Arndt

The two-year IMS Feasibility Study of the Global IMS Program, in which Professor Arndt was a member of the International Steering Committee, was successfully completed in January 1994. The feasibility study was based on projects involving clean

manufacturing, global concurrent engineering, manufacturing in the 21st century, Holonic manufacturing systems, rapid product development, and the systemisation of manufacturing knowledge. The meeting recommended that the full-scale ten-year program (estimated at US \$4bn) be started at the beginning of 1995, with Australia taking on the chairmanship during 1997 and 1998.

While on study leave during 1994, Professor Arndt, in addition to his research into TQM implementation, investigated IMS activities in the USA, Germany and Japan, with all countries including Australia presently preparing for this ten-year program.

Technology transfer/asparagus harvester

R Rudziejewski and CAMIA

Development of the advanced prototype of an automated selective asparagus harvester continued during 1994. Significant improvements in reliability were achieved with the modified prototype during field trials at Jugiong, NSW towards the end of the year.

The photograph supplied separately shows the prototype harvester undergoing pre-field trial tests at the University of Wollongong.

Maintenance management and systems engineering

R Dwight, D Saini, MP West and AK Tieu

Post-graduate courses of maintenance management attracted wide industry support such as City Rail, Water Board and Sydney Electricity. Professor A Jardine from University of Toronto Canada and Professor B Blanchard from Virginia Tech University, USA, delivered lectures and several seminars in Maintenance Management and Systems Engineering (March and May 1994). As a result of his active involvement, R Dwight has been appointed Co-ordinator of the Maintenance Management and Systems Engineering programs.

*Modernisation in the Asia-Pacific region
Economic processes and
cultural, social and political implications*

Asia-Pacific Development Studies

Co-ordinators: Dr Adrian Vickers (tel 042 21 3626) and Mr Tony Naughton (tel 042 21 3377)

THE ASIA-PACIFIC Development Studies Program is concerned with interdisciplinary approaches to modernity in the region. It particularly concentrates on the economic processes of modernisation and their interrelation to the cultural, social and political implications of the idea of being modern. No other research program in Australia has this combination of disciplinary interests covering South-east Asia, East Asia, South Asia and the Pacific, particularly Melanesia.

The year saw a dramatic re-organisation of the Program with a change of Co-ordinators, new membership and a redefinition of aims to sharpen our focus. Collaboration with the Centre for Multicultural Studies was strengthened, particularly through the involvement of Dr Rochelle Ball in an APEC consultancy with the Centre.

Visitors to the Program included Professor Alexander Woodside

(University of British Columbia), one of the world's leading historians of Vietnam, who gave a seminar on current attempts in Vietnam to find an historically relevant model of the state as the basis for economic reform.

Professor A K Dasgupta (Otago University) furthered his collaboration with Program members, particularly Associate Professor Chaudhri, on the social and political implications of major economic trends in the region.

Dr Robert Norton (Macquarie University) provided a new analysis of the political economy of ethnic relations in Fiji, specifically looking at why Fiji has not had the major ethnic conflicts experienced by other countries in the region.

Professor Shihung Chu (National Chiao-Tung University) visited the Program in conjunction with his visit to the Economics Department, as did Professor Wang Jue of the Central Party School, Beijing. Professor Wang is also a member of the Chinese People's Political Consultative Committee and President of the China Market Economy Society.

During the year members gave seminars on their research activities. Dr Stephen Reglar is currently following up his co-written book on the Chinese Economy with a re-evaluation of why China's economic position in the world economy declined compared to Europe's; Dr

Gail Graham is using an Action Research approach to understanding Chinese perceptions of consumerism; Associate Professor D P Chaudhri is demonstrating how Gunnhar Myrdal's famous work on the political economy of the region has proved to be more accurate in its judgments than prevailing IMF wisdom; and Dr Adrian Vickers is researching how Balinese views of modernity are shaped by the mass media and the experience of rapid industrialisation. The year saw increased post-graduate participation in the seminars.

Associate Professor Chaudhri's research, which looks broadly at aspects of trade and economic policy, is being pursued in collaboration with Dr Ed Wilson, Dr Khorshed Chowdhury and Dr Chung-Suk Suh. Of particular value to their joint research is the further development of a data base on major economic trends in the region. Their research projects have already led to joint conference papers and publications, and more are in progress. They are all also pursuing individual projects on industrial development in Korea, Bangladesh and India.

Dr Vickers's research has received initial ARC (Small) funding. This in turn has led to gaining an ARC (Large) Grant of \$265,000 over three years to carry out his project in collaboration with colleagues at Murdoch University, the School of Oriental and African Studies, London

Members

Dr R Ball, Dr H Beran, Associate Professor D P Chaudhri, Dr K Chowdhury, Dr A Cornish, Dr G Graham, Dr Li Tana, Dr S Reglar, Dr P Sales, Dr C-S Suh, Dr G Waitt, Dr E Wilson, Professor E P Wolfers

RESEARCH PROGRAMS



Photo-montage from Bali illustrating modernity in the Asia-Pacific region



University, and Udayana University in Bali. To quote the Vice-Chancellor, the achievement of this grant is evidence of the success of the Program. An initial collection of papers on the topic edited by Dr Vickers is in press with the South-east Asian Centre of Yale University.

Dr Vickers' project is a further demonstration of the Program's networking with regional colleagues. Other links in the region include collaborations with universities in Papua New Guinea, Thailand, Taiwan, Korea, India and China.

Other research activities of Program members included Dr Harry Beran's completion of a study on a Papua New Guinea sculptor, which is due to be published with assistance from the Program; Dr Andrew Cornish's ongoing research on development triangles in Southeast Asia; Dr Peter Sales's research on political conflict in the Philippines; and Professor E P Wolfers's continuation of his research on constitutional change and electoral administration in the Pacific, which has seen field visits to Fiji and Papua New Guinea.

A number of conference papers, articles and working papers have been published by these Program members. Dr Rochelle Ball continued her work on labour migration and development in the Philippines and Hong Kong, further demonstrating the University's continued recognition as a force in Philippine Studies in Australia. Dr Gordon Waitt continued his work on Korean tourism to Australia. Dr Li Tana, a new staff member, has joined the Program, and her research on Vietnam's rice-trade in the 19th century promises to change current views of Vietnamese history.

Consultancy and other external research grants included Dr Rochelle Ball's participation in an AIDAB-funded training scheme held at Macquarie University, Dr Adrian Vickers becoming a senior research advisor to a Ford Foundation Project on traditional *gambuh* theatre in Bali, and Dr Gordon Waitt's research, funded by the National Korean Studies Centre, on Korean Manufacturing. Various members of the Program participated in training and other consultancies run by the Centre for Maritime Studies.

The Program's support of the *Journal of Contemporary Asia* saw an international conference of the journal being held at Wollongong. Although, with Dr Melanie Beresford's departure, the link has been broken, Dr Vickers was successful in having the journal *RIMA (Review of Indonesian and Malaysian Affairs)* co-published from the Program.

The Program has embarked on a new publishing venture, an electronic newsletter, the first issue of which will feature commentaries by Dr Cornish on Australia's aid budget and notes on Associate Professor Chaudhuri's research.

Dr Vickers and Professor Wolfers gave several radio and television interviews on tourist developments in Bali and political events in Papua New Guinea respectively.

*Fire ecology : out-of-season burning
Biodiversity and pollination biology
Evolution of warm-bloodedness*

Australian Flora and Fauna

Co-ordinator: Associate Professor David Ayre (tel 042 21 3440)

THE AUSTRALIAN Flora and Fauna Research team consists of a group of ten academic staff and more than 20 research students. Research within the program focuses on the biology of Australian animals and plants and has traditionally had a strong emphasis on 'fieldwork'. However, recent strengthening of expertise in physiology and the adoption of molecular techniques for population genetics studies has increased involvement in laboratory based investigations. Major areas of study include evolution, physiology, ecology and genetics. Systems studies include subtidal and intertidal marine, freshwater streams, forest heathland and arid zones, and industrial lands.

Previous *Research Reports* have described studies in areas including

insect behaviour, endangered orchids, natural marine antifouling compounds, animals in stressful environments and the dispersal of sea squirts.

The Australian Flora and Fauna Research Program logo combines symbols of the natural environment: eucalyptus trees, wallabies and starfish, in an interconnected series of arrows representing links between organisms and ecosystems.



tions and the animal's physiological state. She also studies the interactions of hormones and reproductive behaviour in birds in both field and laboratory settings. Australia's bird populations provide a great opportunity to carry out comparisons with separately evolved northern hemisphere species. Lee collaborates on this work with another recently appointed member of the Program, Dr Bill Buttemer.

Paul Else is a University of Wollongong graduate and has returned to the University after academic appointments at the University of Melbourne and most recently at Deakin University. His interests are in the area of comparative cellular physiology, energy turnover and the evolution of warm-bloodedness in mammals and birds.

Dr Else's appointment provides the opportunity to strengthen a long-term collaboration with Associate Professor Tony Hulbert. Their recent work has shown that animals have membrane proteins (ie sodium pump) that use more energy in mammals compared to the lower vertebrates but the number of these proteins is about the same and their composition is known to be similar. It would therefore appear that changes in the fats associated with cell membranes, that surround these proteins, during the evolution of endothermy has allowed the same proteins to work up to four

Members and Associate Members

Dr Lee Astheimer, Dr Bill Buttemer, Dr Jim Campbell, Dr Andy Davis, Dr Paul Else, Dr Kristine French, Dr Ross Goldingay, Associate Professor Tony Hulbert, Professor Rob Whelan

New staff and research directions

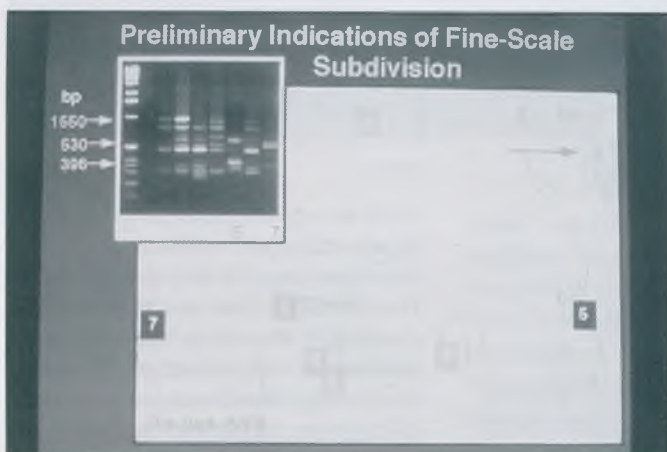
Two new staff joined the Program in 1994. They were physiologists Dr Lee Astheimer and Dr Paul Else. Lee Astheimer is a North American biologist and carried out her PhD research at the University of California, Davis. Her interests are focused on adaptations of the endocrine stress response in vertebrates, particularly in relation to environmental condi-



A diver collects specimens of sub-tidal sea squirts for genetic analysis and genetic variation is revealed by the presence of different bands of DNA revealed by PCR RAPD analysis



Research into the evolution of endothermy compares the metabolic characteristics of mammals and reptiles



times harder, in the process helping to fuel the evolution of endothermy.

Future work will begin to examine the basis of 'hot-blooded' plants and how some plants can have structures that consume oxygen at a rate equal to that of the flight muscle of active humming birds and thereby get up to 35 deg C hotter than their environments.

International links

The Program was once again host to several visitors in 1994, including two long-term visitors who undertook major research projects.

Dr David Lyon (Cornell College, Iowa) visited for six months, studying the Illawarra flora. His interest is in worldwide patterns in the ratio of male and female reproductive effort in plants – the pollen:ovule ratio. The

pollen:ovule ratio is thought to correlate with a plant's breeding system and mode of pollination. Plants that are self-compatible (can self-fertilise) typically have fewer pollen grains per ovule than those that are obligate outcrossers. The Australian flora, especially the Family Proteaceae, offers great opportunities for extending our knowledge of pollen:ovule ratios, and Wollongong was the place to come because Rob Whelan, Kris French and David Ayre along with several research students, have accumulated a substantial body of knowledge of breeding systems of native plant species.

Du Zaixiang, a lecturer from Qufu University in the Peoples Republic of China, was a visiting fellow (on a Chinese government fellowship) with the Australian Flora and Fauna Research Centre for a year from April 1994. While at Wollongong, Du Zaixiang has been working with Tony Hulbert on the effect of temperature on the tissues of warm-blooded (endothermic) and cold-blooded (ectothermic) vertebrates. He is especially interested in determining whether endotherms can maintain cellular ion concentrations at low body temperatures. Ectotherms are able to do this and it seems it is a primary reason why they can survive over a broad range of body temperatures whilst endotherms cannot. This research is supported by a National Health and Medical Research Council Grant.

In addition there were several important short-term visitors including Dr Ib Svane, Swedish Academy of Sciences (Marine Ecology), Professor Robert Cruden, Iowa State University (Pollination Biology) and Professor William R. Dawson, University of Michigan (Vertebrate Physiology). Canadians Professor David Innes and Dr Luise Hermanutz of Newfoundland's Memorial University completed their year long sabbatical visit in July (see 1993 report).

Links with Thailand were strength-



Associate Professor David Ayre censuses populations of intertidal sea anemones at Rottne Island, as part of a 15-year-long study of sexual and asexual reproduction

ened through a two month staff exchange visit by Dr Itsara Intarai, Prince Songkla University who carried out experiments on the effect of algal harvesting on seagrass communities in Lake Illawarra (hosted by Andy Davis). This was followed by a return visit by Andy who visited three Thai campuses with the express purpose of establishing research links.

Radio telemetry is used to track feral goats in the Barren Grounds Nature Reserve



Several members of the Program were active overseas. Dr Andy Davis spent the first half of 1993 on sabbatical leave at Universidad Austral de Chile where he studied the factors affecting the establishment of marine invertebrates. Late in the year Andy visited the University of Barcelona, Spain where he acted as an invited PhD examiner, Tony Hulbert and Paul Else contributed invited papers to a symposium session on 'the evolution of endothermic metabolism' at the San Diego Meeting of the American Physiological Society (convened by Tony); Bill Buttemer gave an invited paper in a symposium on 'the adaptations of birds to winter' at the 21st International Ornithological Congress in Vienna; and David Ayre, Lee Astheimer and Bill Buttemer all authored papers at the American Zoological Society meeting in Los Angeles; Andy Davis presented an invited paper at the annual Chilean Marine Science Conference.

Successful postgraduates

Postgraduate research is one of the Program's strengths and our PhD students continued to enjoy success in 1994. Highlights included the successful completions by Slade Lee (Citrus



Birds are offered a choice of artificially constructed clusters of fruit during one of Dr Kris French's seed dispersal experiments

genetics), Sue Schibeci (Genetics and Pollination Biology of *Banksia*), and Siegy Krauss (Taxonomy and evolutionary biology of *Persoonia*), and the appointments of recent graduates Drs Kerry Ayre, Stan Bellgard, Patrice Couture and Siegy Krauss as post-doctoral research fellows, and Drs Jennie Chaplin (Murdoch) and Kerry Withers (Toowoomba) as lecturer and associate lecturer respectively.

Vacation research scholarships

This year the Program funded five two-month research scholarships targeting high quality senior undergraduates and honours students. The response from around Australia was very strong and the Program clearly achieved its aim of raising our profile in other Universities, encouraging good students to stay with science and also funding some valuable short-term research. Several students have consequently applied to enrol at Wollongong.

Industry and community links

The Program continues to foster strong links with industry and community organisations, and has been rewarded with the collaborative support of three PhD students under the APRA industry scheme. The latest student will join the Program in 1995 and will investigate 'weed control in bushland and its impact on native flora and fauna' with sponsorship from the Public Works Department of

NSW, and collaboration with NSW Agriculture.

Management and conservation of our intertidal communities are a particular concern of a group including Andy Davis, David Ayre and their research students. This has led to projects ranging from the conservation biology of pipis to the effects of sewage pollution on our rocky shores and sandy beaches. Andy Davis now has a direct input into management strategies following his appointment to the Intertidal Protected Areas Advisory Committee for the Illawarra and South Coast.

Some research in progress and new grants

The 1994 wildfires in Sydney brought the question of ecological effects of fires into sharp relief. With the emphasis on trying to prevent repeats of this bushfire emergency, thoughts have turned to more extensive hazard-reduction burning: that is, burning bushland frequently and in the cool season of the year, to reduce the amount of burnable plant material.

But what effects might frequent, out-of-season fires have on the native biota? Professor Whelan's new ARC-funded project will examine the question of how season of burning influences recovery of plant populations after fire. Experimental fires will be conducted in Spring and Autumns

in 1995 and 1996, and several features of plant survival and recruitment of seedlings will be measured.

Dr Kris French was very successful in attracting external funding during 1994. Her interests are also in terrestrial community ecology result in a great diversity of research projects being undertaken. Most studies concentrate at the interaction between plants and animals. A major new project has begun measuring invertebrate biodiversity in Australian habitats and determining the variation in space and time within a habitat. Few studies have taken such a broad approach to insect communities.

The major study, funded through ARC, will occur on the North Coast of NSW where other surveys have looked at vertebrates and plants. An important component of this study is to determine if areas that conserve diversity of plants and vertebrates are also good areas for diversity of invertebrates. This has been an assumption of Australia's conservation policy which has never been tested.

Work looking at the relationship between bird diversity and insect diversity has been investigated this year in the Sydney region. Research interests in seed dispersal have continued with some students looking at the role of birds in dispersing seeds of Bitou Bush, a noxious weed invading coastal plant communities.

Finally, Kris' interest in birds has led to a major grant being given (administered through the RAOU) for habitat restoration of box-ironbark woodlands near Capertee. This area is one of the few remaining sites for the endangered Regent Honeyeater. Much of this work is facilitated by the bird groups in the Sydney region who closely monitor the activities of the birds and the whole project is closely connected with the National recovery effort for this species. With the severe drought, a grim picture is currently being drawn – but hopefully the species will recover well after the drought has broken.

*Significant increase in industrial support for research into
drug design and synthesis, radiopharmaceuticals
and bioactive chemicals from plants*

Bioactive Molecules

Co-ordinators: Professor John Bremner (tel 042 21 3509) and **Associate Professor Stephen Pyne** (tel 042 21 3511)

THE BIOACTIVE Molecules Research Program links the overlapping and complementary research interests of 11 academic staff from the Department of Chemistry in the area of synthesis, isolation and characterisation of biologically and pharmacologically active molecules. Central to much of this work is the elucidation at molecular level of the physiological action of such molecules and the details of their metabolism.

Significant impetus early in the year was provided by the arrival of two

new academic staff (Dr Joanne Jamie and Dr Paul Keller) and the establishment of their research laboratories. Dr Jamie's research focuses on the interaction of lens UV-filter compounds with proteins, a process implicated in the formation of cataract, and on the isolation and synthesis of new lens metabolites. Dr Keller's research on the asymmetric synthesis of bioactive molecules, including anti-HIV compounds, provides additional and complementary strength in the medicinal chemistry area.

A highlight Program was the installation of a 300 MHz NMR spectrometer. Together with the 400 MHz NMR spectrometer (and the recent acquisition of a 15 percent share of a 600 MHz NMR) and our Triple Quadrupole mass spectrometer, this provides a very powerful world-class facility for the characterisation of bioactive molecules and the elucidation of their mode of action at molecular level.

Use of this facility will further enhance cross-disciplinary collaboration between staff from the Departments of Biological Sciences and Chemistry and the Biomedicine and Health Program at the Australian Nuclear Science and Technology Organisation (ANSTO).

In addition to the 11 academic staff members during the year, research personnel directly involved in the

Bioactive Molecules Centre include 15 PhD students, one MSc (Hons) student, five Honours students, three Post-doctoral Fellows, three Visiting Fellows and three Research Assistants, giving a total of 41 research personnel. Also involved are ten Associate Members.

The Program continues to be successful in attracting external research funds, totalling \$965,231 for 1994. This included \$692,808 from the ARC and \$137,000 from the NHMRC. The Program's strong commitment to industrially significant research is shown also by the five APRA (Industry) Awards, valued at \$137,388 granted to Program members in 1994. Direct research support from the pharmaceutical industry has also increased significantly, with grants to Associate Professor Stephen Pyne from Johnson & Johnson and to Professor John Bremner from AMRAD, CIBA-GEIGY and Glaxo totalling \$135,323.

Members of the Centre presented a number of invited plenary and session lectures at international conferences and 34 research colloquia at other universities in Australia and overseas.

The Program contains two major research strands. The first is concerned with the design, synthesis and evaluation of bioactive compounds, the second with the structural elucidation and analysis of such compounds

Members

Dr Joanne Jamie, Dr Paul Keller, Dr Renate Griffith, Professor Leon Kane-Maguire, Dr Philip Maynard, Dr Garry Mockler, Dr Will Price, Dr Stephen Ralph, Dr Margaret Sheil, Dr Geoff Wickham, Dr Alison Ung, Dr Benoit Joseph

Associate Members

Dr M Binns, Dr D Dougan, Dr R Lambrecht, Dr D McFadyen, Dr V Murray, Dr G Simpson, Dr R Smith, Dr S Smith, Professor L. Storlien, Dr L Woolf



Members of the Program in the Nuclear Magnetic Resonance laboratory. From left are Professor John Bremner (Co-ordinator), Associate Professor Stephen Pyne (Co-ordinator), Michael Davey (summer scholar), Dr Stephen Ralph, Dr Paul Keller, Pily Vazquez (summer scholar), Professor Leon Kane-Maguire and, in front, Anna Siu (PhD student) and Robert Rezaei (PhD student)

from natural sources. The large majority of the projects involve collaboration between several staff, a trend which is encouraged by the regular Program research meetings. Developments in some major areas of work are summarised below.

Heterocyclic bioactive compounds

As part of a search for new medicinal agents having high beneficial activity and minimal adverse effects, Professor John Bremner's medicinal chemistry group is involved in the design, synthesis and pharmacological evaluation of novel lead compounds as potential anti-depressants, anti-psychotics and anti-hypertensive agents. Progress, for example, has continued in the design and preparation of serotonin potentiators based

on new heterocyclic derivatives for potential use as anti-depressants. Structure-activity relationship studies and associated computer-aided molecular modelling have led to a refinement of the key structural requirements for activity. New routes to functionalised benz-fused medium-sized heterocycles have been developed and these derivatives are to be used for probing structural needs for α_1 -adrenoceptor interactions. Prototypes for potential new dopamine pro-drugs have also been made and routes to a range of new heterocyclic derivatives based on aporphine and benzyloquinoline alkaloid precursors have been developed.

New ring-D indole analogues of the aporphine skeleton have been developed for assessment in the treatment of benign prostatic hyperplasia. A

short route to the useful antischistosomal agent praziquantel has been developed and the scale-up potential of this route is to be investigated.

Asymmetric synthesis of pharmaceuticals

A high proportion of drugs exist in two mirror-image (enantiomeric) forms, which frequently have very different biological effects. Many such drugs are currently administered as a mixture of these two forms, only one of which has the desired physiological function. This has led in some cases to serious medical problems, the most publicised of which was the case of the drug thalidomide in which one of the mirror forms led to serious birth defects.

These concerns and recent stringent regulations by the Food and Drug Administration have led to intense interest in developing methods for the production of drugs in only the one desired mirror form. The research group of Associate Professor Stephen Pyne and Professor Leon Kane-Maguire in the Department of Chemistry has recently developed several novel and efficient routes to such asymmetric synthesis. These include a new and general asymmetric synthesis of non-proteinogenic amino acids in high optical purity.

The incorporation of these new amino acids into insect neuropeptides is planned in the near future, potentially providing new, potent and species-selective insecticides. The asymmetric synthesis of a number of analogues to the anti-immunosuppressive drug THI has also been developed. These compounds are currently being tested on diabetic mice at the Walter and Elisa Medical Research Institute in Melbourne as possible drugs to prevent the onset of diabetes and for use in transplant biology.

Chiral iron organometallic reagents have also during the past year been attached to polymer surfaces and their reactions with various reagents examined, as a prelude to their use in asymmetric synthesis. Dr Paul Keller has recently joined this group and has started a project concerned with the design and synthesis of novel anti-HIV molecules.

New anti-cancer drugs

The design and synthesis of compounds that derive their antitumour activity through a specific type of chemical interaction with DNA is being carried out by Dr Geoff Wickham and co-workers. Currently, these studies are focused on directing both alkylating groups and platinum(II) complexes to the minor groove of double helical DNA. Many solid tumours consist of a large fraction of cells that are deficient in oxygen (ie, hypoxic)

and these have traditionally been very difficult to treat with either radiotherapy or existing chemotherapeutic agents. Also being explored are strategies for making DNA-directed agents selectively cytotoxic to hypoxic tumour cells. Synthetic work on some of the compounds mentioned earlier is being done in collaboration with researchers at the University of Melbourne.

In collaboration with researchers in the School of Biochemistry and Molecular Genetics at the University of New South Wales, detailed studies have been carried out on the binding of our synthetic compounds to DNA in intact human tumour cells. This work involves the use of *Taq* polymerase sequencing methods.

Another important component of Dr Wickham's medicinal chemistry research is the use of high-resolution structural methods, such as NMR spectroscopy, and computer-based molecular modelling to characterise ligand/DNA complexes. Recently

completed has been the full (solution) structure of the natural product hedamycin bound to a hexadeoxyribonucleotide and researchers have extensive experimental data on hedamycin bound to a second DNA sequence. These NMR structural studies are now complemented by an active program aimed at developing electrospray mass spectral methods for acquiring detailed structural information on ligand binding to DNA. Doctors Sheil and Wickham have just reported the first observation, by mass spectrometry, of a ligand covalently bound to double-stranded DNA.

Other related studies are being conducted by Dr Stephen Ralph who is examining ruthenium-DMSO complexes as potential anti-tumour agents.

Radiopharmaceuticals

In collaboration with the Biomedicine and Health Program at ANSTO, groups in Chemistry led by Professor

Dr Alison Ung is using computer-generated molecular modelling in the design of new immunosuppressive agents to prevent the onset of diabetes





Paula Iannitti (PhD student) purifying new ligands for novel ruthenium-based anti-tumor agents

John Bremner, Professor Leon Kane-Maguire and Associate Professor Stephen Pyne are developing novel synthetic routes for the preparation of radio-labelled pharmaceuticals.

Bioactive metabolites from plants

The structures of some chromone derivatives from a Thai medicinal plant used in the treatment of malaria have been confirmed by Professor

Bremner's group in collaboration with researchers at Silpakorn University, and the use of the compounds as structural leads for new anti-malarial agents is now being investigated.

Work has been undertaken with GLAXO on the assessment, synthesis and structural elucidation of very minor components in pharmaceutical alkaloid preparations. The synthesis of a calystegin-type alkaloid skeleton has been achieved as part of a project

on these alkaloids and analogues. The calystegins are glycosidase inhibitors and are of interest as potential anti-viral agents.

A project with AMRAD was completed on the isolation and structure elucidation of a new naturally-based antibiotic.

Kinetic studies by Dr William Price in Chemistry of the aqueous extraction of sugar and organic acid components from citrus fruit have established the mechanism as first order. Most significantly, high temperatures were found to cause major compositional changes of the soluble constituents, leading to degradation of the aqueous extract. This is important, since proponents of counter-current aqueous extraction techniques for citrus fruit currently advocate high extraction temperatures.

Biomolecular mass spectrometry

Dr Margaret Sheil's group is exploring a wide range of novel applications of the new electrospray mass spectrometry technique. This has included the development of facile methods for characterising: radioimmunospecific pharmaceuticals (with ANSTO); anti-tumour ligands interacting with DNA (with Dr G Wickham); organometallic peptide derivatives (with Prof Kane-Maguire); and a range of inorganic complexes (with Drs G Mockler and S Ralph). Many of these important bioactive compounds have not previously been amenable to analysis. A major advance this year has also been the observation of non-covalently bound species such as protein-inhibitor complexes by mass spectrometry and this work is being extended to other important biological systems.

*Structure and function of DNA and proteins
Cancer, cataract, apoptosis
Chemiluminescence and Rubisco*

Biological Macromolecules

Co-ordinator: Associate Professor Ross Lilley (tel 042 21 3431)

MEMBERS of the Biological Macromolecules Program are pursuing research on a broad range of topics all centred on the structure and function of DNA and proteins. State of the art facilities acquired include enhanced computer-based molecular analysis capabilities and a FACSort flow cytometer for analysing cells and separating cell populations.

Dr Mark Baker

Cancer and inflammation

Principal research areas are: (a) the molecular cell biology of the serine protease inhibitor PAI-2 and (b) the cell biology of the processes involved in human cancer cell spread (metastasis).

A new research collaboration with American Diagnostica Inc USA aims to

identify and analyse those receptor proteins (and the genes which code for those proteins) responsible for the binding of plasminogen to malignant cancer cells. A study funded by Biotech Australia and the Cancer Council is examining the use of the genetically-engineered serine protease inhibitor PAI-2 to 'image' and detect sub-clinical metastatic cancer.

Dr John Carver

Structural studies of proteins

The studies have concentrated on using various structural methods (NMR, mass, fluorescence and absorption spectroscopy) to probe the higher-order structures of a variety of proteins.

The eye lens crystallins and their interactions play a crucial role in the maintenance of lens transparency. The chaperone or protective role that the major lens protein α -crystallin plays has been of interest lately. It has been demonstrated that α -crystallin has surfactant-like properties and that its chaperone ability does not alter with age. The flexible C-terminal extensions of α -crystallin seem to have no direct role in the chaperone action although alteration of the domain core of the protein leads to large reduction in this ability. The high-molecular-weight (HMW) protein found in older lenses, which is mostly composed of α -crystallin, has very similar properties to that created during the chaperone action of α -crystallin, suggesting

that the HMW protein arises from the chaperone action of α -crystallin. NMR spectroscopic studies of the b - and g -crystallins show that they also have flexible terminal extensions and their roles in crystallin-crystallin interactions have been delineated. For example, the short, hydrophobic C-terminal extension of g -crystallin is involved in interactions with the other crystallins.

In collaboration with Dr John Wallace at the University of Adelaide and Dr Max Keniry at the Australian National University, work is well advanced in determining the solution structures of potent insulin-like growth factor derivatives which have great potential widespread therapeutic uses, eg. in the treatment of trauma patients. Using a ^{15}N -labelled protein, much of the NMR spectrum has been assigned and, using these assignments, the calculation of structures by computer-based methods will commence in 1995.

Associate Professor Roger Truscott

The mechanism of cataract formation in humans

Cataract is one of the major causes of blindness. The group aims to develop a rational approach towards the design of cataract-preventative drugs. The only cure at present is by surgery. The group is investigating the biochemistry and chemistry of tryptophan metabolites and proteins

Members

Dr Mark Baker, Dr John Carver, Dr John Fitter, Ms Julie-Ann Green, Dr Xiao Ming Liang, Ms Therese Marengo, Dr Marie Ranson, Associate Professor Ted Steele, Associate Professor Roger Truscott, Dr Mark Walker, Dr Mark Wilson, Dr Salwa Woodroffe



Dr Mark Wilson (pictured here), together with Dr Mark Baker, led a successful application to ARC Equipment for an analytical flow cytometer. This apparatus can analyse and sort thousands of individual cells per minute

that occur in the eye lens, to gain a better insight into the formation of cataract in humans. Key metabolites have been isolated, characterised and synthesised and metabolic studies using tritium labelling are currently being performed. The interactions between some of these metabolites and lens proteins under oxidative conditions appear to play an important role in cataract formation. To verify this, modelling studies with the metabolites and small peptides are under way and the products characterised and compared with compounds isolated from cataractous lenses.

Associate Professor Ross Lilley

1. Chemiluminescence and the catalytic mechanism of Rubisco

Rubisco is the enzyme in plant leaves that fixes carbon dioxide from the atmosphere into organic carbon, the end-product of photosynthesis. The recently-discovered chemiluminescence (light emission) by this enzyme provides a new probe of

unprecedented sensitivity into the catalytic mechanism. The response of light emission to reaction conditions and temperature has been further characterised, revealing unusual responses to temperature and effects of the bound metal ion on the binding of inhibitor formed by catalytic misfires. An understanding of light emission will provide new information on the mechanism of Rubisco, a major determinant of plant productivity.

2. DNA fingerprinting of *Dunaliella* for species identification

A method has been developed for identifying different species of the salinity-tolerant alga *Dunaliella*, on which is based a new Australian industry producing b-carotene. The powerful technique of Random Amplified Polymorphic DNA (RAPD) has been applied and conditions defined that give reproducible and unique patterns for each of three species tested (*D. salina*, *D. viridis*, *D. tertiolecta*). A unique band for *D. salina* was cloned into a vector and partly sequenced.

3. Isolation of glycerol phosphate dehydrogenase (GPDH) from *Dunaliella*

This enzyme catalyses a regulated step in the production of glycerol, a key compound in the mechanism of salinity resistance. A method for purifying GPDH is under development to allow the N-terminal amino acid sequence to be determined, to allow the future isolation of the gene for GPDH.

Associate Professor Ted Steele

DNA Sequence Structure of Vertebrate Germline Variable Genes: Evolutionary Implication

Associate Professor Steele and his colleagues have determined the DNA sequence patterns found among 52 related murine immunoglobulin (Ig) variable (V) genes that have important implications for the evolution of the IgV multigene family [PNAS vol 91, pp.12163-12167, Dec 1994]. They have extended these analyses to related germ-line IgV genes from other vertebrate species that are available in the literature. The results

demonstrate that in all sequences analysed, variability is concentrated in a highly non-random fashion in the regions that encode the complementarily-determining regions in the expressed proteins, whereas other portions of the germ-line V gene sequences are conserved. Furthermore, all sequence sets display significantly fewer than expected stop codons that are generated by nucleotide substitutions.

Strikingly, these patterns are also present among two sets of chicken pseudogenes. Where the available data allowed appropriate analysis it was found also that the putative coding regions of germ-line V genes were flanked by concentrations of nucleotide insertions and deletions. This supports the Researchers' previous hypothesis that the evolution of germ-line V genes involves hyper-conversion events that are targeted to the putative transcription and/or coding units. The total nature of the patterns is incompatible with conventional evolutionary mechanisms but is consistent with homologous recombination into germ-line sites of cDNA copies of V gene mRNA sequences derived from antigen-selected B lymphocytes.

Dr Mark Walker

1. Development of acellular and live oral recombinant vaccines against the whooping cough bacterium, *Bordetella pertussis*

Oral immunisation with recombinant, live, avirulent *Salmonella* spp. expressing pertussis toxin (PT) subunits S1, S2 and S5 has been shown to develop anti-PT immune responses in mice. Expression of PT subunits in the avirulent *Salmonella* spp. system may lead to the development of an oral whooping cough vaccine. A system has been developed to allow over-expression of the PT antigen in avirulent and virulent *B. bronchiseptica*.

2. Molecular and genetic analysis of *Bordetella bronchiseptica*

The molecular analysis of both urease and flagella biosynthetic genes of *B.*

bronchiseptica has been initiated. Urease-deficient and non-motile transposon mutant genes have been cloned and are now undergoing DNA sequence analysis.

3. Development of recombinant oral and intranasal vaccine delivery systems for the stimulation of immunity against the porcine pathogens *Erysipelothrix rhusiopathiae* and *Mycoplasma hyopneumoniae*



Co-ordinator of the Program is Associate Professor Ross Lilley

In collaboration with the NSW Department of Agriculture (EMAI), vaccine antigen genes of several porcine pathogens have been cloned and expressed in avirulent *Salmonella* spp. The COOH-terminal of one such *M. hyopneumoniae* antigen gene has been sequenced and found to encode a protein analogous to the 5' *proU* linked genes of *E. coli* and *S. typhimurium*. Recombinant overproduction of this antigen has been achieved and the purified protein will now be used in vaccine trials in pigs. The 36 kDa antigen of *E. rhusiopathiae* has been expressed in avirulent *Salmonella* spp. Initial experiments indicate that this antigen promotes a strong T cell response after oral immunisation of mice.

Dr Mark Wilson

Studies on a protein involved in apoptosis

Apoptosis is a form of programmed cell death with implications in growth, development and cancer. This project began with the appointment of Dr Mark Wilson to the University in March 1994. The work conducted so far has included the production of a variety of stably transfected cell lines which inducibly express the protein clusterin. Clusterin has been impli-

Dr Mark Baker, among whose research interests are the molecular cell biology of the serine protease inhibitor PAI-2 and the cell biology of the processes involved in human cancer cell spread





Dr John Fitter and Miss Tanya Dalla-Pozza are working on the development of new vaccines against *Salmonella*

cated in a number of biological functions, including regulation of complement and lipid transport, which operate at the cell surface, and the researchers have shown that 'normal' cells, when stressed, express clusterin at the cell membrane. In one case, they engineered a fusion protein consisting of clusterin fused at its carboxy terminus to a short linker peptide and a glycosylphosphatidyl inositol anchor.

This system was developed to obtain a transfected cell in which expression of clusterin at the cell surface could be induced. These transfected cells have been used in a variety of functional assays designed to ascertain the genuine biological function of clusterin. Results obtained suggest that clusterin is not a physiological regulator of the complement system but may be involved in lipid transport.

Dr Wilson has also been involved in negotiations concerning the further development of an amplification technology evolved by him for use in enzyme immunoassays. Agreement has been reached with an Australian company for kit trials to start early in 1995.

Dr Salwa Woodroffe

Effect of cytomegalovirus infection on the expression of mRNA for plasminogen activator inhibition in human cells

Under normal conditions, the plasminogen activation cascade is tightly regulated at the surface of endothelial cells partly through the activity of their inhibitors (PAI-1). Disruption in regulated synthesis of PAI-1 could result in alteration of the thrombogenic properties of these cells and can affect their controlled proliferation and cell division. Increased production of PAI-1 causes the inhibition of TGF β , a potent inhibitor of endothelial cell proliferation.

Dr Woodroffe's investigations on infection of human endothelial cells by cytomegalovirus showed an increase in their proliferation and cell division. This was followed by investigating the expression of mRNA for PAI-1. A massive increase in mRNA for PAI-1 in these cells at 2-3 days post-infection was revealed. Increased production of PAI-1 production could induce the proliferation of endothelial cells by suppressing inhibitors for endothelial cell proliferation.

Fundamental and applied research providing engineering solutions to industrial problems involving bulk solids handling and particulate technologies

Bulk Materials Handling and Physical Processing

Co-ordinator: Professor Peter Arnold (tel 042 21 4566)

Members of this Program actively engage in fundamental and applied research in the area of bulk solids characterisation, flow, storage, conveying and physical processing. These activities have been undertaken at the University for more than three decades. Members also actively pursue the transfer of the technology developed to the industries which can benefit from that research. Courses concerned with a range of bulk solids handling and processing topics are presented as part of the undergraduate and postgraduate programs at the University as well as to industry through short courses and conferences.

Control of dust generation in materials handling operations is important in many industries. Novel research, under the supervision of Dr Paul Cooper, aims to record, analyse and model dust and fume generation and flow mechanisms. At present three

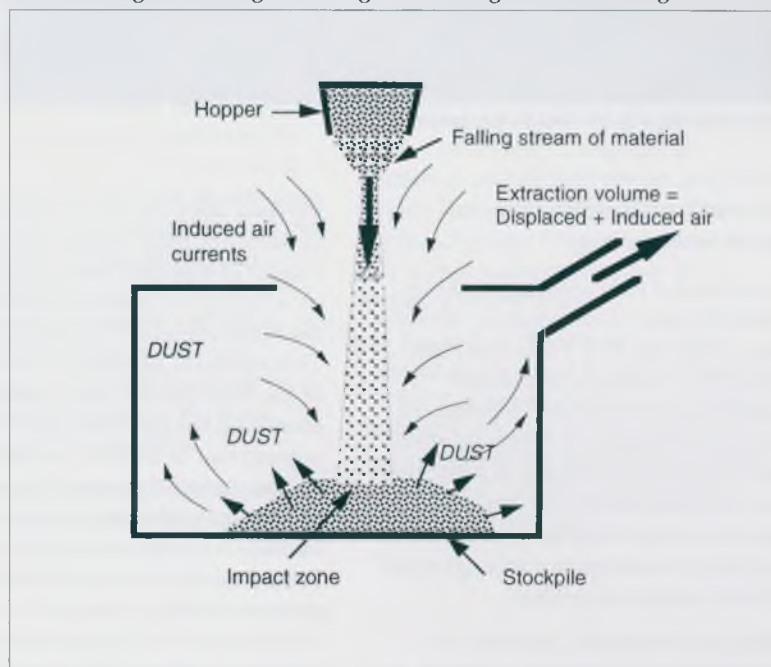
final-year undergraduate thesis students are studying dust generated from a falling stream of dusty material.

Dust generation research

Some aspects of this project are illustrated: (a) a schematic of the test rig to measure dust generation from a falling stream of material; (b) an experiment under way; (c) typical quantitative results from a laser particle counter.

Screw conveyors have been in use since Archimedes but when used as feeders under bin outlets the mechanics of screws are not well understood. A PhD project, supervised by Professor Peter Arnold, is developing design strategies to establish optimal configurations and make accurate power predictions for screw feeders. The approach taken aims to eliminate the current reliance on empirical factors and replace them with parameters that are based on bulk solid flow

Line drawing illustrating the dust-generation rig used in the Program



Members

Dr Paul Cooper, Dr Zhihing Gu, Mr Oliver Kennedy, Dr Arnold McLean, Dr Renhu Pan, Professor Nick Standish, Professor Michael West, Dr Peter Wypych



The dust rig experiment in progress

properties and screw geometric considerations.

An external PhD student working with Portland Aluminium in Victoria and supervised by Professor Peter Arnold is making a significant contribution to the development of improved feeders to meter alumina powder into the reduction cells. The work involves not only improved materials handling but also material selection, maintenance strategies and feeder control algorithms.

Seeking to identify, quantify and improve the extent of segregation in

the feed hoppers of twin-hopper feed systems for blast furnaces is the subject of a project being undertaken by a final-year honours student under the supervision of Dr Arnold McLean. This research, utilising a scaled model of the blast furnace feed system, has identified the fact that significant segregation of the feed ingredients occurs during charging. The work is particularly relevant as No 6 Blast Furnace is constructed at Port Kembla. Improvements examined include geometric design changes to the feed chute system and hopper internal fitments. Aspects of this work will

continue in 1995 as part of an industrially sponsored ME thesis project.

Throughout the year Dr Peter Wypych, Dr Arnold McLean and Dr Renhu Pan continued to make significant progress in the advancement and understanding of pneumatic conveying systems, both lean and dense phase, stepped-diameter pipeline technology, scale-up procedure, system configuration, material/system selection and pneumatic-injection strategies. Particular mention is made of:

- (i) The NERDDP/ACARP funded project 'Development of Handling Techniques for the Injection of Coal into Boilers', Project No C1571, for which the final report was submitted in July. The technology, hardware and operating procedures developed were shown to be successful in
 - providing a stable, controllable and continuous injection rate of pulverised coal under high pressures,
 - ensuring that all transfer operations for the feeding/injection vessel are completed without any effect on the injection process (during all batch, manual- and auto-continuous modes of transport),
 - eliminating flow/pressure fluctuations during start-up and any transfer operation,
 - developing accurate scale-up procedures for the determination of pneumatic conveying characteristics and hence reliable operating conditions for different configurations of pipeline.

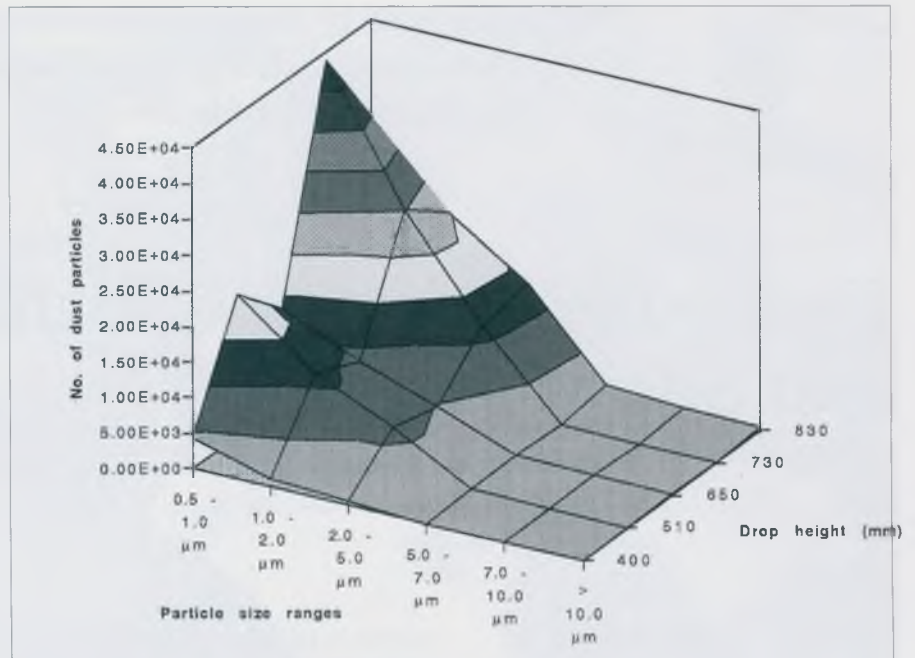
This project was successful in maximising the operational and combustion efficiency of coal-fired boiler applications, such as direct ignition for light-up and support energy. The developed technology has already been implemented in power stations in New South Wales.

The Australian Coal Association selected the project to receive the

inaugural 'Excellence in Research Award' for the best Coal Utilisation Research Project completed during 1994.

- (ii) Bo Mi completed his PhD 'Low-Velocity Pneumatic Transportation of Bulk Solids' research, which resulted in the development of an original model to predict the velocity and pressure drop for low-velocity multiple slug-flow conveying systems. This mode of transport has been developed specifically for fragile and/or granular bulk solids (plastic pellets, wheat, rice, puffed cereals, muesli) and has been proved over the past 20 years to be the most complex and difficult method of transport to investigate and model accurately. Despite these difficulties, Bo Mi developed a series of bench-type experiments to measure certain particle and bulk properties for the estimation of slug velocity, wall pressure and ultimately pipeline pressure drop. Accurate predictions were confirmed by testing a range of fine and coarse bulk solids through various large-scale pipelines – 50 m long x 100 mm nominal bore (NB), 100 m x 100 mm NB, 50 m x 150 mm NB.
- The developed technology has also been used successfully in the design of other industrial systems:
- 40 t h⁻¹ of plastic pellets through 200 m and 400 m pipelines for a chemical corporation in Korea.
 - 15 and 30 t h⁻¹ of urea through a 125 m pipeline for a company in Victoria.

- (iii) Research has continued on explaining the handle ability differences between various pulverised coal fuels (PF) during dense-phase pneumatic conveying in direct coal injection systems (DCI). This work, conducted as a sub-contractor to the Australian Combustion Technology Centre (a division of ACIRL) and funded by ACARP, seek to



Graph showing some results of the dust-generation research

explain the generally poor suitability of local soft coals (characterised by high Hardgrove Grindability Index) for use in Direct Coal Injection (DCI) systems. In contrast, hard coals (low HGI) appear to be extremely good candidates for DCI, can be reliably handled and reveal a greater tolerance over a much wider range of system operating parameters and configurations (including multiple pipelines). This work also seeks to identify whether the coal can be ground to a suitable size consist by suitable adjustment or optimisation of mill parameters. This project has identified, by use of both bench scale measurements and pilot scale pneumatic conveying testing, that vast differences in characteristics occur between seemingly similar PFs.

Members of the Program continued their contributions to continuing

education in bulk solids and particulate technologies with short courses being run at the University in November, in New Zealand in February, Melbourne in August, Gold Coast and Sydney in September, and in-house for several companies (ACI Glass Packaging, Melbourne, February; Alcoa of Australia, Perth, May; Penrice Soda Products, Adelaide, July). Overseas seminars/workshops were presented in April and May to Du Pont, Wilmington DE, Dow Chemical, Midland MI, Pennsylvania State University, University of Pittsburg and at the Powder and Bulk Solids Continuing Education Program, Chicago. Program members throughout also carried out 70 projects for industry.

At the end of 1993 Professor Peter Arnold was elected to the Fellowship of the Australian Academy of Technological Sciences and Engineering in recognition of his contribution to the science and practice of bulk solids handling technology.

*Privacy and confidentiality of information networks
Data integrity, database and access security
Cryptographic and hashing algorithms*

Computer Security – Technical and Social Issues

Co-ordinator: Professor Jennifer Seberry (tel 042 21 4327)

PHENOMENAL growth of information and desire for its rapid dissemination have led to an explosion in the information services, communications and computer industries, accompanied by growing concern about confidentiality, privacy and accuracy of information. This situation has led members of the Centre for Computer Security – Technical and Social Issues to the study of a broad range of issues related to computer and communications security, privacy and ethics.

Professor Jennifer Seberry has spoken three times on ABC radio in the past year about the dangers to individual freedom which may arise from the insensitive use of cryptographic and other security techniques. Security concerns have to be tempered by the rights of individuals to privacy and freedom even though these may be in conflict.

Members

Associate Professor J Peiprzyk, Dr R Safavi-Naini, Dr Y Zheng, Dr T Hardjono, Dr C Charnes, Dr X Zhang, Associate Professor J Cooper, Ms C Alcock, Ms R Lindley

Ms Robyn Lindley's research has shown the need to review and reframe new technology product design. A critical evaluation of results obtained by information based technology trials to date indicates that a large number of unexpected problems arise as a consequence of user resistance and concerns.

Ms Lindley's work provides the sociotechnical basis for smart card design practice and seeks strategies to overcome the concerns regarding the management of the information and perceptions of security which have so far limited the number and type of applications.

In the past consumers' concerns have been treated as *afterthoughts*. Ms Lindley's work is devoted to building a sociotechnical frame work which may well offer an effective technique for introducing new smart card technology and providing a basis for ongoing technological improvement and enhancement of products while addressing user-needs and concerns about privacy and trust in some detail.

The Centre has actively co-operated with the Australian Human Rights Commission's Privacy Section, with nine members co-operating to prepare four papers and presentations on matters related the impact of ad-

vances in security technology on individual rights and developing concerns regarding the use of information superhighways.

Security tends to focus on keeping unauthorised people out. In addressing issues of database and network security, is important that a balance be maintained between providing adequate access to information contained in online databases and protecting the interests of database providers and other network users. Large amounts of useful and otherwise unobtainable data are provided in electronic databases, and means need to be found to provide the widest possible access, while protecting the integrity of database content and financial returns to database providers. Means also need to be found to protect the users and providers of value-added network services.

Centre members are regularly asked to give keynote lectures at conferences: Ms Lindley has been asked to speak in Sydney and Hong Kong and Professor Seberry to speak in Brisbane, Melbourne and Maryland, USA.

Members such as Professor Seberry, Associate Professor Josef Pieprzyk, Drs Reihaneh Safavi-Naini, Thomas Hardjono, Yuliang Zheng, Janusz Getta, Mirka Miller, David Steel, Yan-

Xia Lin and Mr Hossein Ghodosi have been working directly with industry, to use our LOKI '93 encryption codes, HAVAL message hashing algorithm and statistical techniques to ensure data integrity, privacy and security for database information. Work by T Tokita, T Sorimachi and M Matsui of Mitsubishi Electric Corporation of Japan showed that LOKI is twice as strong as the Des (Data Encryption Standard) algorithm.

Centre members are regularly reviewing for international program committees, for example, Professors Seberry and Pieprzyk have been Program Chairs for AUSCRYPT '92 and ASIACRYPT '94 respectively and official program committee members for EUROCRYPT '92, EUROCRYPT '93, CRYPTO '93, EUROCRYPT '94, CRYPTO '94, CRYPTO '95 and 1994 International Symposium on Information Theory and Its Applications (ISA '94). Drs Safavi-Naini, Zheng and Mu Yi have also been deeply involved in reviewing for these prestigious conferences.

Ms Lindley presented a paper and Chaired, Day Two of the *IBC Conference Proceedings on Mart Cards '94: Maximising Provable Applications Conference*, Sydney Hilton, Sydney, 25-26 October, 1994.

Many members of the Centre are regularly asked to referee for international journals. Dr Chris Charnes referees for *Ars Combinatoria* and *Designs*, Codes and Cryptography and Dr Yi for the top journal *Physical Review/Physical Review Letters*.

Professors Seberry and Pieprzyk and Drs Safavi-Naini and Zheng have refereed for the following journals: *Australian Computer Journal*, *Journal of Cryptology*, *Information Processing Letters*, *The Computer Journal*, *Designs*,



Members of the Program – cards, computer disks, compact discs and keys on the table – discuss ways and means of achieving, and maintaining, high levels of security

Codes and Cryptography, *Transactions of IEICE (Institute of Electrical, Information and Communications Engineers)*, *Proceedings of the IEEE (Institute of Electronic and Electrical Engineers)*, *Transactions of the IEEE on Information Theory*, *Journal of Combinatorial Theory*, *Ars Combinatoria*, *Journal of Statistical Planning and Inference*, and *Australasian Journal of Combinatorics*.

Professor Seberry has previously served on the editorial boards of five journals. This year she was asked to join the board of the first electronic computing journal to be published yearly on CD-ROM by Springer-Verlag entitled *Journal of Universal Computing*.

Mr Justin Lister has taken the initiative to establish an Intrusion Detection Systems Mailing List which now has over 260 subscribers from six continents. Our pioneering efforts in this field has created enormous interest among researchers designing European Standards, as well as many members of the SRI Group, Haystack

and the Lawrence Livermore Laboratories. The Centre is intending to setup an ftp site for international collaboration in this important area. The email address for the Intrusion Detection Systems Mailing List is ids@uow.edu.au.

Centre members consistently work with overseas colleagues. Drs Zheng and Hardjono have worked closely with scientists from Asian countries including Japan and Korea.

Professor Seberry and Dr Xian-Mo Zhang have collaborated with researchers in China, Greece, France and the United States.

Dr Zhang has continued his pioneering work in bent functions and their application to cryptographic design. During the year his work with Professor Seberry and Dr Zheng has led to the disproof of an important conjecture of Professor Stafford Tavares with regard to the structure of bent based functions and has led to a profound new understanding of

RESEARCH PROGRAMS

quadratic boolean functions and their intrinsic value in secure cryptographic design and hashing algorithms. Drs Zheng and Zhang, Professors Pieprzyk, Seberry, Mr Tor Nordhagen and other students have applied bent functions to design HAVAL, one of only two survivors of the RIPE (European) project to break hashing algorithms.

This year it has been shown that Professor Pieprzyk's revolutionary concept of non-linearity is exactly what is needed to immunise cryptographic algorithms against the differential cryptanalysis attack.

Professor Pieprzyk is working in a large number of areas related to computer security. He is currently working on provable secure cryptosystems and, with Dr Charnes, on hashing algorithms.

At Crypto '94, Jean-Pierre Tillich and Gilles Zimor from France presented a hashing algorithm which they claimed was secure. Dr Charnes and Professor Pieprzyk showed at ASIACRYPT '94 that their scheme, in fact, is not secure. They are now working to repair the algorithm.

Professor Pieprzyk is also working on society oriented cryptography such as secure electronic voting, secure electronic transactions, secure database design and access schemes with Messrs Hossein Ghodosi and Ahmad Dastjerdi.

Dr Zheng has also worked extensively with Dr Yi and Dr Lin on the amazing new area of quantum cryptography.

Professor Pieprzyk has worked with a large group of other Centre members, and others, to understand and cryptanalysis the former Soviet Union's GOST family of cryptosystems. This research has aroused considerable interest from former Warsaw pact countries.

Dr Safavi-Naini has a broad range of interests in temporal logic, protocol security, provable security, authentication codes and secure systems. This year Dr Safavi-Naini and her student

Mr Anish Mathuria were able to successfully implement the BAN logic used to analyse protocols. Their implementation was successfully used in analysing several well known authentication protocols.

Dr Safavi-Naini successfully supervised Mr Mathuria for an MSc(Honours) in *Automating BAN Logic*. Dr Zheng successfully supervised Mr Azad Jiwa in *Network Security* and Mr Chenturvasan Duraispandan in *Secure Communications*. This research has been accepted for presentation at refereed, international conferences.

Professor Pieprzyk has conducted book review for Addison Wesley and Prentice Hall. Professor Seberry has continued to review books and articles for Zentralblatt für Mathematik and Mathematical Reviews. While Dr Safavi-Naini has been appointed to the Board of *Computer Security Reviews*.

Members of the Centre continued to Review Grants for the Australian Research Council, NSA, NCERC, as well as the Austrian and Swedish Research Boards. Members have continued to examine and average of two external PhD or Masters Honours theses from overseas and Australia, per member, per year.

Ms Lindley is actively involved in consultancy. She has received an ongoing grant for consultancy services of \$4,000 per quarter from the NSW Department of Business and Regional Development (B&RD). The services provided include new initial product development support for individuals and organisations referred by staff from the B&RD department. In a number of individual cases additional grants are also given for further work and support.

Professor Seberry undertook an extensive conference lecture and research trip during the year. She presented three papers at the *Selected Areas in Cryptography Workshop (SAC '94)* held in Kingston, Ontario. This workshop had four Australian

attendees among those from ten other countries and many Canadian Defence Personnel.

She spoke on 'Systematic Generation of Cryptographically Robust S-Boxes' and 'How to Improve the SAC' both by Drs Xian-Mo Zhang, Zheng and herself, which showed new relations between bent functions, quadratic functions and some criteria crucial for VLSI implementation. She also presented a far-reaching paper by Assoc Professor Pieprzyk, Dr Charnes and herself on *Linear Approximation Versus Nonlinearity* which expanded on previous work of Seberry, Zhang and Zheng, to show the crucial importance of an earlier result of Pieprzyk to the protection of cryptanalytic algorithms from a new, powerful attack by M Matsui called *Linear Cryptanalysis*.

From Kingston Professor Seberry went to Perugia in Italy to attend the extremely prestigious EUROCRYPT '94 Conference. Less than one-in-four papers submitted to this conference were accepted. Five were accepted from Australia which was the second largest from any country: USA has twenty-four accepted papers. There were six Australian attendees among the three hundred and ninety registrants from over twenty five countries.

Professor Seberry delivered four papers at the conference: *Authentication Codes in Plaintext and Chosen-Context Attacks* by Dr Safavi-Naini and her PhD student, Mr Leonard Tombak, regarded as an important contribution to authentication design and practice; *How to Break and Repair of the Leighton and Micali's Key Agreement Protocol* by Dr Zheng which drew comment from the eminent Dr Adi Shamir of the Rivest-Shamir Adelman (RSA) public key cryptosystem; *Comments on the Soviet Encryption Algorithm (GOST)* by Associate Professor Pieprzyk, Dr Luke O'Connor, Dr Safavi-Naini, Dr Charnes and Dr Zheng, about the Russian cryptographic standard 'GOST' which drew an enormous

amount of interest from previously Eastern European countries; and *Relationships Among Non-Linear Criteria* by Seberry,

Zhang and Zheng which presented important results on the design and analysis of cryptographic algorithms using bent functions.

Professor Seberry left for Athens to work with statisticians at the University of Athens and the Technical University of Athens.

After Athens, Professor Seberry flew to Curacao in the Netherlands Antilles for the International Information Processing Conference – Security '94 (IFIP)-Sec '94. At this conference Professor Seberry presented two papers. The first, *Exploring minimal BAN Logic Proofs of Authentication Protocols* by Mr Mathuria, a PhD student of Dr Safavi-Naini and Dr Peter Nickolas: an automated tool for analysing authentication protocols. She also presented the paper *Anonymous Verifiable Databases: Towards a Practical Solution*, by Drs Hardjono, Zheng and Professor Seberry, this work is of particular interest because it provides practical and not just theoretical solutions.

Professor Seberry, Drs Zhang and Zheng were the only Australians to have their paper accepted at the prestigious CRYPTO '94 Conference. This Conference had a less than one in five acceptance rate.

Research students within the Program have been particularly successful in having their research papers accepted by prestigious conferences in Australia and overseas: Mr Chenthrivasan Duraippan has had a joint paper with Dr Zheng, accepted at the Fifth International Conference on Speech Science and Technology (SST '94) Conference in Perth. Mr Jiwa has had papers accepted at ACIS '94 in Melbourne and the European Symposium on Research in Computer Security (ESORICS '94) in Brighton, UK.

Mr Mathuria presented a paper by himself, Drs Safavi-Naini and

Nickolas entitled *Some Remarks on the Logic of Gong, Needham and Yahalom* at the 1994 International Computer Symposium (ICS '94) held at the National Chiao-Tung University, Taiwan, in December.

Professor Pieprzyk, Drs Safavi-Naini and Charnes all had papers accepted at the *IEEE International Symposium on Information Theory*, in Trondheim, Norway.

The highlight of the year was ASIACRYPT '94, an extremely high quality security conference held at and sponsored by the University of Wollongong, in co-operation with the International Association for Cryptologic Research (IACR). Centre members were all program committee or organising committee members.

The conference was opened by Vice-Chancellor Professor Ken McKinnon. He expressed his delight that the University hosted ASIACRYPT '94 and totally supported the general aim of the conference – 'to make our world more secure' (by application of cryptology).

The first talk was given by Professor Thomas Beth (the Director of European Institute for Systems Security and Professor of Computer Science at the University of Karlsruhe, Germany) on *Multifeature Security Through Homomomorphic Encryption*. This presentation gave the audience a good understanding of how public-key cryptography (such as RSA) can be used for many different security applications to provide a wide range of secure services.

The morning talks on the second day started with the invited presentation by Dr Catherine Meadows (US Naval Research Laboratory, Washington DC) on *Formal Verification of Cryptographic Protocols: A Survey*. The talk gave an up-to-date on the area.

On day three Professor Hideki Imai (Invited Speaker, Professor of Electrical Engineering, the University of Tokyo, Japan) spoke on *Information Security Aspects of Spread Spectrum Systems*. He covered most of the security issues related to broadcast systems such as mobile phone ones.

Sessions of regular papers were delivered on Secret Sharing, Stream Ciphers, Cryptographic Functions, Authentication and Digital Signatures, Cryptanalysis, Hash Functions, Key Distribution, Public-Key Cryptography and Block Cipher Algorithms.

The number of participants exceeded all numbers from previous ASIACRYPT conferences - there were 120 participants from all continents (excluding Antarctica).

Australia was very well represented by people from government agencies (DSTO, Defence Department, etc), industry (Telecom, Westpac, NAB, CB etc) and academia (QUT, UOW, U of Adelaide, U of Tasmania, U of Queensland).

There were 99 submissions for the conference and after rigorous (blind) review, the Program Committee selected 30 best papers for presentation (local papers were sent to overseas referees).

The proceedings of the conference will be published by Springer-Verlag in Lecture Notes in Computer Science.

The year marks a great rise in the Centre's profile: overseas, members are asked to contribute academically to more social and practical discussions of the implementation of secure technology; at home we are asked to make more media presentations to TV, radio and print.

Professor Seberry has been invited to join the committee to award the *Australia Prize*.

Multidisciplinary in education policy analysis
Resource allocation in education
Performance technology in education and training

Education Policy

Co-ordinator: Professor Carla Fasano (tel 042 21 3957)

LITTLE WOULD have pleased Associate Professor Barry Harper more than shaking hands with Prime Minister Paul Keating. Actually, yes, something did. It was the sight of the PM slipping a copy of the award-winning *Investigating Lake Iluka* in his pocket, to take it home, to the Lodge, to his own children. Indeed the year was propitious for the Education Policy Program. Its Interactive Multimedia group has undoubtedly taken centre stage in the media through its multi award-winning streak, while, like the other Program members, increasing its presence in a variety of national and international publication outlets and policy making bodies.

In 1994, the Australian Teachers of Media (ATOM) established for the first time an Award for the Multimedia category. It went to the group's Science Education CD *Investigating Lake Iluka*, produced under the leadership of Associate Professors

Barry Harper and John Hedberg. The program enables students to take a series of biological, chemical or physical measurements to investigate the various ecosystems that exist in the open lake, the estuary, the mangrove swamp and the surrounding urban environment.

Nearly 20 simulated scientific devices, including thermometers, hygrometers, pH meters and water-quality testers, are available as investigative tools. Students are able to look at changes caused directly and indirectly by natural phenomena and human interference. They measure, record, analyse, interpret, evaluate and present data during their investigations of the lake environment.

As well as exploring the four ecosystems, additional information can be gathered by students from a Field Study Centre, through illustrated plant and animal and general reference books, newspaper clippings, simulated radio and television news reports, interviews and informational video clips. Peter Tapp, ATOM publications manager and award judge, said the judges were extremely impressed with the inaugural winner. 'The quality of the material and the level of research behind *Investigating Lake Iluka* are unprecedented in educational multimedia software.'

Similar opinions were expressed by the judges of the other Awards won by the package this year: the Australasian Interactive Multimedia

Industry Association (AIMIA) award for the best education multimedia title, and the Australian Society for Educational Technology (ASET) award for educational computer software, as well as its premier award for the most innovative product for 1994. Quality recognition has also come from overseas, where Apple has included *Investigating Lake Iluka* in the bundle of educational software offered in their marketing campaign to US schools, the first time an Australian-developed educational software package has been so honoured.

Nor has international recognition failed to be bestowed on other Program members. Professor Ken Gannicott's work in recent years has made a distinct contribution to educational policy in Asia-Pacific, and particularly in the neighboring countries of Papua New Guinea and the Pacific Islands. His work on PNG, carried out directly for the Australian International Development Assistance Bureau, has made a direct contribution to Australia's aid program for that country.

More recent work on population, education and economic development in the South Pacific has received very wide coverage throughout the region at the highest levels of policy making. Professor Carla Fasano's work for the OECD and the Italian National Council for the Social Sciences on the construction and development of

Members

Dr B Harper, Mr B Ferry, Ms C Brown, Mr G Rowland, Mr I Brown, Associate Professor J Hedberg, Associate Professor John Patterson (Dean) Professor K Gannicot, Dr M Harris, Dr M Gillett, Dr W Cheung



From left are Professor Carla Fasano, Associate Professor Barry Harper, Margaret Cameron, Associate Professor John Hedberg, Lorraine Morris – holding a 'Basket of Awards' for *Investigating Lake Iluka*, produced by the Interactive Multi-media Development team. Designed for secondary school students, the Program is enjoying international success

performance indicators, a hot political issue in current educational policy debates, has also come to fruition with research papers published nationally and internationally. Her appointment to the Amelia Earhart Awards Committee of the Chicago-based ZONTA International Foundation has provided further testimony to her reputation overseas.

Also in the international policy field, Associate Professor Malcolm Harris undertook a study program in the USA in September/October, to examine current trends in teacher education. His discussions with academics at the Universities of Texas (Austin), North Carolina, North Carolina Central, Wisconsin (Madison and Milwaukee), Michigan (Lansing) and California (Berkeley) complemented his knowledge and experience gained over several years in East Asia.

Together they were the foundation to a review of pre-service and in-service teacher education programs, policies and provisions for the Government of Pakistan. The report flowing from this review, extending to more than 100 pages, is currently being considered by the Pakistan Ministry of Education.

Policy making has also been on the agenda of Associate Professor John Hedberg as an executive member in such national and international research bodies as the Association for Educational Communications and Technology (President Elect for International), the Australian Society for Educational Technology (AJET Journal Editor), the National Society for Performance and Instruction (Pacific Rim Co-ordinator) and ASCLITE (member of editorial board); and on that of Ian Brown, who is now part of the Executive of the

National Council for Art Education with a key role in developing the National Register for Art Education Supervisors and Researchers.

No doubt being part of policy making in education facilitates, these Program members' ability to bridge the gap between policy and research in their respective areas to the advantage of all Program members. Everyone's research becomes more attuned to what is needed and feasible in education. Credibility with policy practitioners adds to peer-endorsed recognition as researchers. The outcome is a research output of increasing quality.

Increased quality, has indeed, characterised the output from others in the Program. Research in the area of implementation of policy and programs has seen Associate Professor John Patterson co-edit books on

Health and Physical Education; Ian Brown progress with his work and publications on the implementation of Art Education policies in Australia, with a special focus on the impact of national curricula and aesthetic outcomes; and Dr Nita Temmerman publish a series of articles on the issue of Commonwealth policy and support for music/performance arts in Australia. Dr Temmerman shared her understanding through invited lectures at the International Research Centre for Music Education of the University of Reading, UK, and at New Mexico State University, US.

Focusing on the management and programs in professional development on the national scene, Greg Rowland has pursued his collection of data on the management of school-based, staff-development programs in NSW, Queensland and Tasmania, feeling quite happy on the much-higher-than-average response rate to his very large questionnaires sent to every secondary school in these states. Results will be presented at conferences in Australia and US in 1995.

Working at the higher-education end of the area, professional development has preoccupied Dr Max Gillett, who has researched and published on the needs of academics to improve their teaching and relevant clinical models to support performance objectives.

Performance support for teaching has also been the focus of 'technology' researchers such as Brian Ferry, Christine Brown and Dr Wing Cheung, who have explored different facets of the problem and developed solutions. The multi-media journal approach developed for Design and Technology Education Teachers by Brian Ferry and Christine Brown was presented at several conferences, including the NSW Science Teachers Association annual conference, the AARE annual conference and the Engineering Education conference, and received very well. Dr Cheung presented research papers on the analysis of instructional events in educational software and on the role

of the teacher as a software evaluator, at the AARE conference in Australia and the international IFIP conference in the US.

The focus on electronic support for learning has also proved a success: John Hedberg presented the results of a research study on the role of agents, guides and wizards to a conference on educational applications of computers in Auckland.

Christine Brown presented a synopsis of her work to the new managing director of Apple Computer Australia and has received enthusiastic offers of support from the company for her efforts. Dr Wing Cheung has received an ARC grant to work with Dr Bill Winser (Social Literacy Research Group) on the learning of English using a computer-based approach.

To complete the presentation of the Program's output in 1994 it is appropriate to mention new kinds of research directions which, ranked as a priority in previous years, have materialised only recently. They refer to what is currently considered a 'must' in policy and management research: the need to shift from mono-disciplinary to multi-disciplinary approaches. Two activities have allowed Program members to implement the decision. One, now completed, has been the Quality Assurance Project of the University of Wollongong. Under the co-ordination of Professor Carla Fasano, the R&D project, funded by a large DEET grant, has seen two other Program members, Associate Professors John Hedberg and Barry Harper, join a multi-disciplinary team in the design and development of a user-driven information system and user interface to support quality management in the University. The work of the team, comprising colleagues from the Department of Management (Professor Gill Palmer) and the University's Planning and Marketing Branch (David Macpherson and Brenda Weeks), was published with considerable success as a book, including a presentation CD, and presented at the

annual conference of the Australasian Institute of Tertiary Education Administration. At present the prototype is being included in the work of the UniOn group, within the overall CASMAC project, for possible implementation in this and other universities.

The second project aiming at multi-disciplinarity in policy and management research has seen its foundations set by Professors Carla Fasano and Jim Walker (University of Western Sydney, Nepean) through the launching of a Special Interest Group in Policy Processes in Education with the AARE. Their proposed rationale and plan of action was presented at the annual conference of the AARE and attracted the interest of more than 25 educational researchers and policy analysts from 14 Australian universities, the ACER and the NSW TAFE Commission. Co-operation in a number of policy research enterprises is expected to be established in 1995.

In 1994, the 13-researchers-strong Program survived its second triennial evaluation and was confirmed by the University as a research centre. Over time, the Program has grown stronger, as a variety of performance indicators (research, publications, conference presentation and software production) show. It has also changed to be distinct from its origins.

Initially, the Program involved a variety of research foci and strands in policy, planning, management and performance technology, more or less equally represented. After six years of operation, the balance among research directions has changed, with one of the strands, Performance Technology, brought to take a prominent position through the growing contribution by the interactive multimedia researchers. This development has been recognised as a strength and is reflected in the Program name change for 1995. Next year's report will not be from the Educational Policy Program. It will be from the Centre for Educational Policy and Performance Technology Research (CEPPTER).

*Research in industrial automation technology
and systems to help keep industry
efficient and competitive*

Industrial Automation

Co-ordinator: Professor Chris Cook (tel 042 21 3065)

NO MODERN country can have a sound economy without a thriving manufacturing industry.

The productivity and competitiveness of its industry depend on the quality of automation available to it. It follows then, that research in industrial automation is essential to develop adequate systems for the future. The Industrial Automation Research Centre (IARC) concentrates on such research, grouping it into three major, interdependent program areas:

(i) **Power engineering** describes that part of the research which concentrates on hardware and software for actuation and materials handling purposes, and on the systems which condition and control electric power. This work is highly relevant for most Industry sectors because very little

moves in a modern factory unless an electric motor or actuator moves it.

Actuator research aims to enhance performance – higher torque-to-weight ratios, faster response and superior efficiencies. This requires new types of motors (requiring better modelling and understanding of their fundamental physics), combined with new types of motor control using power electronics, high-speed computing and innovative control strategies.

Such systems interact with the mains power supply, so improvement in power-system quality and performance is also supported by the Pro-

gram. This work requires expertise in such areas as signal processing and neural nets, also used in other IARC programs.

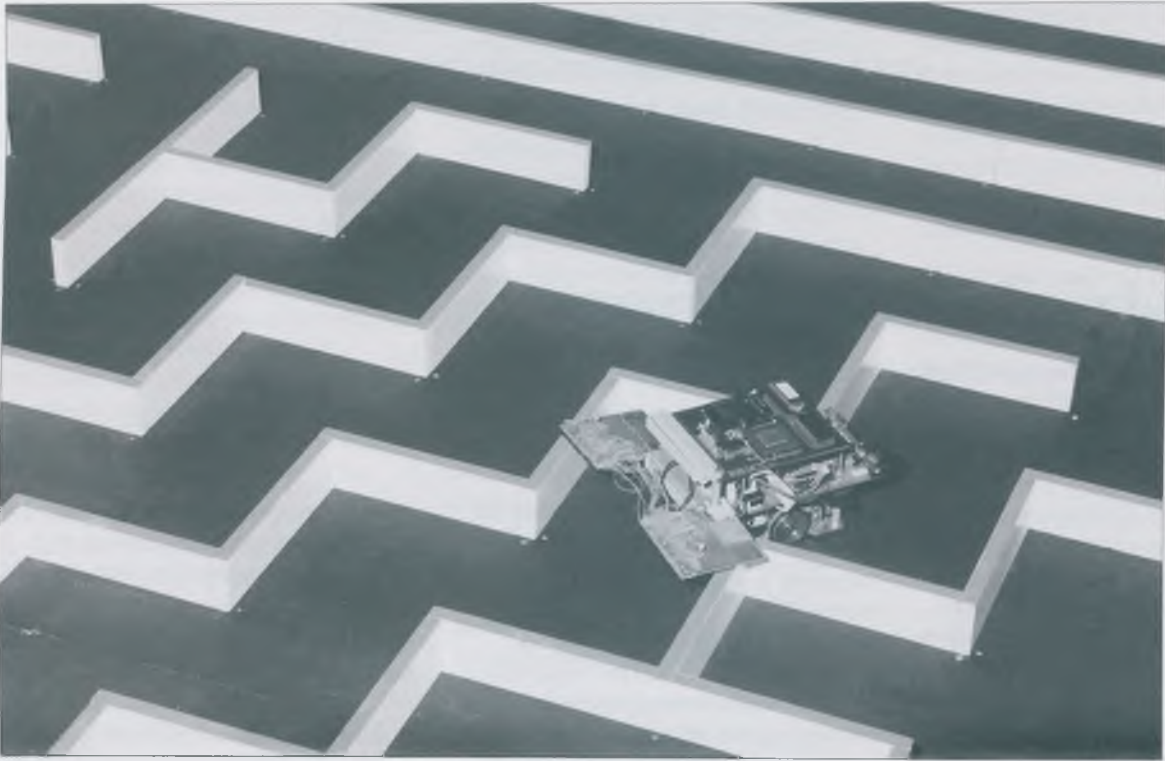
(ii) **Mechatronics and control** refers to the integration of a number of actuator systems, such as those developed in (i), with computer software and hardware, embedded controllers and electronics and sensors, in order to make up a mechanism or automation 'cell' such as an assembly system or robot arm. Research in this area aims to produce greater accuracies, superior flexibility, ever-higher speeds, greater decision-making capacities

Mrs Bronwyn Evans, an IARC PhD Student, is working on the dynamic control of robot arms



Members

Dr J F Chicharo, Dr P Doulai,
Dr A L Elshafei, Associate
Professor V J Gosbell, Mr V
Ilango, Dr F Naghdy, Dr G
Naghdy, Dr P O Ogunbona,
Dr B S P Perera, Dr D Platt,
Ms G Sadagopan, Dr G W
Trott, Dr J A Fulcher, Dr J Grey,
Dr P McKerrow, Dr A Zelinsky,
Dr E Siores



An autonomous mobile robot, built by the industrial Automation Research Program, navigates its way through a maze

and autonomy within a cell. The research includes development of new embedded controllers for intelligent sensing and processing, the development of new control algorithms and other decision-making strategies such as neural nets and fuzzy logic.

Both the development of innovative control theories and that of new control applications for neural nets and fuzzy logic are applicable to most automation areas, and such techniques can also be used in the other two interrelated IARC programs.

(iii) Intelligent manufacturing concentrates on the interaction between and autonomous integration of the combination of automation cells and systems, such as those developed in (ii), which make up complete manufacturing systems. For example, operators have to be able to interact with, monitor, and control the production process (requiring novel software architectures and user interfaces), and materials have to be

delivered to the right place at the right time (requiring mobile robots and scheduling systems). Again, processing speed is of the essence, and so research into distributed manipulation and parallel control methods must be pursued. The controlling computers require better sensors to provide more accurate information about the environment in which they are working. The IARC therefore supports projects to support powerful (and computer-intensive) sensing methods such as image processing.

Members of this Program comprise 14 academic staff and three professional officers as well as 20 postgraduate students, currently enrolled in Honours Masters or PhD programs, who have thesis topics in various automation areas. In addition, in 1994 more than 20 final-year electrical engineering undergraduate students completed their final-year theses in automation areas.

Meanwhile, the IARC continued to produce research outcomes in ad-

vanced industrial automation by supporting research in the three inter-related program areas outlined. It continued to support the setting up, operating and maintaining of research infrastructure (most of its budget is allocated to equipment, facilities and professional engineering support for its generally experimentally-intensive research work), continued attracting research grants, obtaining industry interaction, the gaining of substantial industry support and the dissemination of its research through academic publications.

Examples of the way it strengthened research facilities during the year included the setting up of a mechatronics laboratory (currently 40 percent complete), and assisting in the operation of the Manufacturing Research Laboratory (also partly funded by the University and the Faculties of Engineering and Informatics). These facilities will provide better access to robots, actuators and servo-systems for



Supervised by Professor Vic Gosbell, Mr Ali Jalilian is also working on the effects of harmonic 'pollution' of the electrical mains

researchers, and undergraduate and postgraduate research students.

The Manufacturing Research Laboratory is also intended to combine the resources of the IARC and several other groups on campus in order to foster an interdisciplinary approach to manufacturing systems research by encouraging the building of co-operative research groupings which cross faculty and departmental boundaries. One of the projects in this laboratory which the IARC is setting up is a robotic assembly cell using a very fast robot manufactured by ADEPT, a manufacturer in the USA.

One development in 1994 was the setting up of additional interdisciplinary work with other groups. This results from the fact that some Industrial Automation areas, such as image processing, high-speed computer processing, sensing, and neural nets can all have wider applications. For example, the IARC has already funded work in image processing applied to Health applications, and has also funded projects jointly with the Applied Mechanics program in the area of flexible robot arms and the development of grippers and assembly methods.

Because the IARC supports the implementation in Industry of manufacturing and industrial automation technology, it continues to have interaction with and be influenced by Industry. For example, during 1994 the R&D company set up jointly by the University with Pacific

Power (the Energy Efficient Research Centre Ltd) continued to provide a substantial amount of power electronic and variable speed drive expertise to Industrial customers with the assistance of IARC researchers.

A few of the specific projects undertaken in the general areas outlined above in 1994 include:

i) Power Engineering

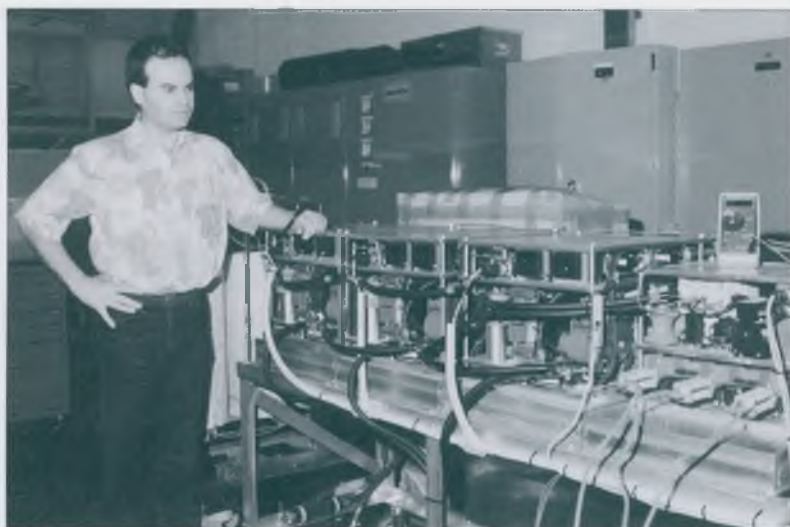
Researchers are Drs Platt, Perera, Doulai, Associate Professors Gosbell and Chicharo and Mr Ciufu

Industrial drives and power electronics: Modern power electronic equipment, when connected to the electricity supply mains, can produce undesirable 'pollution' affecting mains voltages and currents, and can also have undesirable effects on the equipment, such as electric motors, they are controlling. Several projects are under way to devise and implement improved signal processing and control techniques to help reduce such pollution.

Actuators and Electric Motors: The IARC designs and manufactures prototype motors for research purposes. For example, a large ARC grant

Mr Ali Jalilian, another IARC PhD candidate, stands by a 'calorimeter', funded by an AESIRB grant, to measure, to a high degree of accuracy, losses in electrical machines





Mr Dominic Cui, Senior Research Engineer with the Energy Efficient Research Centre Ltd, prepares to test an electronic 250kW, 11000, compact inverter developed by the Program to control electrical power for mining applications

with Newcastle University has recently been obtained to enable the modelling and control of a novel electric motor. This motor is likely to have significant cost and performance benefits over conventional machines. Additional novel machines have also been analysed using finite element techniques, and their performance quantified. Such research also sometimes requires novel control systems to be designed and implemented to control these unconventional motors, and a number of these systems, using heavy current power electronic devices, have been developed.

Power Quality and Power Systems: A harmonic analyser to assist in detecting and better understanding the pollution effects described above, and a load testing facility to accurately monitor electric motors controlled from such equipment are two new IARC projects undertaken in 1994. The IARC also has work under way which is intended to produce new methods of reducing this pollution by developing different methods of controlling the electronic switching devices which produced it in the first place. Much of this research work is supported by industrial collaborative research grants.

Because the presence of unwanted harmonics affects the operation of the power system in general, the IARC also has a research interest in power systems. For example, work has been carried out to better understand and forecast electrical loads on the power system using neural network techniques.

ii) Mechatronics and Control

Researchers are Drs Li, Trott, Naghdy, Doulai, Platt, Associate-Professors Basu, Gosbell, Professor Cook, Ms Evans, Mr Ciufu, Mr Lachsz

One major IARC project in mechatronics is being carried out with the Co-operative Research Centre (CRC) in Intelligent Manufacturing Systems and Technologies. This CRC, set up and funded by the Australian Government, combines the abilities of a number of private manufacturing companies, several universities and the CSIRO, to form one of Australia's major research institutes in manufacturing.

One of the CRC's partners is ANCA, a manufacturer and exporter of machine tools, and Dr Don Platt, a

member of the IARC, is working with ANCA on the development of systems to improve the speed and accuracy of these machines. To achieve this it is desirable to provide full digital computerised control over the modern electric motors used to give the precision and speed of movement necessary in ANCA's machines. The intention of this project is to incorporate recent research developments at the University into products for ANCA. Good progress was made during the year, with new engineering research staff employed, design of relevant electronics completed and implementation work started.

Other projects continuing in 1994 included robot control, force and compliant control, robot gripper design and the application of techniques developed for automation to medical areas such as surgery and decision-making in intensive care.

(iii) Intelligent Manufacturing

Researchers are Drs Naghdy G, Naghdy F, Ogunbona, Zelinsky, Trott, Mr Ciufu, Professor Cook

One project in this area involves collaboration with Loughborough University in the UK. A common industrial problem, with CIM (computer integrated manufacturing), is the integration of many different machines and processes in a factory so that the whole factory operates as a single co-operating, communicating and well-controlled manufacturing system. This project addresses such integration problems by providing a software-based 'platform' which is sufficiently general to provide assistance for most CIM systems.

Other continuing projects in 1994 included the development of generalised architectures for distributed robots and systems and the use of image processing techniques to provide enhanced information not only to machines but also for various medical applications.

'In our pursuit of intelligent polymers we have developed strategies that enhance our level of communication with the molecular and biomolecular world – so much so that truly cellular communications are now possible'

Intelligent Polymer Systems

Co-ordinator: Professor G G Wallace (tel 042 21 3127)

THOSE OF US involved in the development of Intelligent Polymer Systems strive to assemble structures (from the molecular level) that are capable of monitoring and responding to their environment to produce enhanced performance without human intervention.

We are in a sense communication engineers at the molecular level. We strive to produce sensing and monitoring technologies to access new sources of information. We also pursue the design and development of new response systems based on appropriate molecular assemblies. These functions are then combined into practically useful structures using innovative processing technologies.

We instigated studies into the unique dynamic chemical properties of electronically conducting polymers. These materials, discovered in the early 'seventies, were first noted for their unique electrical properties.

However, it is the study and utilisation of their unique chemical and biological properties that is now having a greater technological impact. These properties have enabled the design and development of new sensors and response actuator systems.

We have, for example, developed a new biosensing technology based on conducting polymers. In one version an antibody is immobilised in the conducting polymer sensor and with the use of electrical stimuli we are able to monitor and control the protein-polymer interaction. This was a clue that we could communicate with biosystems by utilising conducting polymers: ie the first step towards biocommunications. Using these materials, IPRL has also developed molecular response systems: membranes that can be stimulated in-situ to allow the passage of ions, molecules and even macromolecules.

Our recent focus has been on the integration of conducting polymers into other structures that provide infrastructural support for these functional components. Of particular interest is the incorporation into hydrogels (polymer systems containing large percentages of water). They in themselves are useful molecular response systems since they can be made to undergo a phase transition (shrink/expand) with appropriate stimuli: the basis of artificial muscles and novel drug delivery systems. It is

possible to grow conducting polymers throughout the gel while maintaining the properties of both components. A particular advantage of this discovery is that the structures produced are biocompatible. We have used this in developing systems that allow us to communicate with living cells. Truly cellular communication!

The research activities of IPRL are divided into the following areas:

Processing dynamic polymer systems

Intelligent behaviour can only be expected if the polymeric structure is multifunctional and dynamic. At a molecular level this means the system is delicately poised and input of even small amounts of energy can alter its properties. As with all materials processing, construction of intelligent polymers requires that energy be injected into the system; however, their delicate nature demands that this energy level be more tightly controlled.

The process must be so designed that mechanical properties are optimised while chemical and electrical properties are maintained. Invariably, this requires the use of composite systems with more conventional polymers (eg poly vinyl chloride or polyurethane) providing the structural support.

IPRL has contributed to this area during 1994 with the development of novel processing techniques. We have invented a new method to produce

Members

Dr A Hodgson, Dr N Barisci, Dr M Imisides, Dr W Price, Dr S Ralph, Dr H Zhao, Dr G Spinks, Professor L Kane-Maguire, Dr F Chen, Ms K Gilmore, Dr R John, Dr C O Too

RESEARCH PROGRAMS

conducting polymer colloids (extremely small particles) that can then be readily mixed with other polymers. We have also developed techniques for growing conducting polymers throughout other polymer (hydrogel) structures.

This latter approach enables the spatial distribution of function (for example, sensors separated from actuators) within a totally synthetic polymer system.

We are also concerned with the molecular events occurring during polymer processing and how this influences the eventual properties of

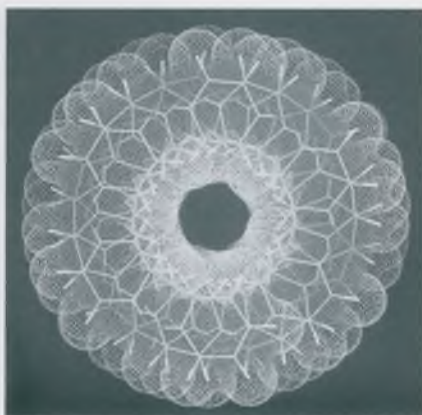


Figure 1: An example illustrating how the additives used during polymerisation influence conformation of the polymeric chains at the molecular level

materials characterisation methods. During this year we have developed a method that allows the mechanical properties of dynamic polymer systems to be measured in-situ as electrical stimuli are applied. This is important in many application areas (eg actuators and membranes – see later) where mechanical integrity must be retained as the polymers are stimulated.

This information is also important to another emerging area in intelligent polymer research, the development of artificial muscles. IPRL initiated a research program in this area during 1994.

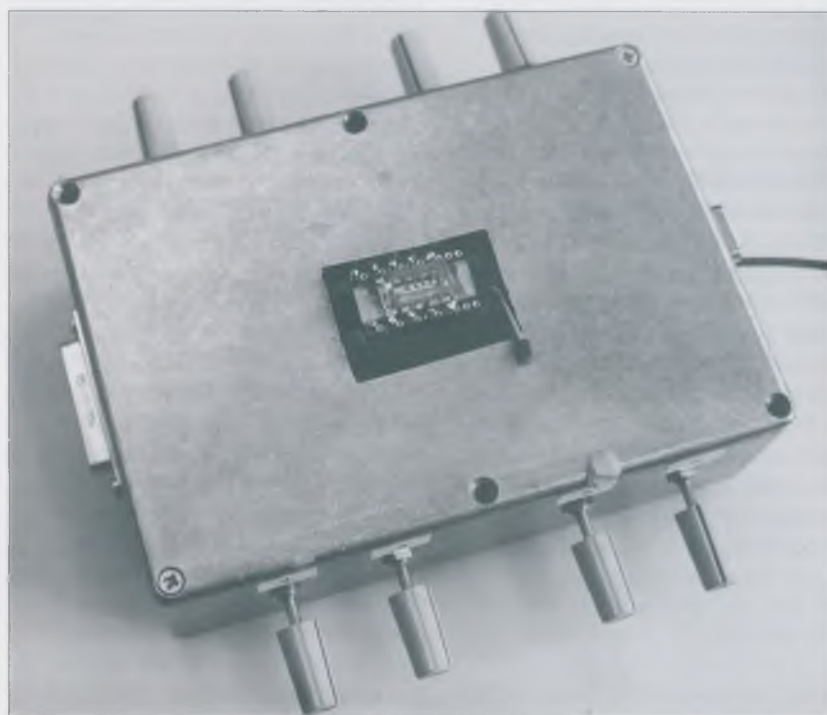


Figure 2: the micro density chip



The microchip measures 1cm wide

Sensors and actuators

IPRL continues to lead the international research community in this area.

During the last year we have developed a system (in collaboration with Oxford University, UK) that enables us to carry out multicomponent analysis for chemical components on

the polymer. It is in the course of such studies that we discovered an extremely simple approach to making chiral conducting polymers (see Figure 1). This example illustrates how the additives used during polymerisation influence the conformation of the polymeric chains at the molecular level.

Characterisation techniques

Since conventional methods of material characterisation cannot be performed in operational environments they provide limited information on dynamic polymer systems.

Consequently we continue to be involved in the development of new



Relaxing by one of the University's landscaped ponds – the entire IPRL team

a device the size of an electronic chip (Figure 2).

These systems are applicable to detection of ions, small molecules and even macromolecules such as proteins.

We have developed polymer based membrane systems that can initiate chemical events in response to electrical stimuli. For example, membranes that can regulate the transport of selected ions, molecules and macromolecules have been constructed. These chemical events are response systems in themselves but can also be used to initiate other electrical responses (eg changes in resistance), physical effects (change in colour) or even mechanical effects (electrochemical actuators).

A new generation of intelligent systems

This area involves the development of intelligent polymer systems that communicate with living cellular components. It is envisaged that the use of naturally occurring components in construction of intelligent polymers will facilitate enhanced performance.

All the above elements of research – processing, characterisation, sensing and actuation – are embraced in this project, albeit at an embryonic stage. We have shown, for example, that a range of mammalian cells, eg fibroblasts, human carcinoma cells, endothelial cells and PC-12 cells, can be grown on our dynamic polymer

substrates. Preliminary data suggest that the growth and differentiation can even be controlled through application of electrical stimuli during growth of the structure. Part of this effect may be mediated by the release of crucial cellular messages from the polymer. We have recently shown that large macro molecules can be incorporated into the polymers. These can be released in a controlled fashion by applying electrical stimuli to the polymer. This has important implications for delivery of new recombinant protein drugs and vaccines.

As well we have shown that intact living cells can be incorporated into the polymeric structure during synthesis. Molecular events occurring

at the cell membrane surface can then be regulated and monitored, enabling truly cellular communications.

Collaborative activities

IPRL has established an extensive domestic and international research network. Without the input of such expertise from various disciplines we would not have advanced our research activities as we have. Our links with Dr A Mau (CSIRO, Chemicals and Polymers), Dr D Barnett (CSIRO, Food Science), Professor J Unsworth (UTS), Professor R Burford (UNSW) and our commercial collaborators in Australia CRA, Pasminco, MM Cables and Tecra Diagnostics are invaluable.

A strong link with the Illawarra Area Health Service has been forged and a new collaborative Research Unit has been established at the Wollongong Hospital.

In addition, we have overseas research links with Dr D Kaplan (USARO, USA), Professor S W Kim (University of Utah, USA), Professor N Ogata (Sophia University, Japan), Professor Y Osada (Hokkaido University, Japan) Professor C Y Kim (KIST)

and with Dr M Boutelle (Oxford University, UK) as well as our commercial collaborators Gamma Biologicals, Dionex. Their input is invaluable.

Summary of research projects

IPRL projects cover a wide range of interest. Listed below are industrially focused areas, community related areas such as biomedical technologies and environmental monitoring, and visionary areas such as multifunctional and intelligent polymers and structures, which are the materials of the future. Many are truly collaborative projects in that staff and students travel on exchange visits between the respective establishments.

Selected industrial projects

- Development of smart membrane technology
- Corrosion protection
- Sensors and biosensors
- Electrode materials development

Selected postgraduate projects

- Monomer synthesis
- Chiral polymers
- Conducting polymer/hydrogels

- Separations technology
- Materials characterisation
- Sensor technology
- Biomaterials
- Colloid technology
- Controlled release
- Cell culturing
- Processing of conducting polymers
- Actuators
- Multifunctional polymers and structures
- Intelligent polymers and structures

Closing remarks

Advances in communications have always resulted from advances in materials science and technology. To date however, this has only given us improved intersystem communications. There is indeed a need to develop more independent material systems capable of intrasystem communication and then intelligent behaviour.

Now advances in molecular assembly are improving our ability to construct such systems. We are developing the ability to produce systems capable of intrasystem communication and hence enhanced performance without human intervention.

*How labour markets function in conditions of high unemployment and rapid international competitive change
Disadvantaged labour groups and regional industrial developments*

Labour Market Analysis

Co-ordinators: Dr Chris Nyland and Associate Professor Ray Markey (tel 042 21 4027)

THE LABOUR market in recent years has continued to be a major focus for Australian policy-makers. Encouraged by the impact of micro-economic reform on labour, the government is now examining closely the effects on labour of its labour market, education, health and regional policies. The Program has been closely involved in high-quality research on these issues, which has contributed to policy-making at Federal, State and Regional levels. In addition, the Program's work has contributed to the development of theory in economics and industrial relations in both national and international publications.

Don Lewis's work on education and health; Ann Hodgkinson's study of regional industry policy and labour market training; Chris Nyland's research on management and health and safety; Ray Markey's work on trade unions and industrial democracy; Di Kelly's international steel project; and the work of many program members on disadvantaged

labour groups have all contributed both to theory and policy. The Program has strong links with other research groups (eg ACIRRT) as well as regional state and national trade unions and employers. Links with overseas scholars have been strengthened and collaborative research is being undertaken with academics in several countries on an international steel project and on industrial democracy projects.

The Program has also placed great emphasis on collaborative research between its members. This has been most evident in the research into disadvantaged labour market groups such as Aborigines (Castle-Verrucci) and women (Nyland-Kelly-Harvie). This collaboration has led to new initiatives focusing on regional policy in the context of the integration and internationalisation of the global economy. Active regional policy is a key to enabling labour in regional areas to participate in and benefit from the emerging global economy.

Chris Nyland increased his international reputation over the year in two fields – the history of management and the status of women in economic theory. He has presented papers at leading universities in the USA and England (Duke and Cambridge) and was invited to act as a discussant at the International History of Economic Thought Conference held in Boston, USA. He continued his record in obtaining ARC funding for the sixth successive year and by being pub-

lished in leading journals such as *History of Political Economy* and the *Journal of Industrial Relations*. His leadership was instrumental in developing the new focus on regional labour markets. He is also involved with D P Chaudhri and Robert Castle in a project on the effects of child labour in developing economies.

Ray Markey's landmark history of the NSW Trades and Labour Council – *In Case of Oppression: The Life and Times of the Labour Council of New South Wales* – was published during the year, complementing his earlier work on the origins of the Labour Party in NSW and reinforcing his credentials in the labour history of the state. His links with the Free and Unfree Labour Project based in Amsterdam and his continuing work on industrial democracy with colleagues in Europe and the USA have further enhanced the international reputation of the Program.

Don Lewis continued his work on health and education with the publication of two major reports on the economics of health care for the Department of Health and the *Performance of Students admitted via Alternative Modes* for the Department of Employment and Industrial Relations. He is involved in several projects with health-care professionals; his standing in the field of health economics was recognised by his appointment as Chairman of the Australian Health Economists Society in 1994. Don is in strong demand as a

Members

Associate Professor Rob Castle, Ms Di Kelly, Dr John Rogers, Dr Joan Rogers, Dr Charles Harvie, Ms Ann Hodgkinson, Ms Nada Verrucci, Professor Don Lewis, Mr Gary Fulton



Labour Market Analysis Program members have been involved in issues which have contributed to policy-making at federal, state and regional levels of government

consultant and his work has important implications for other studies undertaken by the Program on women and other disadvantaged labour-market groups.

Di Kelly's work on the steel industry received national and international recognition. She was invited to join a major international steel research project co-ordinated by Professor Kockan of the Sloan School of Management as well as an Australian project co-ordinated by Professors Lansbury and Nyland for the Universities of Sydney and NSW. The latter group received nearly \$180,000 in a three-year multi-campus Large ARC Grant in 1994 in addition to earlier funding from BHP. Di has presented papers on this project and on the status of women at Cornell, Warwick, Cardiff and Toronto Universities and has published in leading journals. Her work has special significance for the Wollongong region: linking between regional and international concerns clearly demonstrates the new focus of the Program.

Ann Hodgkinson's work on regional and environmental issues continued to attract attention and support. The

emphasis of the new World Trade Organisation (WTO) on labour and environmental issues in the context of a liberalised global trading system makes this work particularly important and fits well with the new regional/global emphasis of the Program. Charles Harvie's work on the impact of macro-economic shocks on economies and regions also reflects this thrust.

Nadia Verrucci and Rob Castle's work on the labour market as it affects Aboriginal Australians demonstrates continuing concern for disadvantaged labour-market groups within the Program. Rob Castle and Jim Hagan received multi-year ARC funding to complete a History of Aboriginal involvement in the Australian economy in 1995.

The Program received funding from the ARC through both Large and Small Grants, DIER, Department of Health, BHP and other sources. This increasing success rate in obtaining outside funding reflects the development of the Program in recent years. The involvement of more than a dozen research students at Doctoral and Masters level also reflects the maturity of the Program. Chris

Nyland and Ray Markey both received ARC Small Grants for 1995.

Over the next year, the Program will be strengthened by the addition of new members — Joan and John Rodgers, whose primary research areas are poverty and internal migration, and Gary Fulton, who is working on the impact of overseas management practices on Australian labour.

The primary questions asked by the Program about the ways in which the internationalising of the global economy impacts on disadvantaged sectors of the labour market at regional, national and international levels are of central concern to all involved in labour market issues in the late 1990s. The expertise developed by the members of the Program will continue to be called on by policy-makers as the social and economic impacts of these policies impact on labour markets.

The Program will tie into the planned International Business Institute and this will provide further focus and direction to our activities. In short, the Program had a successful year in 1994 and is well placed to build on that success in the coming years.

*Critical analysis of the discursive formation
of subjects within culture, nation, modernity,
decolonisation and global media*

Literature and the Colonial Legacy

Co-ordinators: Professor James Wieland (tel 042 21 3677) and
Dr Paul Sharrad (tel 042 21 3705)

THE LITERATURE and the Colonial Legacy Program has been innovative in its research in textual and cultural production and has reflected developments in a rapidly broadening research field. Screen and media studies are necessary and important inclusions in our research brief, as are the study of electronic texts, the internet and desktop publishing.

The 'colonial legacy' is one of national formations, but recent movements in theory and in nationalities and cultures have problematised this at both multi-national and micro-national levels. Theorising of gender and discourse analysis in legal,

environmental and media studies now overlaps with analyses of urbanity and modernity central to Cultural Studies. For this reason, the Program will change its name in 1995 to the Centre for Research in Textual and Cultural Studies (Incorporating the New Literatures Research Centre).

Research projects

The 'biography and autobiography' focus of the past two years involved staff and postgraduate students in producing several conference papers outside the University, Sharon Clarke's literary biography of Sumner Locke-Eliot, to be published in 1995, the 'Self, Life and Writing' conference in July 1994 at Wollongong and a number of related theses to be completed in the next two years.

'Self, Life and Writing: Post-colonial Perspectives' focused on life-narratives from Australian, Pacific and Asian post-colonial writers. Keynote speaker was Professor Sidonie Smith of Binghamton University, USA, and author of a seminal work in the field, *A Poetics of Women's Autobiography: Marginality and the Fictions of Self-Representation*. Anne Lear and Paul Sharrad are co-editing the conference proceedings.

Journal projects

Australian Canadian Studies will continue to be produced out of the Program, through the collaboration of

Gerry Turcotte (English) and Luke McNamara (Law), and *New Literatures Review* has won a challenge grant to upgrade its presentation and international profile. This will involve cooperation with 'post-colonial' staff at Macquarie and Tasmania Universities.

Another project will develop around the 1994 challenge grant to establish *Law/Text/Culture*, a journal on law and literature produced jointly by Joseph Pugliese and Maurie Scott from the Department of English and Penelope Pether and Robin Hanley from the Faculty of Law. Through articles, artwork and poetry, *Law/Text/Culture* crosses boundaries and reflects the societies and cultures in which the law operates. Launched in October 1994, the first issue included a poem by Ruby Langford-Ginibi of the Bundjalung people, crime writer Sara Paretsky's contentious 'The protocols of the Elders of Feminism' and Professor Richard Weisberg's 'Codification of Western Law and the poetics of Novelistic Disclosure'. The journal will offer opportunities to people who have not usually had access to academic journals and who have traditionally been relegated to 'sub' or marginal cultures.

Paul Sharrad's major research project, 'A Systematic Analysis and Bibliographic Listing of Literary Criticism of South Asian Writing in English Since 1970', is now the priority

Members

Dr Graham Barwell, Ms Kate Bowles, Dr Melissa Hardie, Dr Richard Harland, Ms Efi Hatzimanolis, Dr Tom Jagtenberg, Associate Professor Dorothy Jones, Dr Anne Lear, Dr Kate Newey, Ms Margaret Nixon, Dr Joseph Pugliese, Associate Professor Gaetano Rando, Dr Louise Ravelli, Mr Maurie Scott, Dr Gerry Turcotte

RESEARCH PROGRAMS



Members of the Research Program seen here met to discuss preparation for publication of the 1944 proceedings of the Self, Life writing conference. In the group are, from left, Mr Marvin Gilman, Ms Kate Bowles, Dr Anne Lear, Ms Efi Hatzimanolis, Dr Joseph Pugliese and Dr Paul Sharrad

research project being undertaken by the Program. His work on the Pacific is continuing, with the publication of his *Readings in Pacific Literature* and his project on Pacific life narratives with post-graduate research student Michael Hayes.

Kate Bowles's book on *Women and Australian Television* (with Dr Susan Turnbull and Professor Ina Bertrand from the Media Centre at La Trobe University) is scheduled for publication in 1995. *Crediting Women: Women and Australian Television* is the first book on this subject, and is a good example of what can be achieved between textual and cultural studies, using industry interviews, program content analysis and audience research. Ms Bowles's book on Australian soap-operas, *Only Tomorrow*

Knows (with Susan Turnbull) was published early in 1994.

Graham Barwell and Kate Bowles have set up a new project area, researching the management of the Internet in Canada and Australia, looking at issues of censorship and self-regulation, the production of meaning, gossip and ritual, and the challenges to policy nationalism which the Internet represents.

In December 1994 Graham Barwell chaired the session on electronic scholarly editions at the Modern Language Association Convention, San Diego.

Kate Newey was invited to present a paper on her current research project 'Nineteenth Century Women Playwrights' at the inaugural conference

of theatre historians in Australia (UNSW, September 1994), and will be involved in the editing of a volume of Australian plays 1830-1930, for the Academy Editions project. On her current study leave, she was invited by the *Moscow Times* to visit Russia to observe the theatre there, and was invited to present a paper at the Dickens Project, University of California, Santa Cruz, in August 1994.

Anne Lear presented papers at the 1994 'Religion, Literature and the Arts' conference (Australian Catholic University, Sydney): in 1995 she will be presenting a paper on the 17th-century writer Alice Thornton's construction of the self in her autobiography.

As part of her work on sexual representation, Melissa Hardie presented a

paper entitled: 'Woman, Camp and Emulation' at the *Fin de Siècle* Feminisms Conference at UNSW in September and attended the Modern Language Association Convention in San Diego in December.

Dorothy Jones's research in the field of post-colonial women's writing has resulted in several publications and conference papers. The Report of the AVCC Standards Panel on the Teaching of English in Australian Universities, to which Dorothy Jones contributed as one of its seven members, was published during the year.

Richard Harland spent two months visiting universities in England lecturing on his newly-published book, *Beyond Superstructuralism*, which expounds his original syntagmatic theory.

Margaret Nixon's current research is in the area of television studies and its connections with cultural studies, focusing particularly on the social semiosis of television texts viewed from a cross-cultural perspective. During a research trip to the United States, she attended the conference, *Console-ing Passions: Television, Video and Feminism*, (University of Arizona in April). She also presented two papers at IASS (International Association for Semiotic Studies), University of California, Berkeley in June.

Assisted by a grant from the Canadian Government, Gerry Turcotte has spent several months in Canada working on his comparative study of indigenous Australian, Canadian and New Zealand writers. His book on Australian writer Jack Davis was published in 1994. James Wieland's 'Australian Critical Bibliography' is in press, and his 'Shaking Hands with Shadows: Australian Responses to War' is in its final-draft stage. The program's other Australian projects, Maurie Scott's 'Aboriginal Theatre Database', Gaetano Rando's 'Italians in Australia' project, Louise Ravelli's 'Linguistics in Australia' project, and James Wieland and Joseph Pugliese's

'Reader in Australian Literary Criticism' are all proceeding on schedule.

Visiting Fellow

Professor Anna Rutherford, head of Australian Studies at Aarhus University, Denmark, and director of Dangaroo Press, spent several months in Wollongong as Visiting Fellow with the Program. Professor Rutherford has been a pathfinder in the field of post-colonial studies, and was one of the founders of the Association of Commonwealth Literature and Language Studies. Professor James Wieland is collaborating with Professor Rutherford on an issue of the journal *Kunapipi*, dealing with Australian war writing.

Pacific theatre project: new initiative

An exciting initiative arising from the Program's existing work on Aboriginal and Pacific literatures is the establishment, within the Program, of the Australian branch of the Pacific Theatre Project. Organised from the University of Santa Cruz and based on a writing centre in Western Samoa, this is an informational database, electronic journal and library of theatre material from the Asia-Pacific region. The Program has been consulted on contacts in Singapore, PNG, Fiji and India. It will receive a dedicated computer terminal with modem and annual funding of \$10,000.

Postgraduate research

The Program's Postgraduate Associate Members have made a major research contribution during the past year. Sharon Clarke's book on Sumner Locke-Eliot, mentioned earlier, commissioned by Angus and Robertson, is in its final draft form. Marilla North has been contracted by Allen and Unwin to write a biography of Australian writer Dymphna Cusack. Karen Brooks interviewed expatriate writer Shirley Hazzard in New York and presented papers at the 'Self, Life and Writing' conference and the CRNLE conference at Flinders University. Jeanette Dean presented a

paper on Women under Apartheid at the 'Self, life and Writing' conference, Kerry Goddard presented a paper on Elizabeth Jolley at the Association for the Study of Australian Literature conference (ADFA, July), and had an article on Jolley published in the journal *SPAN*.

Glenda Moylan-Brouff presented a paper on Geronimo at the American Studies Association Conference (Melbourne University, July), and Antoinette Holm presented a paper at the 'Body in the Library' Conference at the University of Queensland. Michael Hayes presented papers at the 'Self, Life and Writing' conference, at the 'Colonial Inheritance in the Pacific' conference at the ANU (December, 1993) and the conference, 'Identities, Ethnicities and Nationalities in the Asia/Pacific Region' (LaTrobe, July). Efi Hatzimanolis wrote two chapters in books published during the year and was an invited speaker at the XIV International Comparative Literature Congress, University of Alberta, Canada, in August and the 'Fin de Siècle Feminisms' conference (UNSW, September).

Greg Ratcliffe published an article on Michael Ondaatje in *New Literatures Review* and two reviews in *Australian/Canadian Studies*. Lorraine Barrow was published in *Hecate* and Melissa Boyde in *Kunapipi*. Marvin Gilman presented a paper at the CRNLE Conference at Flinders and was published in *Australian Canadian Studies*. Geoffrey Sykes presented papers at both the 1994 and 1995, Religion, Literature and the Arts' Conferences, and his play *Dream Machine*, on Lawrence Hargrave, was produced by Theatre South.

The close relationship between teaching and research in the English Department provides a strong, cohesive foundation for a group of researchers and the Program continues to give a sense of 'critical mass' and collegiality that will become more necessary with increasing expansion into team and interdisciplinary work.

*'...the historical sense involves a perception
not only of the pastness of the past,
but of its presence...' T S Eliot*

Quaternary Environmental Change

Co-ordinator: Associate Professor Colin Woodroffe (tel 042 21 3359)

UNDERSTANDING present-day environmental change often requires a knowledge of environmental changes that have occurred in recent earth history. Studies of the Quaternary Period, the last two million years of the earth's geologic record, provides a framework to evaluate the nature of earth surface processes. Quaternary studies permit, for example, assessments of the magnitude and recurrence time of geologic hazards such as earthquakes, floods, volcanic activity and droughts, which may not always be determined on the basis of human instrumental records alone. Similarly, in attempts to rehabilitate landscapes to their former 'natural' state, information gained from Quaternary sediments may assist in determining the original nature of a landscape, particularly for regions that have experienced a lengthy history of human-induced

modification. Quaternary studies also provide an opportunity to rationally assess whether aspects of present day environmental change are part of natural, ongoing phenomena, or the results of human agency.

The Australasian region has a distinctive Quaternary record, which in some respects differs significantly to that of the northern hemisphere, and has led to considerable attention by overseas researchers to the findings of the Quaternary Environmental Change Research Centre. As in previous years, members of the Quaternary Environmental Change Research Centre have maintained a high level of research productivity examining Quaternary records from diverse settings in Australasia.

Quaternary Projects

Lead in estuarine systems

Collaborative research by Dr Bryan Chenhall with Drs Brian Gulson and Massimo Chiaradia (CSIRO - North Ryde) was initiated late in 1994 examining the sources of lead in estuarine systems. The research involves finger-printing the source of lead in sediments based on isotopic analyses using high resolution thermal ionisation mass-spectrometry. Core samples were collected from Lake Illawarra and other estuarine environments and preliminary analyses were undertaken. Preliminary results indicate that it is possible to identify lead introduced to the

environment from different sources (eg vehicles, industrial sources, waste disposal) and identify the geological deposits from which the lead was derived.

Lord Howe Island

Field work continued on Lord Howe Island, site of the world's southernmost coral reef. Further samples were collected for dating by several methods (eg amino acid racemisation, radiocarbon, thermoluminescence and uranium-series dating) as well as detailed stratigraphic analyses of ancient dunes and fossil soil deposits, believed to have formed when sea level was slightly lower than present levels. Shallow seismic sections were also taken in the back-reef lagoon in attempt to identify older reefal deposits.

Archaeological studies

In a paper presented to the World Archaeological Congress in New Delhi in December 1994, Drs Lesley Head and Richard Fullagar (Australian Museum, Sydney) explored the possibility of identifying in the archaeological record, hunter-gatherer attachments to place. They compared a particular dreaming story, symbolising present-day relations to the land, from the Keep River region, north-west Northern Territory with the archaeological evidence from the Jinmium rockshelter in the same region. The dreaming story links a series of rocky hills that share two

Members

Associate Professor Ted Bryant, Dr Bryan Chenhall, Professor Allan Chivas, Dr Lesley Head, Associate Professor Brian Jones, Mr John Marthick, Dr Colin Murray-Wallace, Ms Toni O'Neill, Mr David Price and Dr Colin Woodroffe



Dr Bryan Chenhall collecting sediment samples for lead isotope analysis from a core collected from Lake Illawarra



Lord Howe Island site of the southernmost coral reef. In the middle distance, emergent shore platforms provide evidence for a higher sea level during the past 6000 years

important characteristics. First, they are the most permanent features of the landscape. Today they are prominent points on an alluvial and coastal plain. Eighteen thousand years ago,

with the sea at least 600 km away and about 140 m lower than present, they would have been even more prominent. Second, individual hills provide important hunter-gatherer resources that are archaeologically visible. Paintings on the rockshelter walls and ground ochre in the excavated sediments are traceable to an ochre mine on one of the hills. On another is found a silcrete quarry whose distinc-

tive artefacts are found throughout the deposits. In innovative work comparing starch residues on stone tools and in the sediments themselves, the use of yams over a very long period from yet another hill on the track is being elucidated. Drs Head and Fullagar suggest that while the antiquity of the story itself can of course never be known, the antiquity of mapped landscapes, and of per-

An oblique aerial view of the Macquarie Rivulet Delta, a coastal feature of Lake Illawarra that has formed in the past few hundred years. A large portion of the delta has developed since European settlement and is the focus of a lead isotope study





Ancient dune sediments on Lord Howe Island. The sloping beds indicate former dune surfaces. A plant root has also been replaced by calcium carbonate

ceived links with specific places, can be traced to the Pleistocene.

Central Australia

Research continued on the response of dune building episodes and river flow regimes to climate change in central and northern Australia during the

Gypsy Jinjair demonstrates the use of the pounding stones to process starchy plant foods such as yams



A huge boulder tossed by a major tsunami to the top of 30-metre sea cliffs at Jervis Bay

past 300,000 years. Several graduate students are involved in this research, which will ultimately provide one of the most comprehensive overviews of fluvial stratigraphy and chronology, encompassing a full glacial cycle in the world.

Recent work examining flooding of Cooper Creek in SW Queensland shows these events to be widespread (ie tens of km in extent) but not to be very erosive. Velocities are low and they transport surprisingly little sediment – mostly mud and some sand. In contrast, floods in the high energy channels of the Kimberley region, affected by the northwest monsoon, are catastrophic in nature, ripping huge slabs of rock from the channel floor and stacking them like dominos downstream of waterholes. The frequency with which these events occur is not known but is being evaluated by Associate Professor Gerald Nanson.

New South Wales outer continental shelf

Research commenced examining the chronology of depositional events on the outer continental shelf of New South Wales. Dr Colin Murray-Wallace in conjunction with Dr Marie Ferland (Sydney University) and Dr Peter Roy (NSW Geological Survey) have undertaken extensive analyses of core-sediments of the outer continen-

tal shelf. A chronology of sediment deposition based on amino acid racemisation and radiocarbon dating, indicates that there are distinct intervals when sediment is deposited on the outer shelf. Thick shell beds comprising abundant scallops (*Pecten fumatus*) and other shallow water molluscs formed on the outer shelf during glacial maxima when sea level was some 120 m below present. The ultimate aim of the research is to refine models of Quaternary sea-level and climate change.

Coastal records of rapid change

Increasing attention has been drawn recently to the effect of high intensity events such as storms and tsunami (often incorrectly termed tidal waves) on the evolution of coastlines. Tsunami have been identified as a significant geomorphic process along the southeastern Australian coastline during the Pleistocene. The cause of these tsunami is uncertain but earthquakes, underwater slides and volcanism are all possibilities in the Tasman Sea region.

Further field work along the southern New South Wales coastline was undertaken in 1994 by Dr Ted Bryant and Associate Professor Bob Young, examining evidence for tsunami sedimentation. Evidence for tsunami along the New South Wales coastline was compared with previously documented examples from Scotland



An example of the enormous slabs of rock that have been moved by catastrophic flows along the Durrack River in the Kimberley region of Western Australia. The scale is five metres long

during fieldwork conducted by Dr Ted Bryant in the Shetland Islands in 1994. Similar geomorphologic features were noted in both settings lending further support to the tsunami interpretation.

Spatial analysis

Geographic Information Systems have become an important tool for understanding, monitoring and predicting environmental change. A Mechanism C grant in 1994 awarded to Ms Toni O'Neill led to an upgrading of the spatial analysis laboratory facilities with a new Silicon Graphics workstation and suite of new GIS software. GIS research has centred on the Illawarra and the Shoalhaven. Several projects commenced in 1994 that involve modelling changes in the distribution and extent of wetlands, avian habitats, introduced weeds as well as mapping fire history and land-use change.

Remote sensing research has focussed on environmental change in the semi-arid region of western New South Wales. Recent research has combined biogeographic studies and remote sensing techniques. Results show that although there is considerable seasonal and annual variation in plant species due to unpredictable rainfall events, some plant groups are both ecologically and spectrally-distinct. For example, the two major groups of plants, C_3 and C_4 plants, which differ in their utilisation of carbon and energy at different temperatures, have

been shown to reflect radiation slightly differently. The aim of this research is to spectrally characterise the mix of these plant types. By monitoring the spectral changes it may be possible to delineate subtle effects due to climate change.

Another indicator of change highlighted in this research is the ground-cover of microphytic crusts in the semi-arid region. These crusts play an important role in soil stabilisation, nitrogen fixation and water infiltration. Crusts can also be used as important ecological indicators of

climatic change. Lichen crusts, for example, are sensitive to humid heat. They occur in areas where summer rains are uncommon. If the climate changes and rainfall patterns change, it is predicted that the distribution of the lichen crusts will change. Research completed this year has shown that the distribution and photosynthetic condition of crusts can be monitored using high spectral resolution remotely sensed data. Further research is planned utilising only recently available hyperspectral-resolution airborne remotely-sensed data.



The sinuous bedrock channel of the Prince Regent River in the north-west of the Kimberley region of Western Australia, one of the areas being investigated by Associate Professor Gerald Nanson and his postgraduate students

*Understanding and managing science and technology
in their social and cultural contexts
Aspects of sustainable development*

Science and Technology Analysis

Co-ordinator: Dr Brian Martin (tel 042 21 3763)

MEMBERS of the Science and Technology Analysis (STA) Research Program are involved in promoting and integrating research into the nature, dynamics, impact and management of science and technology in their social and cultural contexts. Most STA members are from the Department of Science and Technology Studies with a few from other parts of the University.

The main formal activities of STA are seminars, several discussion groups – covering areas including environment, economics and sociology of scientific knowledge – and production of STA working papers, which have been distributed to dozens of centres around the world. Some of the activities of STA members during the year are described below.

Members

Mr Stan Aungles, Associate Professor Richard Badham, Dr Sharon Beder, Professor Jim Falk, Mr Greg Hampton, Dr Richard Joseph, Mr David Mercer, Dr Glenn Mitchell, Ms Rhonda Roberts, Mr Brian Rogers, Dr Stewart Russell, Associate Professor John Schuster

Stan Aungles has continued to work on information technology and higher education, looking at computer literacy, computerised curricula, university libraries, educational technology (including open learning) and secretarial work. He approaches these areas using organisational theory to analyse the way organisational changes relate the particular configurations of information and communication technologies.

Richard Badham has been engaged on a major ethnographic study of human-centred manufacturing, using the approach of action research. During 1993-94, the project focused on Hoover Australia. Detailed dictaphone notes, minutes and interview information were collected. In order to introduce a comparative dimension to illuminate unique and shared elements of human-centred initiatives at Hoover, a series of case study analyses was begun during 1994 in two other companies using smart manufacturing techniques, carried out by Associate Professor Badham and Dr Paul Couchman. The project will continue in the coming years.

In July, Sharon Beder was invited to Japan as a guest of Tokyo Metropolitan University (TMU). While there she delivered a public lecture on science and technology education for social responsibility. She also gave papers at two symposia; one on engineering codes of ethics at TMU

and one on trends in environmentalism in Australia at Osaka University. Dr Beder has also continued to research, write about and give papers on various aspects of sustainable development, especially the ethical and political aspects of environmental economics.

Professor Jim Falk continued to develop the Technology and Environmental Strategies research grouping (TES) which he directs. In 1994 the group carried out several major projects for government agencies including the National Review of Greenhouse Information Materials and Programs which was commissioned by the Australian and New Zealand Conservation Council (ANZECC) as part of the government's National Greenhouse Response Strategy. The Report is to be published in 1995. TES has also won a grant from the Environmental Trust (NSW) – in collaboration with the Graduate School of Environmental Studies at Macquarie University – to carry out a feasibility study for developing a National Clearing House for Environmental Education. The study involves the development of both traditional and electronically networked systems and will be the basis of a proposal for the development of a full-scale clearing house.

Working in TES, Greg Hampton carried out a study of community preferences and attitudes towards the East Coast Armaments Complex,

a proposed armaments depot at Jervis Bay. The construction of this depot will have environmental impacts in the form of destruction of seagrass beds and disturbance to the habitat of a variety of marine species. The social impacts of the construction involve loss of visual and recreational amenity in the Jervis Bay area and an increase in hazards associated with the transportation and storage of armaments. Economic impacts involve a possible decrease in income from tourism and a possible increase in employment opportunities in the Nowra area, though the extent of this increase is disputed. Community preferences for the construction of the depot were assessed by telephone survey using the random digit dialling sampling method, and the relationship between preferences and attitudes towards the impacts of the construction were investigated.

Dr Richard Joseph has continued his work in the areas of electronic mail, information policy and telecommunications policy. He takes a critical view of many of the 'reforms' of telecommunications, arguing that the concept of 'deregulation' is much too simple to explain the complexity of the changes that are occurring in Australia and other countries. He looks at these changes as part of a longer-term involvement of the Australian government in confronting and shaping processes of technological and institutional change. His focus is on the use of political rhetoric which hides many of the social impacts of the changes.

Dr Brian Martin, in collaboration with Mary Cawte, continued his ARC-funded project on science and technology for non-violent struggle. They have focused on communication technology, looking closely at a certain paradox: in general, network communication media (such as telephone and electronic mail) are expected to be more helpful in non-violent struggle than broadcast media (such as radio and television), but in some specific cases, notably the

Researching electronic mail: Stan Aungles is investigating the effect of communication technologies, including e-mail, on patterns of academic work; Dr Brian Martin, middle, in collaboration with Mary Cawte, is researching the possible uses of science and technology for nonviolent struggle, with a special focus on e-mail; Dr Richard Joseph has been studying the way e-mail can be used as a form of social control



Czechoslovak resistance to the Soviet invasion of 1968, radio has been extremely useful in non-violent struggle. The paradox is resolved by noting that a completely unified resistance – as was the case in Czechoslovakia – is not hindered by the unidirectionality of broadcast media. The introduction of diversity in the resistance shows the superiority of network media, and even in Czechoslovakia the active phase of the resistance finished as soon as the Soviets took over the radio system.

Rhonda Roberts has been working to complete her PhD thesis, which looks at high technology 'incubators' designed as an innovation management tool to accelerate rates of innovation in high technology industries. Her case study is an investigation of the negotiations between the Australian and Japanese governments to build the Multi-function Polis. Her analysis critically examines the MFP incubator design process discussing implicit assumptions made about the nature of innovation and cultural difference in innovation management. Also discussed is the use of incubator developments by governments and business to fulfil private agendas and how this influences incubator design.

Brian Rogers has continued his work on the historical archaeology of salt

manufacturing. Over the past several years he has studied sites in New South Wales, Victoria and Tasmania, and has visited salt museums in Europe. His studies bring together an historical overview, detailed attention to artifacts and sites, assessment of processes used in salt manufacture, and conclusions about the relationship between technology and society.

Dr Stewart Russell continued his research on combined heat and power in Britain. He wrote a specially commissioned historical study for the Swedish National Board for Industrial and Technical Development which was published this year.

Associate Professor John Schuster has continued work leading towards a new overall interpretation or master-narrative of the period known as the 'Scientific Revolution'. This project, involving the participation of honorary fellow Alan Taylor, aims to revive large-scale narrative as both research strategy and outcome for historians of science. The study questions current interpretations of the Scientific Revolution, both the traditional heroic narrative of Western science as internally driven, uninterrupted progress and the apparently contrary view explaining developments in terms of external economic and political influences.

*Engineering risk assessment and quality issues in the geo-water environment
Geomechanics and mining
Environmental engineering and management*

Water Engineering and Geomechanics

Co-ordinator: Associate Professor Robin Chowdhury (tel 042 21 3040)

A COMMON theme of the Water Engineering and Geomechanics Research Program is the understanding and analysis of issues related to safety, quality, risk and reliability in the geo-water environment, including natural hazards as well as infrastructure and resource development. This Research Program is unique among university engineering departments in adopting strategies for interdisciplinary work alongside traditional discipline-based research.

During 1994, six PhD projects were completed and 33 other PhD projects were continued. In the same period,

additional research funds totalling \$300,000 were attracted from outside the University. The Program co-organised a national conference during this year and successfully hosted three new short courses.

Urban stormwater quantity and quality management

Under the leadership of Associate Professor Boyd, work is continuing on the design of detention basin storage to control floods in urban areas. In practice, it is possible to use a small number of large detention basins or a large number of small detention storages located on the many developed sites on the catchment. The second approach is the recent trend in Australia. It has been found that performance over the total catchment should be considered in evaluating a system rather than the performance of individual sites. The work is being supported by Wollongong City Council, whose engineers are actively participating in computer modelling and other aspects of the research.

Associate Professor Sivakumar and his group are working on three projects, modelling water quality of urban catchments, red-line monitoring of catchment water quality and design and analysis of stormwater pollution control structures. Extensive data collected by the NURP (National Urban Run off Program) study from

the United States as well as Australian urban water quality data have been analysed. Based on this analysis, a pollution wash-off model has been developed to predict significant pollutants washed from urban areas.

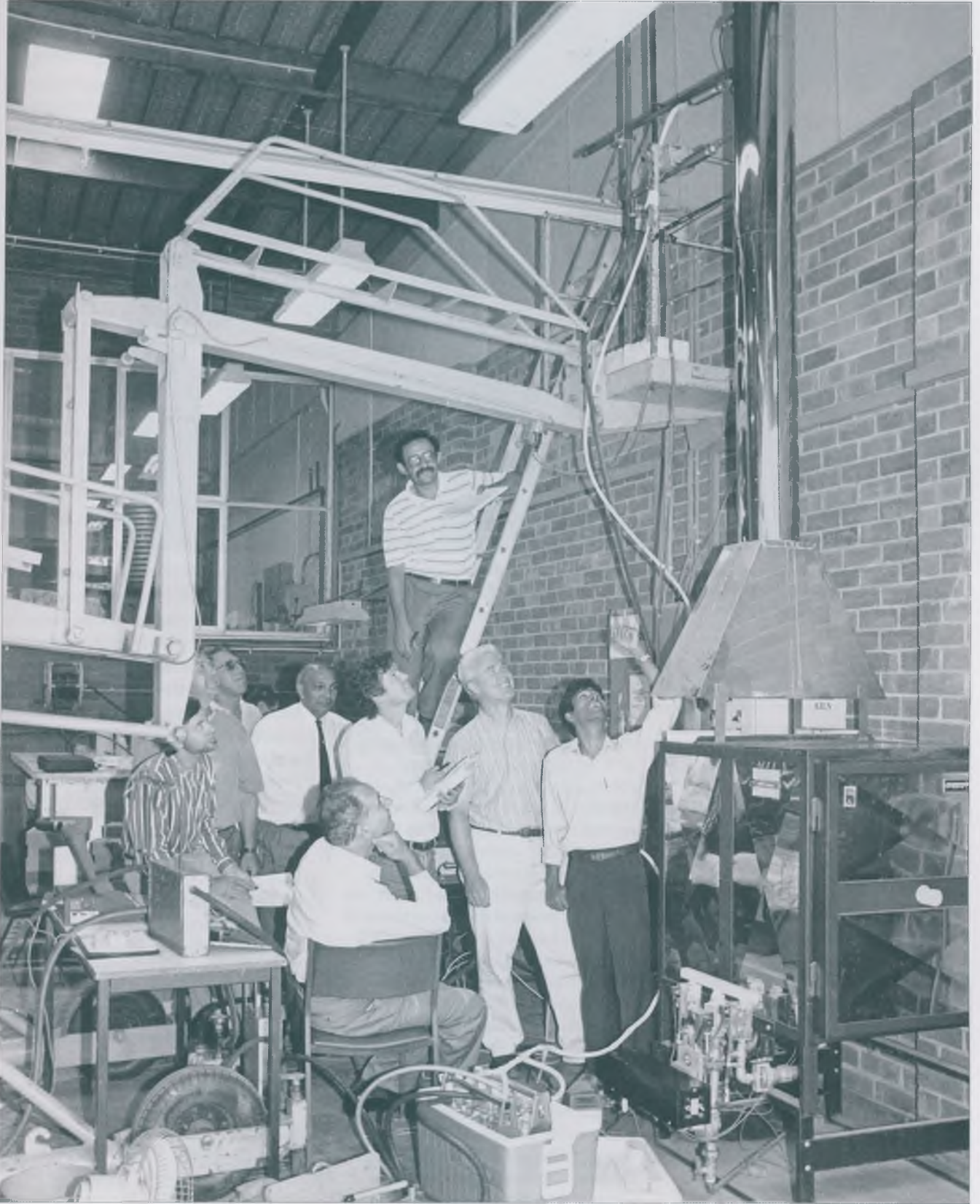
Work related to real-time monitoring of stormwater quality in two West Dapto streams is also in progress. A remote-control facility has been developed at the University, through cellular phone hook-up, to monitor water quantity and quality data during storm water events from two creeks in West Dapto. Associate Professor Sivakumar's team is developing new strategies for modelling pollution control ponds in urban areas. These projects are being undertaken with funding and assistance from a number of authorities including ARC, WCC, PWD, EPA and CALM.

Engineering applications of waste materials and reinforced soils

A major project – Biofly brick – is concerned with the use of fly ash and sewage sludge in making construction materials like bricks. This project is supported mainly by Pacific Power, the Water Board and Boral Resources. The project leader, Associate Professor Sivakumar, reports that Stage II of the Biofly project is about to be completed. Stage III will include

Members

Dr Richard Arenicz, Dr Ernest Baafi, Associate Professor Michael Boyd, Dr Bruce Cathers, Dr Hagare Dharmappa, Dr Mohammad Hadi, Dr Buddhima Indraratna, Associate Professor Denis Montgomery, Dr Ian Porter, Professor Raghu Singh and Associate Professor (Siva) M Sivakumar



Associate Professor Sivakumar points out to colleagues the flue in the upper reaches of the gas-measuring system of the Biofly Project. In the foreground, seated, is Professor Robin Chowdhury (Co-ordinator of the Program). Others, from left, are Dr Richard Arenicz, Messrs Norm Gal and Jim Britton, Professor Raghu Singh, Dr Ian Porter, Mr Fady Sidrak and Associate Professor Denis Montgomery



PhD students in conference mode. Considering aspects of the Bubbleless aeration project with their Supervisor, Associate Professor Siva Sivakumar, are, from left, Messrs Saied Boronnard-Nasah, Cheng-Ching Shriau, Fidelis Rutundo Musari and Mehdi Ghomesh

planning and design of an appropriate Biofly brick plant and a market acceptability study.

The use of slag for road and pavement engineering applications has been undertaken by a PhD student under the supervision of Associate Professor Montgomery and Dr Arenicz with application to the third runway for Sydney Airport.

Dr Arenicz has continued his research work on the behaviour of reinforced earth walls and dams and a PhD thesis was completed by Mr M R Maghareh during the year.

Dr Hadi has initiated work on the analysis and modelling of recycled flexible pavements under static and dynamic loads.

Associate Professor Montgomery has spent six months study leave with industry and during this time has developed a user-guide for the use of slag products in flexible and bound (cementitious) pavements.

Slope stability and geotechnical risk

Fundamental research concerned with conceptual advances has been continued. At the same time research of practical value concerned with slope stability in the Illawarra has been carried out, primarily by two research students. One student (working under the joint supervision of Associate Professor Chowdhury and Associate Professor Jones of the Department of Geology) has just completed a PhD thesis concerned with the influence of major geotechnical and geological factors on the stability of slopes along the coastal escarpment. This research will enable improvement of methods to reduce environmental degradation of slopes and cliffs and of engineering approaches or development processes to minimise the risk of failure and damage. The work of another PhD student, supervised by Professor Chowdhury, is supported by a scholarship from an APA(I) award involving ARC and WCC. The aim of

this research is to prepare reliable maps of slope stability for the Greater Wollongong area of the Illawarra region and to develop procedures for assessment of risk concerned with proposed development of individual zones or sites.

Professor Chowdhury was invited to present a keynote paper and to chair a session at an International Conference on Landslides Slope Stability and the Safety of Infrastructures held in Kuala Lumpur, Malaysia, in September 1994. This year he will visit the Public Works Research Institute in Japan as part of an International Collaborative Exchange Project recently funded by the Department of Industry, Science and Technology.

Mining geomechanics, geo-statistics and minewater engineering

Several projects are concerned with the analysis and design of support systems, pillar design, strata control, groundwater modelling and mine inundation. Research work supervised by Dr Ian Porter and Professor Raghu Singh has led to several successfully completed research theses. Dr Buddhima Indraratna has also started a significant research activity related to modelling of groundwater flow in mines.

Professor Singh and colleagues have continued work on methods of analysis of problems concerned with minewater in surface and underground mining operations. Several engineers have been trained and have developed short courses, which have been well received by the mining industry.

Dr Baafi has continued his studies and research with geostatistical modelling of mining resources and mining operations. A workshop on modelling, planning and evaluation of resources on computers has also been developed.

Modelling of dams and foundations

Current research in this area is led by Dr Indraratna and encompasses constitutive modelling of the behaviour of construction materials under saturated and partially saturated conditions. The concepts of soil mechanics have been extended to evaluate the behaviour of mine waste and fine coal tailings, with special reference to their undrained failure mechanisms, including liquefaction. Dr Indraratna presented several professional development seminars in this research area at the National Building Research Organisation in Sri Lanka.

Water treatment and re-use

Increasing deterioration in the quality of natural water together with stringent water quality requirements warrant better and more efficient treatment facilities for the provision of drinking water. Work undertaken by Dr Dharmappa is focusing on modelling and optimisation of individual processes as well as the modelling of whole systems. A similar approach could also be applied to wastewater treatment systems, with further emphasis on the application of artificial neural networks to water treatment systems. Dr Cathers is developing a methodology using

artificial neural networks for determining the optimal dosage of chemicals and the operating parameters of various processes.

Geotechnical earthquake engineering

It is important to understand the response of embankments, earth dams and slopes to earthquakes. The consequences of failure may be very serious and far-reaching, especially if the waters of a reservoir are released as part of the failure process. Work has continued with the development of methods for computer simulation of the behaviour of earth structures. Success has been achieved in understanding how localised failures may initiate as a consequence of degradation of shear strength of soils, including strain-softening and increase of excess pore water pressures.

During 1994, short courses were organised on 'Engineering Seismology' and 'Geotechnical Earthquake Engineering'. Participants from different parts of the country included engineers from government and industry concerned with the safety of dams and infrastructure. Research needs related to geotechnical earthquake engineering and dam safety under earthquake conditions were the focus of all discussion periods.

*Differential equations,
functional analysis, logic, topological groups
Distinguished mathematicians visit Wollongong*

Analysis Research

Co-ordinator: Professor Sid Morris (tel 042 21 3843)

THE YEAR 1994 was excellent for the Analysis Research Group. Associate Professor Rodney Nilsen's monograph entitled 'Difference Spaces and Invariant Linear Forms' was accepted for publication by Springer-Verlag, one of the premier international mathematics publishers.

A major achievement over the past three years was greatly increased joint research activity, attracting to Wollongong more than 20 distinguished visitors from Canada, China, Czechoslovakia, France, Germany, Israel, Japan, the Netherlands, New Zealand, Oman, Russia, USA and Vietnam, some half of whom, during their visits or since have carried out joint research with members of the Analysis Research Group. Professor Morris travelled to Russia in August and established an exchange relationship with Krasnoyarsk State University, and it is planned that two members of the Analysis Research Group will

travel to Russia to do joint research during 1995.

In recognition of his overall performance and, in particular, his research performance, Dr Philip Laird was promoted to Associate Professor. Associate Professor Laird was selected by the Institution of Engineers, Australia, as the winner of a national competition for his paper on transport analysis. The paper which was entitled 'Increasing Energy Efficiency In Australian Land Freight Transport' in part reported on the Land Freight Transport Energy Project completed in 1993 for the Energy Research and Development Corporation.

Associate Professor Martin Bunder won an ARC grant and brought to Wollongong seven eminent scholars: Professor Barendregdt and Dr Dekkers (University of Nijmegen, Netherlands), Dr J R Hindley (University College, Swansea, Wales), Professor J P Seldin (Concordia University, Montreal, Canada), Professor Phan Dinh Dieu (University of Hanoi), Professor R K Meyer (ANU) and Dr A Dekker (University of Tasmania). These visits resulted in successful research collaborations and several papers published in international journals. Associate Professor Bunder's research is in logic and, in particular, type theory, illative combinatory logic and lambda calculus.

Dr Graham Williams continued his research with Professor Bill Ziemer and Dr Peter Sternberg, both of

Indiana University. This research appears in a series of papers on least-gradient problems.

Until the establishment of the Analysis Research Group there were no PhD students in pure mathematics at the University of Wollongong. With the establishment of the Group, Dr Williams and Associate Professor Nilsen began to do joint research and took on a PhD student, Mr Wai-Lok Lo. Mr Lo is progressing satisfactorily on his doctoral studies and has presented a paper at a conference and submitted one for publication. A second PhD student has now been taken on – he is Mr Weiju Liu, and he is working on control theory for partial differential equations. Dr Williams and Associate Professor Nilsen together with the research students have held a series of research seminars.

Ms Joanna Goard had her first paper (co-authored with Professor Philip Broadbridge), 'Non-classical Symmetry Analysis of Linear Reaction-Diffusion Equations in Two Spatial Dimensions', accepted for publication.

Dr Peter Nickolas did joint research with Professors Ralph Kopperman, Mike Mislove, Sid Morris and Doctors Vladimir Pestov and Sergey Svetlichny on topological laws in wide varieties of topological groups. This research is a breakthrough in the understanding of topological laws. A joint paper is being written which answers a 20-year-old problem in this area.

Members

Associate Professor Martin Bunder, Ms Joanna Goard, Associate Professor Philip Laird, Mr Wai-Lok Lo, Dr Peter Nickolas, Associate Professor Rodney Nilsen, Dr Frank Prokop, Dr Graham Williams



Researchers: from left, Dr Rodney Nillsen, Mr Wai-Lok Lo, Associate Professor Philip Laird, Ms Joanna Goard, Dr Frank Prokop, Professor Sid Morris, Associate Professor Martin Bunder, Dr Graham Williams and Dr Peter Nickolas

Dr Longin Latecki from the University of Hamburg visited Wollongong in February to work with Dr Frank Prokop. They did some joint research, recently presented at international conferences, on a new model for digital images, a topic which is at the interface of topology and computer science.

Professor Sid Morris was an invited speaker at an international conference on topology sponsored by the Mathematical Society of Japan and held in Matsuyama in December. He delivered a paper on topological generators of locally compact groups. This

resulted in some joint research being done with Professor Wis Comfort, Dr Desmond Robbie and Dr Sergey Svetlichny, Professor Mikhail Tkacenko and Professor V V Tkachuk. He also completed joint research with Professor Jerry Itzkowitz of City University of New York on the size of the Stone-Cech compactification of locally compact groups.

Professor Morris attended, as a delegate of the Australian Academy of Science, the International Mathematical Union Assembly in Lucerne, Switzerland, and the International Congress of Mathematicians in

Zurich. He spent some time visiting Technische Hochschule Darmstadt, where he continued his major research project on compact groups with Professor Karl Hofmann. He also did joint research with Professor Hofmann and Dr Markus Stroppel on locally compact groups and varieties of topological groups. This research resulted in two papers which answered a series of questions on varieties of topological groups and exposed the structure of residual Lie groups. Professors Hofmann and Morris wrote three chapters of a book on compact groups.

*Scholarly and artistic research on interchange
between artforms and cultures;
new research group*

Contemporary Arts Practice and Performance in Australia

Co-ordinator: Dr Andrew Schultz (tel 042 21 3302)

THIS IS the final report of the Research Group 'Contemporary Arts Practice and Performance in Australia'.

From 1995 the Group has expanded its membership and becomes the Research Centre for Artistic Exchange and Innovation (CAXI). The Group was established six years ago and still represents a unique grouping of researchers in the Australian tertiary sector. In that time it has developed and focussed to the point where the past activities, plans for the future, stability of direction, success in achieving external funding, and growth and quality of membership have supported a case for its upgrading as a Research Centre.

CAXI will have as its field artistic and scholarly work that relates to interchange and exchange between art forms and cultures; this is a field that a Centre within the Faculty of Creative Arts is well positioned to explore. The aim of the Centre will be to foster

innovation and excellence in artwork and scholarship relevant to this field.

The idea of artistic exchange will be interpreted in two primary and overlapping ways:

1. *The creation and study of artwork that results from an interchange or collision of cultures.*

Projects completed and planned show strong examples of this. Instances include:

- reciprocal art exhibitions including the Identities: Art From Australia exhibition that toured Taiwan in 1993 and Australia in 1994–95 (Peter Shepherd), a Turkish-Australia exchange in 1994 (Liz Jeneid) and a planned US-Australia exhibition in 1995 (Sue Rowley);
- artwork exploring cross-cultural issues by individual members of the group such as the epic Philippine-Australian poems of Merlinda Bobis, the operas *Black River* and *Going Into Shadows* by Andrew Schultz and the film *The Songlines* to be produced by Sharon Bell;
- exchanges and residencies such as that organised by Diana Wood Conroy that has allowed her and Leonie Molloy to spend time working with Aboriginal artists at Yirrkala in the Northern Territory. Two Yirrkala artists will exchange in 1995: Banduk Marika (Chairperson, Dhimarlu land council) and

Nawalwarri (Principal in training, Yirrkala Community School). This exchange was supported by a substantial grant from the National Priority Reserve Fund at the end of 1994;

- members' involvement in criticism and theory in this area, as for example in the *Sounds Australian* journal, 'Appropriation – Tradition – Borrowing – Theft' and in the comparative study of epic theatre in Australia and USA undertaken by Clem Gorman.

2. *Explorations of hybrid art forms involving collaboration and cross-fertilisation between artists and the application of new technologies*

Innovation in the arts often occurs through the crossing of discipline boundaries and the extrapolation of ideas from one field to consequences in another. Further, it is often related to new and emerging technologies. Instances of involvement in these areas include:

- creative work and theory in sound art by Frances Dyson through her work for the international Sound Cultures Committee which publishes a journal and organises a festival (approximately once every two years) in countries bordering on the Pacific rim;
- the relationship of music and text in various writings and compositions by Andrew Ford;

Members

Ms Diana Wood Conroy, Mr Andrew Ford, Mr Ian McGrath, Dr Sue Rowley, Associate Professor Peter Shepherd

- new technologies and the development of theatre direction, design and technical production by John Senczuk and Ian McGrath;
- activities by a number of staff in genres such as opera that are inherently cross-disciplinary;
- the enriching and development of theoretical perspective from other standpoints, as in the craft theory developed from archaeological theory by Diana Wood Conroy and Sue Rowley.

As with the former Research Group, output of CAXI will not just be the conventional scholarly style of publication, but will also include artwork in all genres. In this way we hope that the Centre will be attuned to activities within the Faculty and show the ways in which artwork can reflect on significant intellectual and philosophical issues to the University and community at large. Hopefully we will also set the lead nationally in encouraging the premise of artwork as equivalent to research in the University environment.

CAXI draws its members from the four arts disciplines found in the Faculty of Creative Arts and is, therefore, an interdisciplinary group unified by a mode of behaviour and commitment to innovation and experimentation, intellectual rigour and artistic excellence.

Art Taiwan

Artists, journalists and administrators from Taiwan are seen here with members of the Contemporary Arts Practice and Performance in Australia Research Group and members of the Faculty of Creative Arts.

Co-ordinating the exchange visit was Associate Professor Peter Shephard



*Mathematical modelling of corrosion and impedance measurements
Impingement of a liquid droplet on a thin film of fluid
Energy efficiencies of Australian road and rail-freight tasks*

Engineering and Industrial Mathematics

Co-ordinator: Associate Professor James M Hill (tel 042 21 3822)

DURING the year the Centre for Engineering and Industrial Mathematics continued its work on a wide range of mathematical modelling problems arising in engineering and industry. In particular, renewed contact was established with several research scientists from BHP Research and Technology Centre, which resulted in gaining two Australian Postgraduate Awards (Industry) to fund PhD projects. Other highlights of the year included the presentation of the keynote lecture by Associate Professor Jim Hill on double shearing theory for granular materials, delivered at the symposium, 'Anisotropy, Inhomogeneity and Nonlinearity in

Solid Mechanics' at the University of Nottingham. In addition, Dr Xiaoping Lu and Dr Songping Zhu each enjoyed a productive study leave at the University of Cambridge, working respectively with the distinguished mechanicians Professor John Willis FRS and Professor George Batchelor FRS.

The two projects which successfully gained Australian Postgraduate Awards (Industry) involve the mathematical modelling of corrosion and impedance measurements and the impingement of a liquid droplet on a thin film of fluid. The first project – Professor Phil Broadbridge and Dr Geoff Walter (BHP) – aims to improve the interpretation of both DC current/voltage and AC impedance measurements, so that corrosion characteristics can be monitored and predicted more confidently.

Corrosion currents are usually predicted from DC current data by the Tafel equation, which is established from the kinetics of charge transfer. This is found, however, not to be a good predictor over some ranges of current/potential data. In practice, corrosion rates are limited not only by charge transfer rates, but also by the diffusion rate of reactants to or from the electrodes. In corrosion degradation experiments, AC impedance measurements, including both

reactive and resistive contributions, are taken over a wide range of frequencies.

Interpretation of the data is usually based on equivalent linear circuits, using similar reaction-diffusion partial differential equation models as for the DC problem, but incorporating periodic boundary conditions for the AC set-up. The result will be better prediction of the extent of degradation of painted and unpainted metals.

The second project – Dr Songping Zhu and Mr Cat Tu (BHP) – aims to better understand the general dynamics of a liquid drop colliding with a thin liquid film on a solid. This occurs during zinc coating and spray painting of steel sheet. In particular, given the size and speed of the droplet, we would like to predict the deformation of the surface and the drop. This is a very interesting free surface problem, as the evolving shape of the droplet must be determined as part of the problem. In some situations, such as a water spray cooling a hot metal surface, the droplet may evaporate before it reaches the surface. Given this circumstance, the researchers would like to predict the heat transfer rate for a range of spray parameters.

Dr Xiaoping Lu carried out research in the area of linear elastic fracture mechanics. Her major research for the

Members

Dr Danny Arrigo, Dr Vladimir Belov, Professor Phil Broadbridge, Associate Professor Des Clarke, Ms Maureen Edwards, Associate Professor Jim Hill, Associate Professor Phil Laird, Dr Xiaoping Lu, Dr Tim Marchant, Dr Annette Worthy, Dr Songping Zhu

year was on the analysis of three-dimensional cracks. She collaborated with Professor John Willis of Cambridge University on the analysis of three-dimensional surface-breaking cracks with partial closure due to some residual stresses, and developed a new asymptotic procedure using the dislocation method, which has wide industrial applications. She supervised a Masters student project on the effect of curvature of plain cracks to the stress intensity factors and the closure of the cracks; the results obtained furthered her past research on this aspect. Dr Lu had also jointly worked with Dr Songping Zhu and Mr Pornchai Satravaha on the application of the combined Laplace transform and DRBEM to heat transfer problems. Dr Songping Zhu continued his research in the area of numerical modelling wave diffraction and refraction in coastal regions. A new model based on the dual reciprocity boundary element method (DRBEM) was developed for long as well as short waves diffracted and refracted by large islands. Such a model can be easily extended to modelling harbour oscillations induced by waves from deep oceans. Nonlinear waves behind fully submerged disturbances such as humps and trenches were also studied with a newly developed highly efficient and accurate numerical model.

As a result of collaboration among Dr Zhu, Dr Marchant and Mr Yinglong Zhang, the DRBEM was also applied to model microwave heating processes. The conditions under which hot spots would occur were studied for several different boundary geometries of a heated work-piece. Some of the underlying physics during a microwave heating process is now better understood with the aid of the newly developed two-dimensional numerical model.

Studying linear and nonlinear heat transfer and diffusion processes is another area of interest for Dr Zhu. A combined Laplace transform and DRBEM turns out to be very efficient

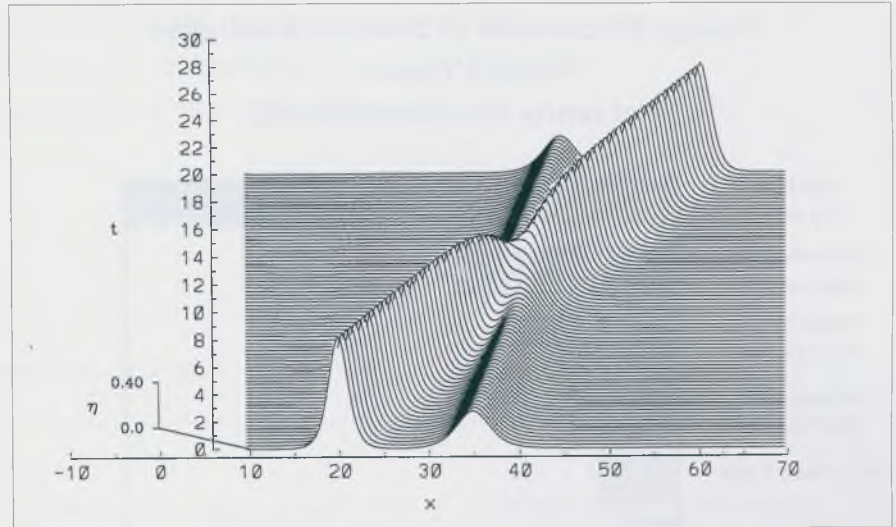


Figure 1: Interacting higher-order solitary waves

numerically in studying linear diffusion process. The method can be extended to solving nonlinear diffusion problems as well. Further research is, however, still being carried out to examine the validity of such extensions.

Dr Tim Marchant spent the first half of the year on sabbatical leave at the University of Edinburgh collaborating with Dr Noel Smyth. During this period they prepared a paper on soliton interaction for the extended Korteweg-de Vries (KdV) equation. It is well known that the KdV equation has soliton solutions. These are solitary waves which interact (collide) with each other without change of shape, except for a phase shift. The extended KdV equation is a higher-order correction to the KdV equation, valid for steeper waves in deeper water. Their research focused on determining if the higher-order solitary wave solutions of the extended KdV equation are also solitons. They found that they are solitons to leading order and any change in amplitude is due to the interaction being of higher order (see figure 1). Dr Marchant presented seminars on this topic at the Universities of Edinburgh and Exeter. He also received a Small ARC Grant for

\$7,250 for further research on this topic. This will involve examining the interaction of steeper solitary waves governed by the extended KdV equation to determine the precise magnitude of any higher-order change in amplitude during the interaction.

Ms Maureen Edwards continues to work towards the completion of her PhD thesis on the nonlinear diffusion-convection equation which has a variety of applications including the modelling of unsaturated flow in porous media. Classical symmetry analysis has been carried out for the general class of equations in one, two and three dimensions and new symmetries and new reductions have been found. The two and three dimensional Burgers' equation, a special nonlinear case of the diffusion-convection equation which has been used to model unsaturated flow in field soils, has been shown to possess the greatest number of symmetries compared to any other form of the general equation. The additional symmetries allow full reduction to ordinary differential equations.

Investigation of these ordinary differential equations has led to some new exact non-singular time-dependent solutions, which satisfy feasible

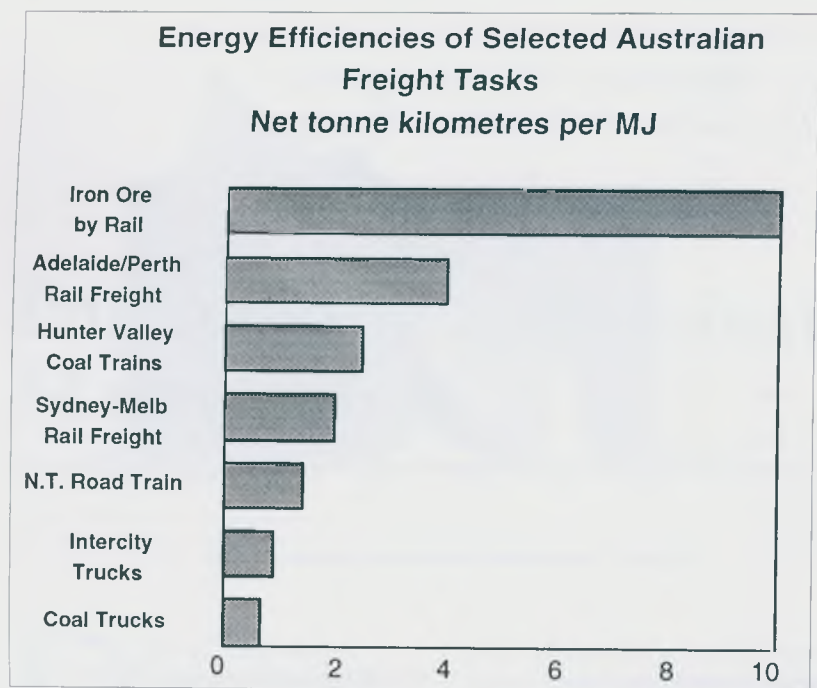


Figure 2

initial and boundary conditions. Ms Edwards' future work will include the exploitation of a transformation between a special nonlinear form of the diffusion-convection equation and the linear diffusion equation. By constructing exact solutions to the linear diffusion equation and using this well known transformation, new closed form solutions of the nonlinear diffusion-convection will be constructed.

Dr Vladimir Belov investigated a model describing the state of a viscous, incompressible, chemically active fluid. It is assumed that the fluid fills up a bounded cylindrical domain and is in the field of a temperature gradient (directed along the vertical axis). Gravitational forces are included and a catalytic reaction on the lower and upper lids of the cylinder is assumed.

A joint paper with Dr Graham Williams and Dr A Resnyanski of Lavrent'ev Institute of Hydrodynamics (Russia) is in preparation. In this work they investigate the motionless state of the above system in terms of stability with respect to some class of

perturbations. They show the existence of convective solutions, corresponding to rectangular cells when the domain is a cylinder with a rectangular cross section.

Other research by Dr Belov includes studying a free boundary problem for a viscous heat-conducting gas; together with Dr Graham Williams, Dr Belov is also investigating the construction and application of new dynamical models for fibrous and laminated composites. Such models take into account the constituent interaction and also the strain-rate and temperature influences on material behaviour. Specifically they use structural parameters describing incompatibility of the constituent strains along the bonding lines responding to internal microstresses, as well as the rate-dependent kinetics of the constituents.

Associate Professor Des Clarke has been investigating storm intensities around southern Australia for their

long-term trend and for their cyclic behaviour. Rotary spectra have been calculated for the 'centre-of-mass' of these storms at each of the stations Fremantle, Albany, Ceduna, Warrnambool, Gabo Island and Port Kembla. These spectra define how the centre-of-mass varies in latitude and longitude during a cycle. In particular, the centres-of-mass for the storm intensities off Fremantle vary in an almost exact alignment north-to-south, while at Port Kembla they vary more along a shore-normal direction to the general coastline. These spectra clearly illustrate that the movement of storm-tracks around southern Australia is certainly not a straightforward shift in latitude.

Associate Professor Phil Laird continued his research in freight transport with the assistance of Ms Gabriella de Battista. This extended research stems from a major ERDC Land Freight Transport Energy Evaluation Project completed in 1993. The 1994 research includes energy efficiency in freight transport, questions of relative funding of road and rail track in Australia, and a detailed study of rail track alignment between Melbourne, Sydney and Brisbane (see figure 2).

This work has been well received, with a paper, 'Increasing Energy Efficiency in Australian Land Freight Transport', being awarded in June 1994 the National Paper Prize - 1993 from the Institution of Engineers, Australia, National Committee on Transport. In addition a Small ARC Grant awarded for the project 'Modelling rail freight energy efficiency' will allow work to proceed on more theoretical studies. The accompanying graph shows energy efficiencies for various Australian road and rail freight tasks and demonstrates clearly that there is considerable scope for improving energy efficiency in freight, both within transport modes and, where possible, by substitution of more energy-efficient modes.

*Coal, petroleum and oil shale source rocks;
new applications for quantitative x-ray diffraction
analysis of fine-grained rocks*

Fossil Fuels

Co-ordinator: Dr Adrian Hutton (tel 042 21 3832)

THE FOSSIL Fuels Group has continued to foster research through its postgraduate students and academic members. During 1994, four PhD candidates graduated after completing their theses with research projects on topics as diverse as gas in the coal measures of the southern Sydney Basin (Australia), calculation of coal reserves and the influence of geology on the occurrence of coal in Indonesia and the utilisation of coal from eastern Kalimantan, Indonesia.

The main areas of research continue to be the geology and organic petrography of coal and petroleum source rocks, with some research on oil shales. In relation to the latter, the Group is finding new applications for quantitative X-ray diffraction (XRD) analysis of fine-grained rocks. Until now, mineral compositions of these rocks, obtained by XRD, have been semi-quantitative at best but with the new methodology, pioneered at the CSIRO, Lucas Heights, it is now possible not only to give percentages

of minerals to one per cent absolute, but to give an accurate measurement of organic matter in the rocks. This research has been undertaken by a PhD candidate who has shown that the methodology has applications in a diverse field of geological disciplines. Future research with quantitative mineralogy will focus on the use of quantitative XRD analysis of waste materials such as coal wash, fly ash and lake sediments.

During March, Adrian Hutton was Co-convenor of the Maceral/Kerogen Symposium at the prestigious American Chemical Society annual meeting held in San Diego, California. This symposium attracted approximately 50 papers with contributions from the Middle East, Europe, USA, Australia, New Zealand and Russia. Selected papers were printed in a special volume of *Energy and Fuels*, one of the American Chemical Society journals.

Aivars Depers attended the ICCP meeting in Oviedo, Spain, in September. The ICCP is a world-wide organisation that monitors research on the organic matter in rocks. Aivars has pioneered research on particulate materials, especially environmental applications of the organic petrography of particulate matter.

Adrian Hutton and Aivars Depers attended a meeting of the Organic Petrography Working Party of the Australian Standards Association in Brisbane in December.

With the change in structure of geoscience disciplines in 1995, the formation of the School of Geosciences following the amalgamation of the Departments of Geology and Geography, the Fossil Fuels Group and the Tasmanides Group will combine to form an Earth Resources and Environments Research Group. Amalgamation of the two Groups will permit closer collaboration between their academic staffs.

Dr Adrian Hutton and Mr Aivars Depers examine an exploration drill hole core from the Southern Coalfield, Illawarra Coal Measures



Members

Associate Professor Ernest Baafi, Associate Professor Naj Aziz, Associate Professor Brian Jones, Dr Leonie Jones, Mr Aivars Depers

*Fundamental experimental and
theoretical research relevant to the
electro-optic and electronics industries*

Fundamental Properties of Semiconductors

Co-ordinator: Professor Peter Fisher (tel 042 21 3556)

THE PRINCIPAL aim of this Group is to study intrinsic and extrinsic states of semiconductors using optical spectroscopy, electrical techniques and theoretical and computer modelling. A large resurgence of interest in fundamental electronic properties of semiconductors is substantially due to the revolution in modern crystal growing techniques. These enable the engineering of microscopic (nanometer size) layered structures which are of great value for device technology and also provide controlled conditions for studying new fundamental physics, especially that associated with confinement of electronic particles. Impurities in semiconductors often form solid-state analogues of atoms, while electron-hole entities (excitons) bound to impurities in bulk materials form analogues of atomic and molecular systems. Impurity states are studied using photoluminescence, optical absorption, reflectivity and photoconductivity.

The spectroscopy of impurities, excitons and other complexes not only provides information about the 'atomic' or 'molecular' system itself, but also about the host crystal by virtue of their interaction with it. Similar measurements are also made on layered semiconductor nanostructures. In narrow (~10 nm) structures (nanostructures), quantum size effects become a dominant feature, changing bulk into quasi-two-dimensional behaviour. Among the structures available are heterojunctions, quantum wells, double and triple barrier structures and superlattices. Quasi-one-dimensional (quantum wires) and zero-dimensional systems (quantum dots) are also fabricated.

The significance of the experimental facility in use is that low-temperature optical spectroscopy can be carried out on materials of topical interest from the blue end of the visible spectrum to the millimetre region using state-of-the-art instrumentation and applied external perturbations such as uniaxial forces and magnetic fields. Also, an innovative technique has been developed recently by members of this Group to study the electrical characteristics of electron tunnelling through barriers in two-dimensional structures. This technique, together with theoretical modelling, has already identified a

previously unreported tunnelling mechanism in these structures.

Research highlights

Zeeman, piezo- and piezo-Zeeman effects of acceptors in bulk germanium and silicon

The nature of the ground states of acceptors in the classic elemental semiconductors, silicon and germanium, is not fully understood even for the simplest of these impurities. The latter are the group III impurities, boron, aluminium, gallium, indium and thallium, all of which have hydrogenic characteristics in these semiconductors. High field Zeeman measurements made here are providing for the first time significant experimental information to indicate the way in which the models for these states should be modified. Once the simplest acceptors have been clarified attention can be turned to the more complex systems. For example, the properties of neutral zinc in germanium are akin to those of neutral helium. The spectrum shown in figure 1 is that of one of the absorption lines of neutral zinc subjected to a large magnetic field, 7 T. The model developed for this impurity requires that some of the splittings of the same feature for group III impurities should recur three times in the zinc spectrum; this is indeed found to be the case. Valuable information is also obtained

Members

Dr Carey Freeth, Dr Roger Lewis, Dr A David Martin, Dr Phil Simmonds, Dr Rodney Vickers and Dr Chao Zhang

from piezo- and piezo-Zeeman studies, the latter being pioneered here.

Studies on low-dimensional structures

A novel technique has been developed here which enables previously inaccessible regions in the current-voltage characteristics of a resonant tunnelling device to be measured. These characteristics are a rich source of information on the physics of the tunnelling process – a purely quantum mechanical effect. Figure 2 shows the current-voltage characteristic of one such structure with and without a magnetic field; both observations were made at liquid helium temperature. Theoretical modelling is essential to understand these observations quantitatively and has been successful in clarifying an hitherto unobserved effect (see below). This work is being carried out in collaboration with colleagues at the Department of Physics, University of Nottingham, UK, where the low-dimensional structures are grown. Such materials are state-of-the-art semiconductors and require expensive and highly sophisticated equipment for their growth.

Semiconductor theory

New theories are being developed for transport and optical properties in semiconductors and various nanostructures made of different semiconductors. Specific problems under investigation are: electron-electron interaction in nanostructures and its effect on resonant tunnelling; electronic properties of impurity states due to different acceptors in semiconductors in a magnetic field; cyclotron resonance in heterostructures and possible appearance of a new quantum phase in a strong magnetic field; quantum coherence and dissipation in electron transport. We have recently made some important progress on the problem of plasmon-assisted tunnelling and Fermi-edge singularity-enhanced electron transport.

Dr Rodney Vickers (left) and Professor Peter Fisher are cooling an infrared detector. The black cylinder in the background is the high-field superconductivity magnet

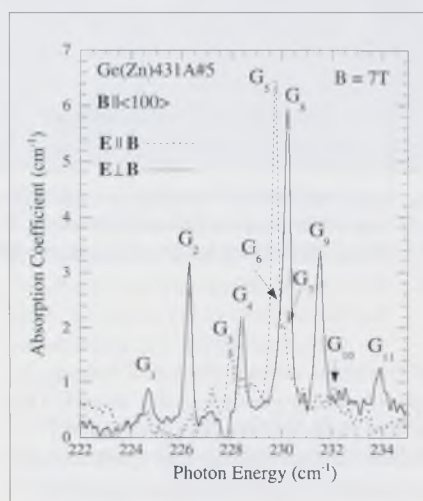


Figure 1. Effect of a high magnetic field on the G line of neutral zinc in germanium at liquid helium temperature. The dashed curve is for the electric field of the radiation, E , parallel to the magnetic field, B , while the solid curve is for E perpendicular to B .

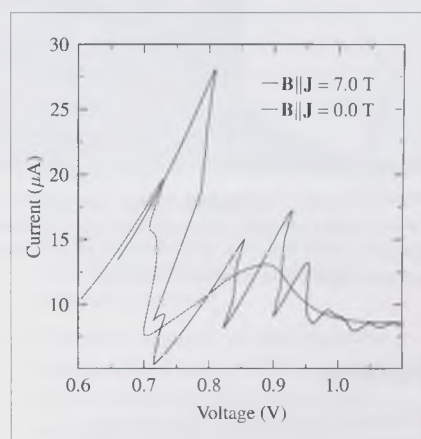


Figure 2. Part of the current vs voltage characteristic for a layered semiconductor tunnelling structure without a magnetic field (dashed curve) and with a high magnetic field applied in the same direction as the current (solid curve).



Members and colleagues of the Research Group, from left, are Ms Tania Silver, Mr George Takacs, Dr David Martin and Professor Peter Fisher (seated); also sitting are Mr Shaun Stewart, Mr Duncan Fisher, Dr Rodney Vickers and Dr Chao Zhang; in the background (left) are Dr Carey Freeth and Dr Roger Lewis; also in the background, second from right, is Mr Richard Baker and, background right, Mr Andrew Warner

Funding

External funding for the above activities was derived from a three-year Large ARC Grant. Following are some of the comments by the Assessors of this Grant. One said, 'This is an excellent proposal by a first-class experimental group, one that has a consistent record of world-class research.' A second assessor stated, 'It is with pleasure that I am writing this review of a research proposal of one

of the most outstanding solid state spectroscopy groups in the world. The senior principal investigator, Prof P Fisher, has an unmatched track record in pursuing high resolution spectroscopy research of the highest quality and originality. His work on dopant impurities in semiconductors has set the standard for the field and his group's papers belong to the most cited publications on acceptors and donors in semiconductors. The group has kept pace with the new, lower

dimensional aspects of semiconductor physics and technology. I am very pleased to note that one of the youngest members of the group, Dr C Zhang, has worked and published with Nobel Laureate Prof Klaus von Klitzing.' A third assessor said the following about Dr Zhang, '...has a very impressive record of publications within a short career in prestigious journals, which puts him in the best world class of solid state theorists.'

*Application, development, support
and evaluation of information systems
in business organisations*

Information Systems in Organisations

Co-ordinator: Professor Graham Winley (tel: 042 21 3760)

ESTABLISHED IN 1993, this Group aims to research issues related to the application, development, support and evaluation of information systems in business organisations. The Group's research interests are organised around three interacting projects which address specific areas relevant to this general aim.

Project 1 is concerned with the investigation, development and implementation of knowledge-based information systems and associated development methodologies for the purpose of managerial decision support. The work focuses on three related topics:

- the development of an intelligent heuristic search algorithm and its

application to project scheduling problems with multiple-resource constraints;

- the application of knowledge-based techniques to the problems associated with the retrieval of statistical data;
- the production of a practical framework which forms the basis for a methodology that addresses the analysis, planning, knowledge-base design, prototyping, implementation and maintenance phases of expert systems development.

Work on these topics has been supported by industry partners including the State Bank. Research funding has been provided by a Small ARC grant in 1994. Three doctoral candidates are involved in this research.

Project 2 addresses aspects of support important to the efficient and effective operation of information systems in organisations. These include education and training needs of information systems professionals and users, the interface and interaction between personnel and computer-based systems, the management of information systems resources and issues related to the technology of electronic commerce.

- A delphi study completed in 1994 considered the relationship between new technologies and the knowl-

edge and skills required of Information Systems professionals in organisations in Thailand and Malaysia. This study was supported by a Small ARC Grant.

- Studies of the perceived usefulness of information technology in the medical and veterinary professions. This research was extended in 1994 to examine software performance measures and aspects of vendor negotiation and support with a much larger group of small business professionals.
- Preliminary work on an investigation of tools, techniques and methodologies for the design and implementation of intelligent tutoring systems.
- The continuation of an extensive longitudinal study of the impact of Open Systems approaches and architectures on information technology management policy in Australian organisations.
- An investigation of the organisational issues related to the introduction of electronic commerce tools and techniques.

Support for these activities has been obtained from DMR Group (Australia), which is providing significant financial and other resources for the Open Systems study and Telstra and CSG (NSW Government), which has financially supported the electronic

Members

Mr Ang Y Ang, Ms Deborah Bunker, Mr Rodney Clarke, Mr Joshua Fan, Mr Edward Gould, Mrs Helen Hasan, Mr Peter Hyland, Mr Colin Jones, Mrs Sim Kim Lau, Dr Stephen Little, Mr Robert MacGregor, Dr Lawrence Schafe, Dr Li-Yen Shue, Ms Jeanne Wong

RESEARCH GROUPS

commerce research. Two PhD candidates are involved in this work.

Project 3 examines methodologies for the development and evaluation of information systems supporting managerial decision-making with a focus on the use of qualitative analysis.

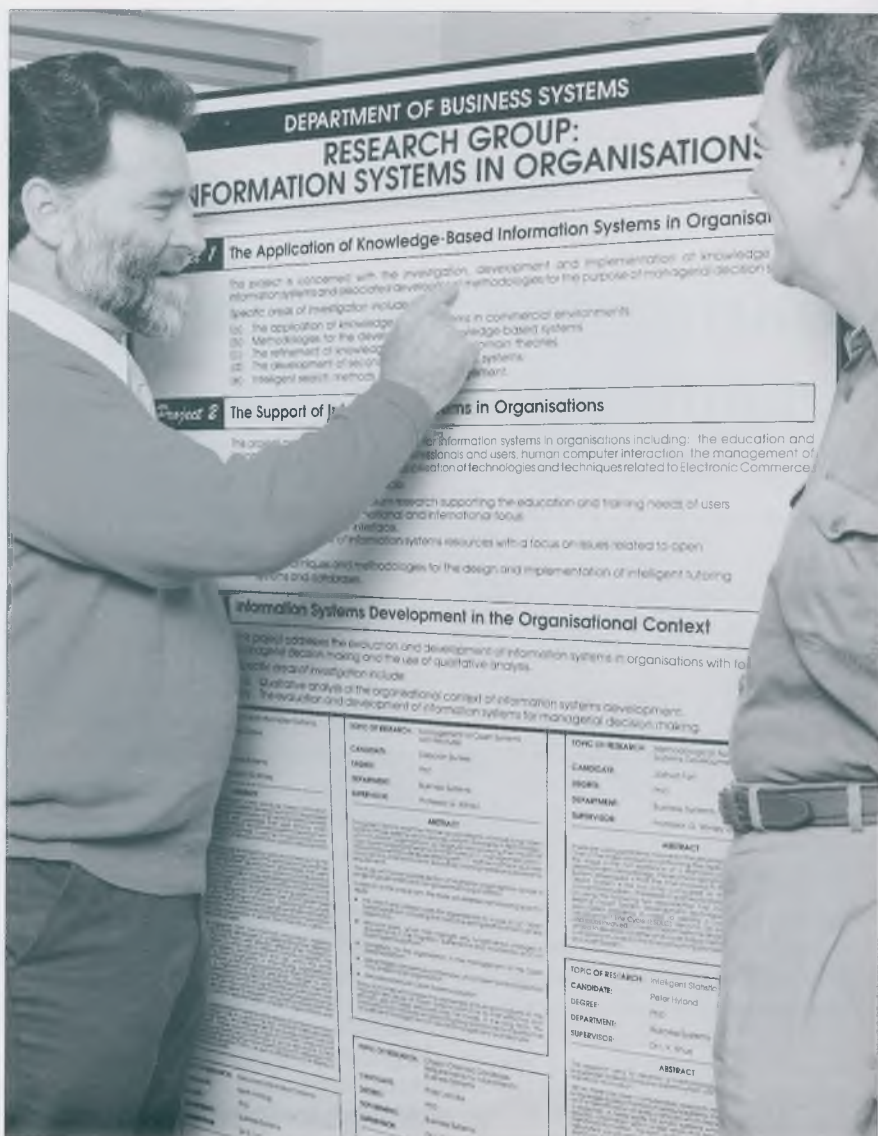
Problem areas include

- Consideration of spatial aspects of information technology and the implications for emerging forms of social and commercial organisations.
- Investigation of the role of information systems in the transfer of advanced manufacturing practice in Australia. This work has been conducted in collaboration with the MITOC research centre at this University.
- Semiotic approaches to information systems research. This work has been closely linked with that of researchers at the University of Twente, the Netherlands and Aarhus University, Denmark. An international working paper series on semiotics in organisations has been established through this international collaboration with a focus on semiotic approaches to the provision of systems development methodologies.
- An investigation of the factors affecting the successful utilisation of information systems by senior executives in Australian organisations.
- A study of the development of Executive Information Systems in Turkey.
- A study of the effects of networking technologies on organisations and households.

Four doctoral candidates are associated with research topics in Project 3.

Other achievements of the Research Group included

- Thirty-four publications in 1994 from the 15 members.
- Distinguished overseas visitors from the United States and the



The message, as Professor Graham Winley, left, is indicating to his colleague, Mr Edward Gould, is investigation, development and implementation of knowledge, and associated development methodologies for the purpose of managerial decisions

Netherlands, as well as other scholars external to the University, participated in a highly productive seminar series across 1994.

- The first Australian Journal of

Information Systems, published by Ajeta (Canberra), continues successfully to its third volume with continuing strong national and international support.

*Comparative labour relations in Japan and other
countries to the north of Australia
Democracy and equity in the Australian workplace*

Labour History and Industrial Relations

Co-ordinator: Professor James Hagan (tel 042 21 3369)

IN 1994, the Group increased in size, and is now probably the largest aggregation of labour historians in Australia. As in previous years, it continued to draw much of its strength from its interdisciplinary nature: its members came from the three faculties of Arts, Law and Commerce.

Their research in 1994 confirmed the twin directions of the Group. Externally, its members continued to work on comparative labour relations in Japan, with some preliminary work being done on investigating industrial change in other countries to Australia's north. This work is of national importance. As Australian government and industry confronts the problems of global competition, and as its economy moves into closer

relationship with those of Southeast Asian and Asian countries, so mutual understanding of industrial relations becomes urgent. The Group aimed not only to extend present knowledge, but also to give it a much-needed depth of perspective.

The most obvious result of our efforts in this direction in 1994 was the publication of the book *Industrial Relations in Australia and Japan*. Professor Hagan and Dr Wells edited the work, and contributed to it, as did five other members. The book was the second in the series on labour history and industrial relations the Group publishes in conjunction with Allen and Unwin. It was launched in Tokyo, where the editors had further discussions with the Japanese contributors on future comparative research. In this connection, Group members also visited Seoul and Beijing, and labour history research centres in Manchester, Warwick and Amsterdam.

In its Australian research program, Group members concentrated on the themes of democracy and equity in the workplace. Ken Hale continued to analyse the development and application of the laws prohibiting sexual discrimination in the workplace; Di Kelly was a member of ACIRRT's national workplace survey team; Andrew Frazer combined Australian and overseas research in his study of connections between labour law in

Australia, Malaysia and Singapore; Rob Castle and Jim Hagan continued their study of Aborigines in the workplace, which will be funded by an ARC Grant in 1995 and 1996.

Work of this kind brings members of the Group into close contact with the trade union movement. Group members have at different times written several union histories, and in 1994, Ray Markey published *In Case of Oppression: The Life and Times of the Labour Council of New South Wales, 1871-1891*. Glen Mitchell has had accepted for publication *Building Work: Conflict and Change in the Australian Building and Construction Industry 1942-1992*, and the book should be published in 1995. By then, the Group plans to marry its theoretical and empirical studies by entering into co-operative research arrangements with a number of national trade unions.

Members

Dr Andrew Frazer, Dr Andrew Wells, Dr Glenn Mitchell, Dr Henry Lee, Dr John McQuilton, Ms Josie Castle, Associate Professor Ken Hale, Mr Michael Organ, Associate Professor Ray Markey, Mr Rob Hood, Mr Stuart Svensen, Associate Professor Rob Castle

RESEARCH GROUPS



Members of the Group work on comparative labour relations with Japan and investigate industrial change in other countries. As Australia continues to increase its relations with its 'near' neighbours to the north, an understanding of industrial relations assumes increasing importance and urgency

As in previous years, members of the Group found that their research contributed to their effectiveness as university teachers. They taught 13 postgraduate students whose work related directly to the Centre's research. At undergraduate level, John McQuilton continued to develop computer-assisted learning tech-

niques applicable to the teaching of history and industrial relations, and piloted to completion the teaching of an Australian history subject by computer-assisted methods.

From the beginning of 1995, the Group will be known as the Labour History and Industrial Relations Research Centre.

Organisational strategy and performance
Culture and change processes
Services marketing strategies

Management Strategy and Organisational Change

Co-ordinator: Associate Professor A B Sim (tel 042 21 3611)

RESearch activities of the Group expanded significantly in 1994. Three new members were formally admitted to the Group and several other new academic staff and researchers were attracted to the Group to form the nucleus of a proposed research centre. This is part of the Department of Management and Research Group's strategy to recruit new academic staff members with established research records and potential to strengthen and add focus to its research profile and reputation.

As a result of expansion, the research interest and activities of current members focused on three main areas of research. The first emphasis is on

international strategic management and change and their impact on organisational performance. Associate Professor A B Sim is researching the interrelationships among strategy, environment and control systems and their impact on organisational performance in different national contexts (particularly Australia and Asia-Pacific countries). His other research is on Australian businesses in the Asia-Pacific region.

These projects involve other international research collaborators. Dr Robert Jones examines change management strategies and practices in small and medium sized firms which have experienced rapid growth as a result of rapid internationalisation. Mr Les Kirchmajer's interest is in the new venture-creation process and small-business management in Australia and selected overseas countries.

The second major area of research is human resource management, focusing on cultural diversity and change. Professor Gill Palmer has done extensive research on Total Quality Management and employment relations and is extending her scope to study culture-sensitive modes of management education and development in terms of diverse social processes, utilising bureaucratic, political and cultural frames of references.

Her other research is in gender in management. In addition to her work on cross-cultural conflict management, Associate Professor Celia Romm is also collaborating with Dr Will Rifkin in a project on inter-cultural communication, particularly on an integrated intervention program to enhance communication and learning. Taking cognisance of the Asia-Pacific region as an important area to Australia, Mr Michael Zanko's research focuses on comparative human resource management systems in South-East Asia with the objective of developing a database for benchmarking and comparative study. This project has direct collaborative links with MITOC (Management of Integrated Technological and Organisational Change).

The rapidly emerging services sector is the third area of research focus in the Group. Professor Michael Hough's main area of research is on linking human resource management techniques to service quality outcomes. Associate Professor Paul Patterson and Dr Muris Cicic are collaborating on their research project on export decision-making processes among Australian service organisations, focusing on the profiles of exporting service firms, barriers to exporting and success factors. Their other research interests are in services marketing and international marketing respectively.

Members

Dr Muris Cicic, Mr John Flanagan, Associate Professor Liz Fulop, Dr Constance Hill, Professor Michael Hough, Dr Robert Jones, Mr Les Kirchmajer, Professor Stephen Linstead, Mr Anthony Naughton, Associate Professor Paul Patterson, Professor Gill Palmer, Dr Will Rifkin, Associate Professor Celia Romm, Mr Michael Zanko



Co-ordinator of the group, Associate Professor A B Sim (standing), at a planning research strategy meeting with Professor Gill Palmer (right), Dr Roland Jones and Professor Stephen Linstead

These three major areas of research activities will constitute the basis for a proposed research centre on international management and diversity (CIMAD). As indicated earlier, several new staff members and researchers have been recruited to be part of the Group and the new research centre. In 1994 these included Professor Stephen Linstead, with an international reputation in research on the management of cultural diversity, and Associate Professor Liz Fulop, an established researcher in the area of regional strategy and capacity building for regional bodies to become internationally competitive. The research centre, CIMAD, has been approved for 1995.

During the year, the international reputation of the Group continues to grow with members publishing their research findings in top international

refereed journals and presenting papers in international conferences and seminars in different parts of the globe. External reputation and linkages were enhanced by participation of members in international research groups and networks in the US, Europe and the Asia-Pacific region.

Distinguished visitors to the Group included Professor Tamer Cavusgil of Michigan State University, who conducted a series of seminars on international business and marketing and research methods; Professor Mark Cusson of the University of Reading (seminar on international business research) and Professor Amos Drory of Ben Gurion University, Israel (seminars on cross-cultural conflict management strategies). These distinguished scholars enhanced the international exposure both of the Group and University.

The Group continued to play an active role in postgraduate training and research, with members supervising 11 PhD and two M Commerce (Hons) students. Dr Constance Hill successfully completed her PhD degree in 1994. Seminars on research methodology and latest developments in relevant fields were held for the benefits of postgraduate students and members of the Group.

In 1995 the Group will expand further, to become the research Centre for International Management and Diversity (CIMAD) and will continue its momentum of growth in quality research, enhancing its reputation, both nationally and internationally.

*Multi-disciplinary analysis of socially
significant medical innovations
and their policy implications*

Medical Innovation: Society, Law, Policy

Co-ordinator: Associate Professor Evelleen Richards (tel 042 21 3627)

THIS RESEARCH Group was established in 1994 in response to the recognition that medical innovation is an area that has profound social, economic and political implications for Australia's future. It is also a politically-charged and socially-contentious area that presents particular ethical, legal and social difficulties for informed decision-making and policy implementation. It can no longer be assumed that old certainties and approaches can resolve the complexity of problems posed by modern medical technologies or address the multi-faceted challenges they present in the policy arena. Many of these problems flow directly from the failures of past policies and from reliance on a too-narrowly-biomedical approach to their formulation. Policy-makers, researchers, practitioners, consumer-advocates and the lay public are all, from their different

perspectives, becoming increasingly aware of the need for a broader approach to the problems confronting medicine and the choices that must be made. Biomedical decision-making necessarily relates to such broad questions as the justice of resource allocation, the nature of judgements about efficacy and risk, the legal and social responsibility for medical injuries, and the governance of science and medicine.

The Group employs a collaborative multi-disciplinary approach to the analysis and interpretation of a range of important areas and issues in medical innovation and policy formulation. Members have special expertise in social aspects of the evaluation and use of prescription drugs; medical, social, philosophical and legal aspects of fertility and reproduction; most areas of health law, history and sociology; and social, ethical, and legal aspects of human subjects research. They have published widely and are experienced in developing and critiquing policy position papers in these areas.

The Group's current research is focused within three principal areas:
*Ethics in social and biomedical research:
Institutional and social contexts*

In mid-1994, Susan Dodds (Philosophy), Rebecca Albury (Sociology) and Colin Thomson (Law) completed a

major report on operational guidelines for the ethics of social and behavioural research for the Department of Human Services and Health which contracted and funded their research. Following on this report, in December, at the invitation of the Federal Minister for Human Services and Health, they submitted a review of the role and functioning of Institutional Ethics Committees, particularly in terms of their appropriateness for the discharge of their responsibilities under the Clinical Trials Notification scheme. In 1995, these three researchers plan to extend and review this research and present their findings at a specially convened workshop and conference to be organised by Vivianne Morrigan, a postgraduate student and associate member of the Group.

Catherine Berglund (Science and Technology Studies) was also successful in obtaining a two-year grant from the Department of Human Services and Health under the General Practice Evaluation Program to co-investigate ethical issues in general practice with researchers from the Faculty of Medicine at the University of New South Wales.

Drug evaluation and policy research
Evelleen Richards (Science and Technology Studies) and Catherine Berglund continued researching a

Members

Ms Rebecca Albury,
Dr Catherine Berglund,
Dr Susan Dodds, Professor
Helen Gamble, Associate
Professor Colin Thomson,
Dr Natalie Stoinoff



Research Group members have particular command in the areas of the evaluation and use of prescription drugs and most areas of health law, history and sociology, and have published widely in their areas of special expertise

multi-year ARC-funded project on the impact of AIDS on drug evaluation and regulation in Australia and the United States. This major project aims at providing a detailed, sociologically informed, comparative analysis of the development, clinical assessments and consumer demand for the drug popularly known as AZT (zidovudine, formerly azidothymidine, tradename Retrovir) in the contexts of medical, regulatory, activist and community responses to the AIDS crisis in the USA and Australia. It is intended to draw out the implications of this case study for consumer participation in the evaluation and implementation of new medical treatments.

Dr Berglund resigned as full-time Research Associate on this project at the end of 1994 to take up a Visiting Fellowship at the University of New South Wales. In 1995, her position on the project will be filled by Karin Garrety, who is currently in the final stages of researching a PhD thesis on the social shaping of the cholesterol controversy.

With Helen Gamble (Law), Evelleen Richards also began work on a project on Drug Regulation and Women's Health in Australia. This project will take as its examples Hormone Replacement Therapy (HRT) and RU-486, the so-called 'abortion pill', in order to develop appropriate models for decision making in the regulation of prescription drugs, specifically targeting 'well' women. It is also intended to prepare guidelines for the dissemination of information about the risks and benefits associated with such drugs.

Medical technology: policy, politics and the law

During the year, Susan Dodds and Rebecca Albury used support from the Group to begin researching a project on a Comparative Evaluation of Canadian and Australian Responses to New Reproductive Technologies (NRTs). They were awarded a Small ARC Grant to continue this research in 1995. They intend to examine critically conceptual problems in government regulation of NRTs and explore implications of

these conceptual problems through comparison of Canadian and Australian policy responses.

Natalie Stoianoff (Law) who joined the Group late in 1994, began work on a number of legal issues affecting medical technology, including intellectual property, consumer protection and medico-legal and commercial law. In connection with this research, she intends to evaluate current legislative regimes and offer alternatives where possible.

Summer Vacation Higher Degree Research Experience Award

In keeping with the Group's aim of providing opportunities for graduate students to pursue research in this challenging area, the Group funded a competitive Summer Vacation Higher Degree Research Experience Award for 1994/5. The award went to Danielle Mills who is completing an Honours Degree in Arts/Law and has a particular interest in research into social and legal aspects of new reproductive technologies.

Can regular physical activity improve the health of ageing Australian men and women? Effect of ageing and exercise on cardiovascular function, neuromotor control and biomechanics

Physical Activity and Ageing

Co-ordinator: Dr Steve Boutcher (tel 042 21 4093 or 21 3881)

IN THE Australian population the proportion of older people has increased dramatically over the past 20 years. For example, during the last two decades the number of Australians aged over 65 has grown by 89 percent. It has been predicted that by 2030 the elderly will be the fastest-growing segment of the population and the number of people aged 80 years or more will have increased by over one million. The majority of the Australian elderly population currently suffer from a variety of chronic diseases and functional problems that are expected to increase substantially in the future. During 1994 the Group has focused on the effect of ageing and exercise on cardiovascular function, neuromotor control of movement and changes in the mechanics of daily living skills.

Cardiovascular Research Laboratory (Boutcher)

Research has focused on comparisons of highly trained older males and their untrained age-matched counterparts. In a series of studies we have compared aerobic fitness (see picture), resting autonomic, cardiac, and

vascular status. We have also examined the cardiovascular response of fit and unfit older individuals to a battery of clinical tests. Results demonstrate that highly trained older runners and cyclists have nearly double the aerobic fitness of untrained older males. Their maximal oxygen uptakes were also some 70 percent greater than a group of young Wollongong male students. At rest these older trained individuals also possessed significantly lower heart rates and greater vagal tone.

During cardiovascular challenge the trained showed lower cardiac reactivity and a more efficient pattern of

autonomic response. Overall these data indicate that older aerobically trained males are significantly fitter and have more efficient cardiovascular response during rest, exercise, and cardiovascular challenge.

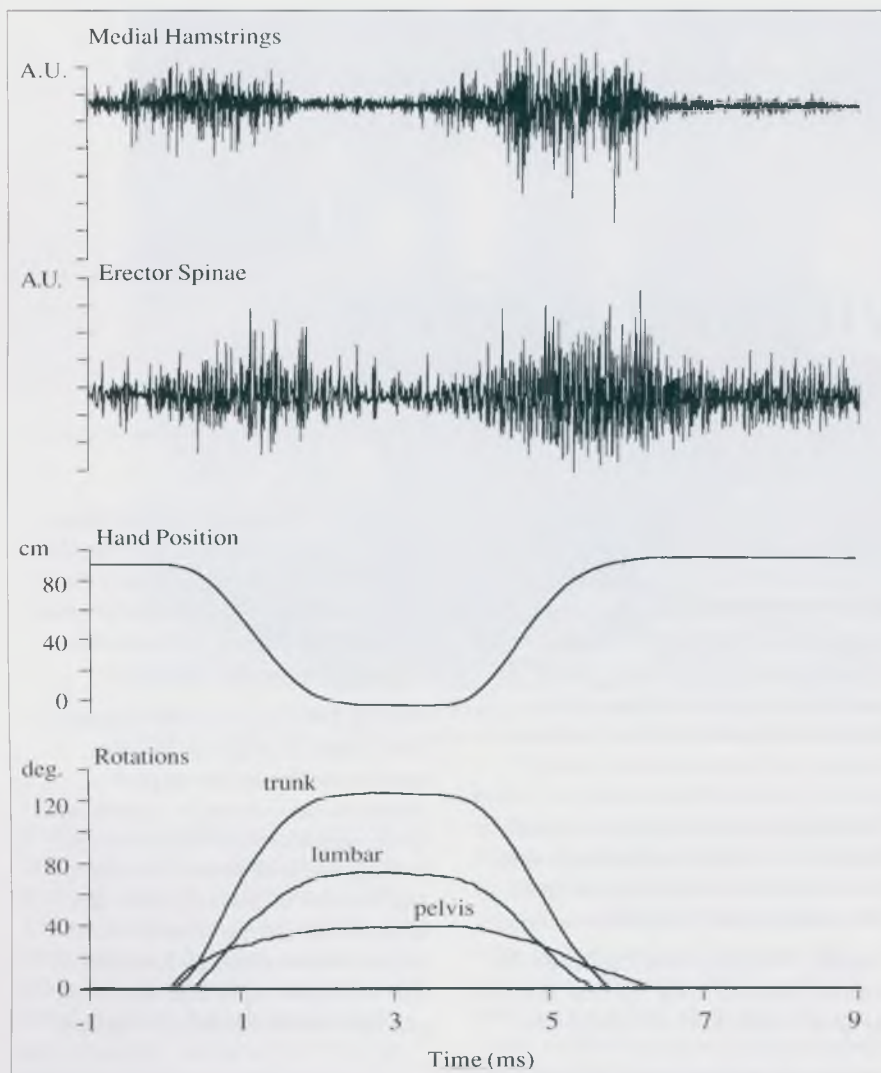
During 1994 we have also initiated a new research program into the cardiovascular health of postmenopausal women. In Australia, cardiovascular heart disease is the leading cause of death in women, and the risk of heart disease rises dramatically at the onset of menopause. Recent research has shown that hormone replacement therapy can reduce the incidence of cardio-

Postgraduate student Peter McLaren collects oxygen uptake and impedance cardiography data performance from an untrained older male



Members

Dr Mark Brown, Ms Julie Steele, Professor Len Storlien, Dr Nigel Taylor



Muscle electrical activity and hand position associated with the stoop lift in the elderly. Note the near cessation of activity (silent period) at the bottom of the lift where the trunk is supported by its soft (eg ligaments) and hard (eg bone) tissues only

vascular problems in post-menopausal women by over 50 per cent. Unfortunately, hormonal replacement therapy possesses a number of disadvantages (eg, hyperlipidemia and elevated blood pressure). Aerobic exercise may help reduce many of the risks associated with the menopause and could possibly be used to help reduce the side-effects of hormonal replacement therapy. The significance of this project is that very few studies have been carried out, particularly in Australia, concerning exercise, cardiovascular health and hormonal replacement therapy administration in post-menopausal women.

Neuromotor Control Research Laboratory (Brown)

1994 saw the completion of several on-going projects with the publication of three papers in international journals. Two studies into the muscular control of stoop-lifting in the elderly have shown (see diagram) that ageing deleteriously affects the ability of the muscles of the back to control the trunk during a stoop-lift. Diminished muscle strength and inflexible joints both combine to reduce the effectiveness of these muscles, resulting in shorter 'critical phases' (muscle deactivation) at the bottom of

each stoop lift (a sign of increased stress). Subsequent experiments have already begun to determine whether chronic exercise can maintain the quality of muscular control during lifting and thereby diminish the potential for injury through this everyday task. These experiments will be the focus of the group's efforts in 1995.

Another 1994 study investigated the influence of age on the ability of skeletal muscle to be rapidly activated, slow muscle activations in part being responsible for the slow pace at which the elderly appear to move. A further study utilised a similar paradigm to investigate muscle activation rates in youths with Downs syndrome.

Biomechanics Research Laboratory (Julie Steele)

During 1994 previous research related to the biomechanics of rising in elderly disabled patients was developed to focus on investigating the effects of using an Eser Ejector Chair on elderly female patients suffering from rheumatoid arthritis. The Ejector Chair uses a spring-loaded action to gently assist patients to rise from a seated position to stand upright. Aids such as this chair are vital to enable many elderly people to continue independent living.

The results of this study indicated increased seat height and use of an ejector mechanism both facilitated rising. Both chair modifications appeared to compensate for those patients with lower-extremity muscle weakness and may help prevent excess joint damage when rising from a chair. The ejector mechanism had the added benefit of reducing forces generated by the upper limbs, thereby preventing excess upper-extremity joint damage. This work was conducted in conjunction with the Institute of Rehabilitation and Allied Health at the Illawarra Regional Hospital.

*Applying health and nutrition research to improve
Australians' well-being
Service development and risk assessment*

Public Health and Nutrition

Co-ordinator: Associate Professor Ross Harris (tel 042 21 3463)

DURING 1994 the Public Health and Nutrition Research Group maintained its track record of productivity in the study of important factors in improving the health and well being of Australia's population.

The total amount won by the Research Group from all external sources to support research and enquiry in the calendar year 1994 was \$1,333,000. Of this, approximately \$1,100,000 were won from competitive, refereed grant applications; and \$233,000 were won by submission of proposals for undertaking consultancies. These usually consist of specified research and service evaluation activities.

To participate in the University's planned restructuring of research activities, the group identified two major domains of research activity which could become hubs of increasing University research pre-eminence: namely, health service development and risk assessment/health outcomes research. In 1995 it is expected that the research group, in new format, will maximise opportunities for enquiry in these two areas, each of which is of great importance to the public's health.

Notable achievements of individuals and coalitions of researchers are as follows:

Risk Assessment Group (Co-ordinator, P Ricci)

Researchers in risk assessment use mathematical and statistical methods applied to epidemiology and toxicology within the context of environmental health and decision making under uncertainty. The thrust of the group is to develop processes in which least-cost solutions are achieved in respect of the 'precautionary principle'.

The group has recently produced a paper for publication in a peer-reviewed Journal and for presentation to national and international conferences, ranging from analytical epidemiology to cancer risk assessment.

Health Outcomes Group (Co-ordinator, R. Jayasuriya)

The researchers in health outcomes focus on the measurement of out-

comes of health interventions, an international priority area in which new techniques for measurement have recently been developed. Epidemiology, psychometry and sociology are the core disciplines which have produced outcome measures in domains such as functional status, emotional/cognitive health and interpersonal/organisational competencies. Public Health, Community Health, Mental Health and Hospital Services are increasingly seeking outcome information in these areas. Researchers in the group are involved in outcome studies on injury prevention, occupational safety, management of chronic illness (asthma, diabetes, mental illness), services such as geriatric care, maternal care and services development innovation, such as shared care.

Health Service Development Group (Co-ordinator, K Eagar)

This group has pursued the theme of casemix classification and funding models in association with a number of local, state and national organisations. Projects have included using health outcome data in a model to determine the mix of acute inpatient services that would most benefit a local community; model development to explain cost variation within DRGs by linking it to variation in disease severity; the development and implementation (for the Commonwealth Department of Human Services and Health) of a National Hospital Price Index applied to

Members

Professor Dennis Calvert,
Ms Deanne Condon-Paoloni,
Professor Christine Ewan,
Ms Mary Harris, Dr Lindsey Harrison, Professor Don Hindle,
David Cromwell, John Halsall,
Ms Kathy Eagar, Ms Heather Yeatman, Ms Linda Tapsell, Paul O'Halloran, Brian O'Neill,
Gordon Lambert, Dr Barbara Meyer, Boris Gazibarich, Dr David Jeffs, Dr Victoria Westley-Wise, Dr Rohan Jayasuriya and Associate Professor Paolo Ricci

RESEARCH GROUPS

updating DRG cost weights; in association with the Australian Institute of Health and Welfare, the exploration of ways for improving management of elective surgical admissions. The Centre has established international research linkage, specifically with North Health, New Zealand, to develop models for the purchasing of public health care.

Risk assessment research was undertaken into the public health implications of sewer outflows; air pollution in California and 'new methods to fuse and propagate uncertainty' (P Ricci – who is also editing a special issue of the *Journal of Energy Engineering*). In association with the University of Sydney, a study funded by the Joint Coal Board Research Trust, commenced into the risks of injury in NSW coal mines, specifically relating to the prevention of leg and ankle injuries in coal miners (R Harris).

Health outcomes research is enhanced by a Workcover grant to examine and improve the occupational injury database used by major employers of the Illawarra (Workcover Corporation), (R Jayasuriya and R Harris).

In terms of management for improved outcomes, studies were conducted to investigate specialist support for general practitioners, in association with the Illawarra Division of General Practice, funded by the General Practice Evaluation Project, and networks of care to improve outcomes of people with serious mental illness, funded by the NSW Department of Health (M Harris).

Awarded a World Health Organisation travelling Fellowship, H Yeatman undertook six case-studies of food policy councils operating in the USA and subsequently made recommendations to the Commonwealth Department of Human Services and Health on the development of similar initiatives in Australia.

Awarded a CAUT grant, Linda Tapsell developed self-directed teaching/learning materials, including a manual,



Dr Rohan Jayasuriya



Mr Gordon Lambert



Associate Professor Paolo Ricci

for incorporation into the training of student dietitians and for potential application to other courses at the University and nationally.

Research on Health Information Systems in developing countries has been continued by Dr Jayasuriya and he was selected as the Chairperson on an Expert Committee for the World Health Organisation that released a Technical Report on Information



Ms Kathy Eager

Support for New Public Health action at district level. During his sabbatical, Dr Jayasuriya carried collaborative research and presented a seminar at the London School of Hygiene and Tropical Medicine on 'Decentralisation of Health Systems'.

*Exploring social and educational problems
through studies of symbol systems – language and mathematics
National curriculum developments*

Social Literacy

Co-ordinator: Dr William Winser (tel 042 21 3963)

ONE OF the highlights of the year's work for the Group was its success in gaining two ARC multi-year Grants totalling \$112,000. The first – Winser, Torr (Macquarie University) and Derewianka – is a study of language development and curriculum that investigates language development in the school years and the relation of this to the new English curricula. Beverley Derewianka's work will support this study; she has completed a study of language development in the transition to adolescence, clarifying some major problem areas in later language development and finding in her case study that the language development of a child exhibited features of mature language use earlier than had been predicted; she has also begun a study of approaches to the introduction of grammar teaching in English.

The second ARC Grant (Harris, Winser and Trezise) is for a study of younger students' acquisition of reading at school and the role of texts, text interpretations and readers. This second team completed preliminary work for the project during the year. Associated with this work has been Bill Winser's theoretical study of a linguistic model of reading; Wing Cheung has collaborated with him in a study of computer delivery of English-language instruction for Chinese speakers (also ARC funded). This program will be trialled in China in 1995.

More specifically in the equity area, Jennifer Jones has completed her studies in gender equity and secondary school Maths and Science, and is embarking on the next phase of this work, on gender equity aspects of national curriculum developments, while Jan Wright continues her own discourse work in studies of meaning about the body in mature women. Penny Pether has published on the topic of the construction of feminine sexuality in Victorian literary and legal texts, and is working on 20th century developments in this field for a book to be jointly edited with Professor Threadgold, of Monash University. She is one of the founding editors of the new interdisciplinary journal *Law/Text/Culture*. She anticipates completing her work on the construction of the nation in the work of E M Forster and Virginia Woolf in 1995.

Particular studies using linguistics have been carried out by Elizabeth Thomson and Louise Ravelli. Thomson has been working on a major function of language in Japanese, looking particularly at the notion of Theme and its existence as a functional category in Japanese. She has determined that it does, in fact, exist and is now working to determine the constituents of Theme in Japanese; she also plans to start a joint project on Grammatical Metaphor in English and Japanese with Louise Ravelli. Ravelli has continued her research and consulting with the Australian Museum, exploring various aspects of text-production for Museum visitors. She contributed the linguistic analysis of student texts in the three reports evaluating the Disadvantaged Schools Project 'Write it Right' produced jointly with Bill Winser and Jan Wright in 1994. These three reports completed a two-year evaluation study of the Project by the team.

In the field of maths and language, Jan Wright and Neil Hall have been working with secondary school mathematics teachers to investigate language and mathematics learning. This work has resulted in a professional development book, together with two conference papers, and they are in the process of writing further material from the data gathered during this investigation. Neil Hall has gathered data on infants and primary school children working in

Members

Associate Professor B
Cambourne, Dr W Cheung,
Ms B Derewianka, Dr C Fox,
Mr N Hall, Ms J Hammond,
Dr P Harris, Dr J M Jones,
Ms D Konza, Ms P Pether,
Dr L Ravelli, Ms E Thomson,
Ms J Trezise, Dr J Turbill,
Dr W Vialle, Dr J Wright

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Four members of the Social Literacy Research Group plan a new project on verbal and visual meanings. Members from left are Neil Hall, Deslea Konza, Dr Bill Winser (Co-ordinator) and Dr Wilma Vialle

computer mediated environments, investigating the learning outcomes and the kinds of language used, while children work with computers in classrooms. He has continued to investigate the use of a self-regulatory teaching strategy as young children learn mathematics while working with computers, as well as the use of a procedural analogy theory in the teaching of mathematics to primary school children.

School-based work has continued as the main focus of the Group. Brian Cambourne and Jan Turbill have been involved in two main projects. The first, in the area of literacy evaluation, involved collaboration with teachers and schools and employed a 'Teacher-as-Co-Researcher' methodology to explore the issues and strategies

involved in implementing a model of evaluation based on the principles inherent in 'Responsive Evaluation' at the classroom level.

The results showed that the model could be implemented by teachers and that the theoretical concepts underpinning Responsive Evaluation are congruent with and supportive of the NSW DSE English K-6 syllabus. The second project was an on-going evaluation of the effect and impact of the integrative/interactive staff development model underpinning the Frameworks Staff Development Program. The data comes from teachers who have participated in the program, comprising reflections on the course, mailed surveys and group interviews. Results so far indicate that teachers' expectations have been met at a high level of satisfaction.

Wilma Vialle has completed the first phase of a study of the role of language in assessing intelligence in minority children in several schools, and has co-authored a book on teaching from a multiple intelligence perspective. Deslea Konza's work has been in the area of reading disability; she has begun a study in the area of attention deficit disorder and its relation to reading development. Jennifer Hammond's study of the grammatical construction of literacy in primary students, is completed, with findings which indicate that teacher sensitivity to linguistic aspects of literacy is a factor in successful literacy teaching. Jillian Trezise is continuing to work on her study of the construction of educational discourse in popular magazines.

The Research Group brings together researchers concerned with the social, cultural and political effects of globalisation, economic restructuring and social change

Sociological Analysis of Political and Cultural Change

Co-ordinator: Professor John Bern (tel 042 21 3745)

GROUP members achieved considerable recognition in 1994 through competitive grants, publications and conference participation. The Group also increased its links with the academic and policy communities throughout the year.

The central theme of social change at local, national and international levels during the year was a sharpening of focus for the Group to issues of social disadvantage and strategies to overcome this. The theoretical and analytical approaches included aspects of globalisation, class, gender and ethnic and racial relations.

The Group carried out empirical social research using a variety of methods (surveys, qualitative studies, content analysis) in the Illawarra and elsewhere. Stress was laid on analytical and theoretical grounding of all work. In each of the projects there was emphasis on both the cultural

constitution of institutions and groups and the social processes affecting their cultural content and political situation. Although the specific themes and locations of the projects vary, they are inter-related through their common focus on social change and its human consequences, and through the objective of linking the local with the global.

Locally-based research dealt with various community groups in the Illawarra (trade unions, women's groups, ethnic groups, indigenous people), while the national and international components addressed non-governmental bodies, governments and international organisations. The Group's projects help fulfil the University's commitment to research which serves community needs.

Work in progress

Crime victimisation on the Illawarra rail line – Ann Aungles

A comparison between recorded and unrecorded incidents of crime victimisation on the rail system and an investigation of gender differences in victimisation and vulnerability among train commuters. The survey of commuters has been completed and reports are being written for various groups. Support for this research came from the State Rail Authority.

Electronically monitored home imprisonment program – Ann Aungles

A review of the range of ways in which electronically monitored home imprisonment is being implemented in Australian penal jurisdictions with a special focus on the intersection between domesticity and penalty.

Penal discourses on parenthood in NSW – Ann Aungles

This project involves monitoring of the various and contradictory ways in which prisoner parenthood is constituted in legal penal discourses. Much of the research has been carried out in conjunction with the Children of Prisoners Support Group.

The hunter in transition: Political and social re-adjustment in a major industrial region – John Bern

ARC funding of this project ended at the end of 1994. All field research has now been completed. A number of papers are in various stages of completion.

National aboriginal politics: Self determinations from landrights to reconciliation and return – John Bern

This project is current and topical. Work during 1994 involved interviewing key Aboriginal political leaders focusing on the negotiations with the Government for the Native Titles Act 1993. An overview paper was prepared for the World Congress of Sociology July 1994.

Members

Dr Ann Aungles, Professor Stephen Castles, Dr Mike Donaldson, Dr Chris Everingham, Dr Tom Jagtenberg, Dr Jenny Jones, Dr Ellie Vasta

RESEARCH GROUPS

International migration and the New Germany – Stephen Castles

The aim of this project was to examine changes in international migration to Germany since 1990, as well as issues concerning existing ethnic minorities in Germany. The project has led to a number of publications, focusing on issues of racism and citizenship.

Hegemonic masculinity – Mike Donaldson

This project culminated in being guest keynote speaker at a major conference in Bielefeld, Germany, in July, 1994, on gender relations. The paper is to be published in the conference proceedings.

Time and society – Mike Donaldson

Work is progressing well on this project, with one major monograph with publishers at University of Western Australia, entitled *Taking our Time: Remaking the Temporal Order*.

Rights or welfare? – Chris Everingham

The overall aim is to identify and analyse the discourses used by agency workers concerned with providing community based services for women, from diverse socio-cultural backgrounds. The preliminary work began on this project in 1994, with the identification and selection of these agencies, and this will continue in 1995 with interviews and compilation of written material.

Peer group influences on students in high school – Jennifer Jones

Current work on this research has involved preliminary investigation observing and interviewing Year 10 students at various high schools. This will be expanded to involve Year 8 and 9 students over the next year. Data collected so far has involved one selective school and one Catholic girls school. Work to be carried out in 1995 will involve the gender roles in peer pressure regarding subject and career aspirations.

Social justice and social change: the position of migrant women in the state and community sector – Ellie Vasta

This project examines the socio-economic position of non-english

Co-ordinator of
the Research
Group is
Professor John
Bern



speaking backgrounds (NESB) women in the Illawarra and the input of NESB women into the development of relevant policy and service delivery at state and community levels. The project has three phases, the first of which entails data collection in the Illawarra and production of a profile of needs and access to policy and programs.

The second stage involves researching state and community sector policies and programs relevant to NESB women and the third stage will entail interviews to ascertain the effectiveness of these policies and an analysis of the level of NESB women's involvement in the process. This project develops from preliminary findings in the ARC funded Fairfield study.

Enabling technologies in artificial intelligence, perception, neural networks, parallel processing and human interfaces with applications in telecommunications, databases, mobile robotics and education

Software Engineering and Intelligent Systems

Co-ordinators: Professor Fergus O'Brien (tel 042 21 3859) and Dr Phillip McKerrow (tel 042 21 3771)

THIS RESEARCH Group had its best year ever, with the successful completion of two large projects, the award of a Large ARC Grant, the award of a Targeted Institutional Links (TILs) grant, the receipt of funding for pilot projects from the Department of Science and Technology Organisation (DSTO) and Fujitsu, and the running of a parallel computing conference. The quality of the Group's work is shown by the fact that PhD students working in the group presented five papers at the Australian AI conference in Armidale in November.

Professor O'Brien and his team in the Telecommunications Software Research Centre (TSRC) achieved further international recognition through their involvement in the International Federation of Information Processing (IFIP) working parties and collaboration with the Telecom-

munications Information Network Architecture Consortium (TINA-C).

The initial three-year program for TSRC is successfully completed to the satisfaction of Telstra. Unfortunately, while negotiations were under way with Telstra for funding for a further project, Professor O'Brien tendered his resignation from the University. Further work on the project will be undertaken at RMIT.

John Fulcher's work in face recognition for airport security with neural networks came to a successful conclusion. His team developed a system which captures facial images of passengers passing through airports and compares these to a local database. Neural network techniques are used because recognition must be performed in real time. Two PhD students are writing their theses from this research. As a result of this research, John has written two articles for *New Scientist*, and three chapters for Oxford University Press's forthcoming *Handbook of Neural Computing*. The team has applied for an Australian patent.

Following a visit to Wollongong by Dr Asakawa from Fujitsu's Multimedia Systems Laboratories in Kawasaki, Japan, Fujitsu has provided pilot funding of \$50,000 to John Fulcher to develop higher-order neural networks



Garry Stafford contemplating artificial life

based on polynomial activation functions for application in economic modelling for financial forecasting.

Dr McKerrow and Dr Zelinsky received a \$165,000 TILs grant for collaborative research in Intelligent Autonomous Systems with the University of Tsukuba, Japan. Professor O'Brien and Dr McKerrow visited Tsukuba in November to plan the research projects that will be undertaken as part of this collaboration. Professor Yuta and Dr Ohya visited Wollongong in December to meet the two PhD students who will work on these projects.

Dr Zelinsky continued to work at ETL in Tsukuba and has started to implement his navigation scheme on a

Members

Associate Professors G Doherty, N Gray, Drs B. Balachandran, M Cross, J R Getta, J P Gray, I G Pirie, G Stafford, A Zelinsky, M Zhang, Mr J Fulcher

RESEARCH GROUPS

mobile robot. This project is funded by the Real World Computing Partnership (RWCP). During their visit to Japan Professor O'Brien and Dr McKerrow met with Dr Shimada, Director of the RWCP, to discuss the continuation of collaboration on this project when Dr Zelinsky returns to Wollongong.

Dr McKerrow was awarded a one-year Large ARC Grant of \$50,000 for research in Echolocation Modelling. This project involves the development and testing of models of ultrasonic backscatter in air for use in visualising wave motion and for developing improved ultrasonic sensing systems for mobile robots. This grant has enabled the development of new electronic equipment for use in the experimental validation of the models.

Dr McKerrow also received a research grant of \$22,000 from DSTO for a pilot research project in data fusion. The High-frequency Radar Division (HFRD) of DSTO is responsible for the operation of the Jindalee Over-the-Horizon Radar Network (JORN). Correct tracking of aircraft involves complex data fusion. DSTO is providing funding for data fusion research with ultrasonic sensors on a mobile robot. Many of the problems are similar and DSTO is interested in applying the results of the research to JORN. The Group is thus able to do research on an unclassified system that is of direct application to the development and control of a classified system without Wollongong researchers having to be involved in the classified work.

Following the success of their workshop in 'Parallel Software Engineering', in Aachen, Germany, in 1993, Jon Gray and his colleagues ran a second workshop in Como, Italy, in September 1994. Also, Jon, with some help from Fazel Naghdly, organised a two-day conference 'Parallel Computing and Transputers Conference (PCAT-94)' at the University of Wollongong in November 1994. IOS Press (Amsterdam) published the conference proceedings.

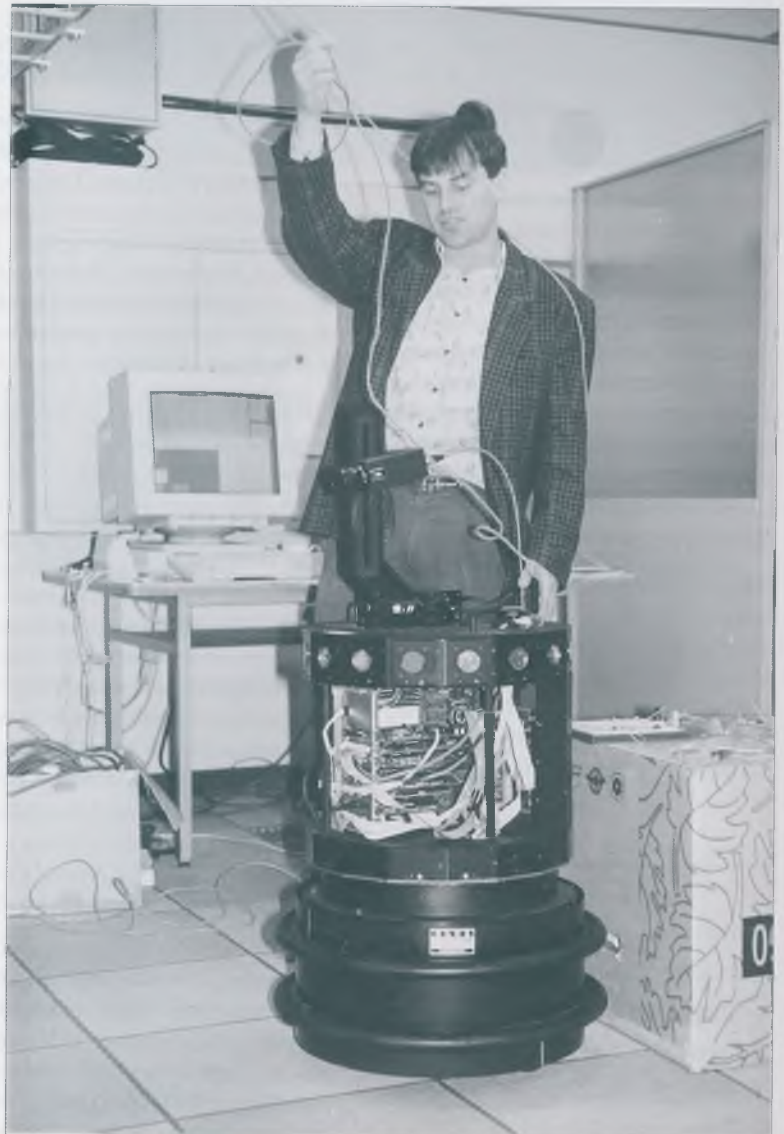
Dr Stafford collaborated with Dr Tognetti to begin research in Artificial Life. They are investigating techniques that will allow self-directed modifications of program behaviour to accommodate to a changing environment. The focus of their research is on the effects of change on the acquisition and extinction of behaviours.

Dr Getta is investigating multi-attribute and partial indexing in database systems. His research is focused on the problem of how to

select and implement secondary indices when designing a large database system. His main objective is to generalise the concept of a secondary index in order to capture information about the queries which have been processed by the data base particularly their multi-attribute data dependencies.

Finally, Associate Professor Gray completed research into the teaching of object orientated programming with the publication of a text book, *Programming with Class*.

Alex Zelinsky working on Autonomous Robot Navigation with the Real World Computer Partnership in Tsukuba, Japan



Improved formulae established for analysis of punching shear strength; tests of precast reinforced concrete connections and of engineering construction materials

Structural Engineering and Construction

Co-ordinator: Associate Professor Yew-Chaye Loo (tel 042 21 3039)

SATISFACTORY progress was made during 1994 in all the Group's research projects, notably the major investigations into punching shear strength of post-tensioned concrete flat plates, strength and deflection characteristics of precast reinforced concrete beam-to-column connections, damping characteristics of cracked reinforced concrete beams and construction materials.

Punching shear strength of post-tensioned concrete flat plates

This is the third and last year for this ARC Large Grant project. The punching shear test program on a series of four half-scale models with torsion strips or spandrel beams was successfully completed. Figure 1 shows the failure crack pattern of a model with spandrel beam. Note the severe cracking developed around the column heads; this is an indication of punching shear failure. Analysis of the test results confirms that the

Australian Standard AS3600-1994 tends to overestimate the strength of these half-scale structures.

In practice this means that punching shear design of post-tensioned flat plates based on the Standard could be unsafe.

Based on the data and results of the experimental study, semi-empirical formulae have been established for the analysis of the punching shear strength. The accuracy of these explicit formulas are found to be superior to the Australian Standard provisions.

As part of this project, non-linear finite-element analysis procedure is being developed. When completed, this procedure will allow an accurate prediction of punching shear strength and the accompanying failure crack pattern to be carried out via a personal computer.

Earlier findings of this project have been presented at various international conferences on structural engineering and mechanics.

Strength and deflection characteristics of precast reinforced concrete beam-to-column connections

The strength and serviceability behaviour of the beam-to-column connections is the most important information necessary for the design of safe and efficient precast reinforced

concrete frames for low and medium-rise buildings.

This long-term project was aimed at providing such information by testing a total of 24 half-scale beam-to-column connections. Two types of precast construction methods recommended by Precast/Prestressed Concrete Institute and Australian Prestressed Concrete Institute were used to manufacture these models. Tests were carried out under static, unidirectional repeated and cyclic loading. The last six models of the series (tested under cyclic loads) were completed this year. A test model after failure is illustrated in Figure. 2.

Comparisons of results from the two types of precast connections and the corresponding monolithically constructed models show that the precast connections were stronger and in most case more ductile. The two precast connection methods can be safely used in building frame construction.

A paper discussing the tests and behaviour of the two types of precast connections has been accepted for publication by the prestigious Precast/Prestressed Concrete Institute Journal, Chicago, USA.

Damping characteristics of cracked reinforced concrete beams

This project involved the testing of

Members

Dr A Basu, Associate Professor
M J Lowrey, Associate Profes-
sor D G Montgomery, Dr Y W
Wong

RESEARCH GROUPS

over 32 full-size reinforced and partially prestressed concrete beams. The main objective of the study is to quantify the effects of cracking on the

damping behaviour of flexural members of a building. This information is important for predicting the structural response of the building

under dynamic loads such as those generated by an earthquake.

The analysis of the test results from this project are those available in the literature has led to the development of a set of formulas for predicting the crack widths and spacings of concrete beams. This is the first step towards establishing the relationship between damping and cracking of reinforced and partially prestressed concrete beams.

Construction materials

Work has continued on projects concerned with the behaviour and applications of engineering construction materials. The first draft of a guide to the use of slag in Flexible and Bound Pavements was developed and written. This document will be assessed by industry and will be used by engineers and other professionals in the design and construction of roads containing blast furnace slag and steel furnace slag materials. The guide will be jointly published by the Australian Slag Association and the Roads and Traffic Authority, NSW.

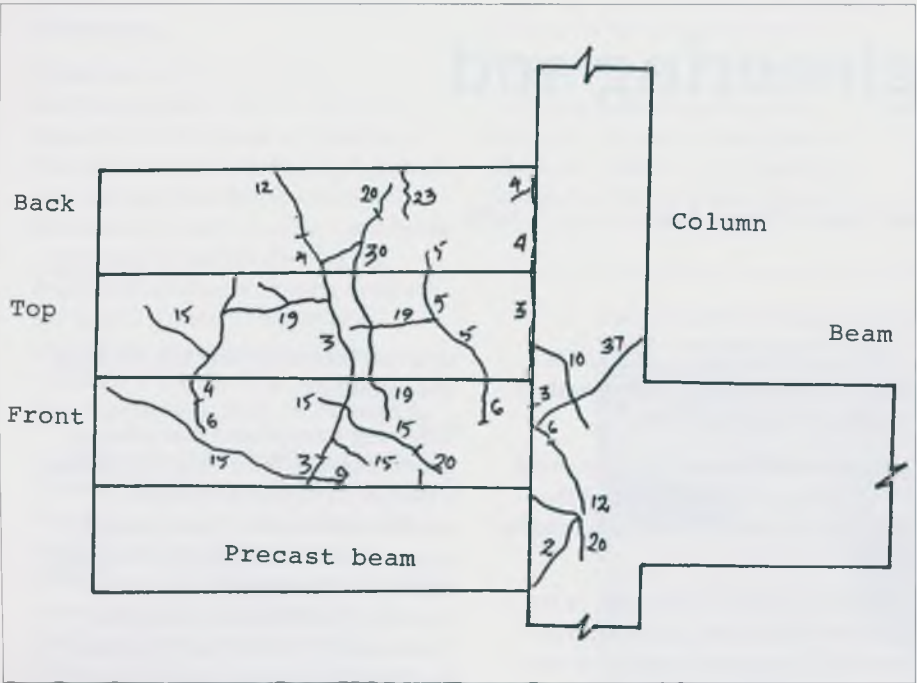
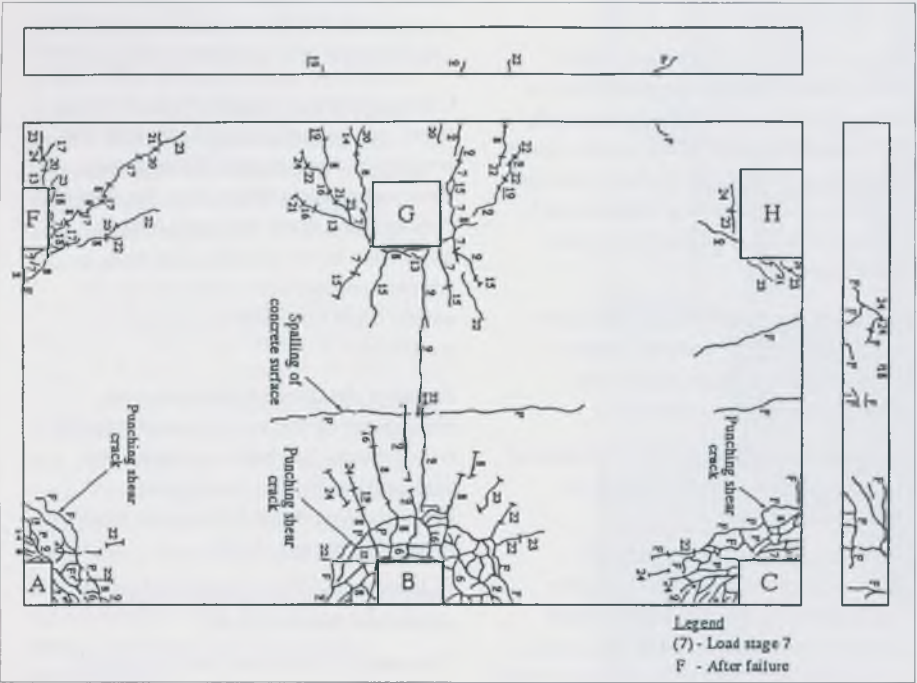


Figure 1: Crack pattern on top and sides of Model P4

Figure 2: Crack pattern for CPA2 – Type A connection



Current projects

Current projects of the Group also include:

- Flexural and shear strength of unconventional composite beams.
- Development of a transient heat transfer model coupled with Navier-Stokes equations to simulate the heat transfer and fluid flow in the weld pools during GMAW process.
- Use of PHOENICS package to calculate temperature distribution, velocity profile and weld head geometry.

Satisfactory progress was made in each of these projects, as evidenced by the publication of some of the research findings by the principal investigators. The projects will continue in 1995 and beyond.

Studies of the ancient bedrock of eastern Australia provide an understanding of past earth environments and processes, as well as a framework for resource exploration and exploitation

Tasmanides

Co-ordinator: Dr Chris Fergusson (tel 042 21 3860)

THE TASMANIDES is the Palaeozoic (250-570 Ma old) mobile or orogenic belt that makes up the bedrock of much of eastern Australia. It represents the roots of ancient mountain belts that developed from interactions between the ancient Pacific Ocean plate and a plate dominated by the former large continent of Gondwana (including Australia, Africa, India, South America, Antarctica, India, and much of South-East Asia and parts of China). The Tasmanides Research Group is concerned with contributing both data and an interpretation of the development of the Tasmanides. This leads to an improved understanding of the geology of eastern Australia with benefits for the mineral exploration industry. Although emphasis of the Tasmanides Research Group has been on the geology of eastern Australia, similar and related geological problems encountered around the globe and particularly in Indonesia, Iran, North America and New Zealand have been examined by the Group.

One of the highlights of the year that has implications for the direction of the Group's research and teaching has been collaboration between Group members with the Geological Survey of New South Wales and the Australian Geological Survey Organisation under the auspices of the National Geoscience Mapping Accord (NGMA). The NGMA was devised as a joint venture between the Federal and State governments in an attempt to address the inadequacy of the geological data base by producing new vastly improved geological maps covering areas of major interest to the general community and exploration industry. This is being achieved by a new generation of geological mapping using closely spaced radiometric and aeromagnetic line surveys carried out by low-flying aircraft. These data-bases can effectively be used to penetrate vegetation and soil cover to reveal details of sub-surface geology. This project also involves geochronological studies using the Sensitive High Resolution Ion Microprobe (SHRIMP) at the Research School of Earth Sciences at the Institute of Advanced Studies at the Australian National University.

Members of the Tasmanides Group including Chris Fergusson, John Pemberton, Tony Wright and PhD student Gary Colquhoun are involved in the geological mapping of the Mudgee 1:100,000 Geological Sheet. This work includes use of the new geophysical data base and already the

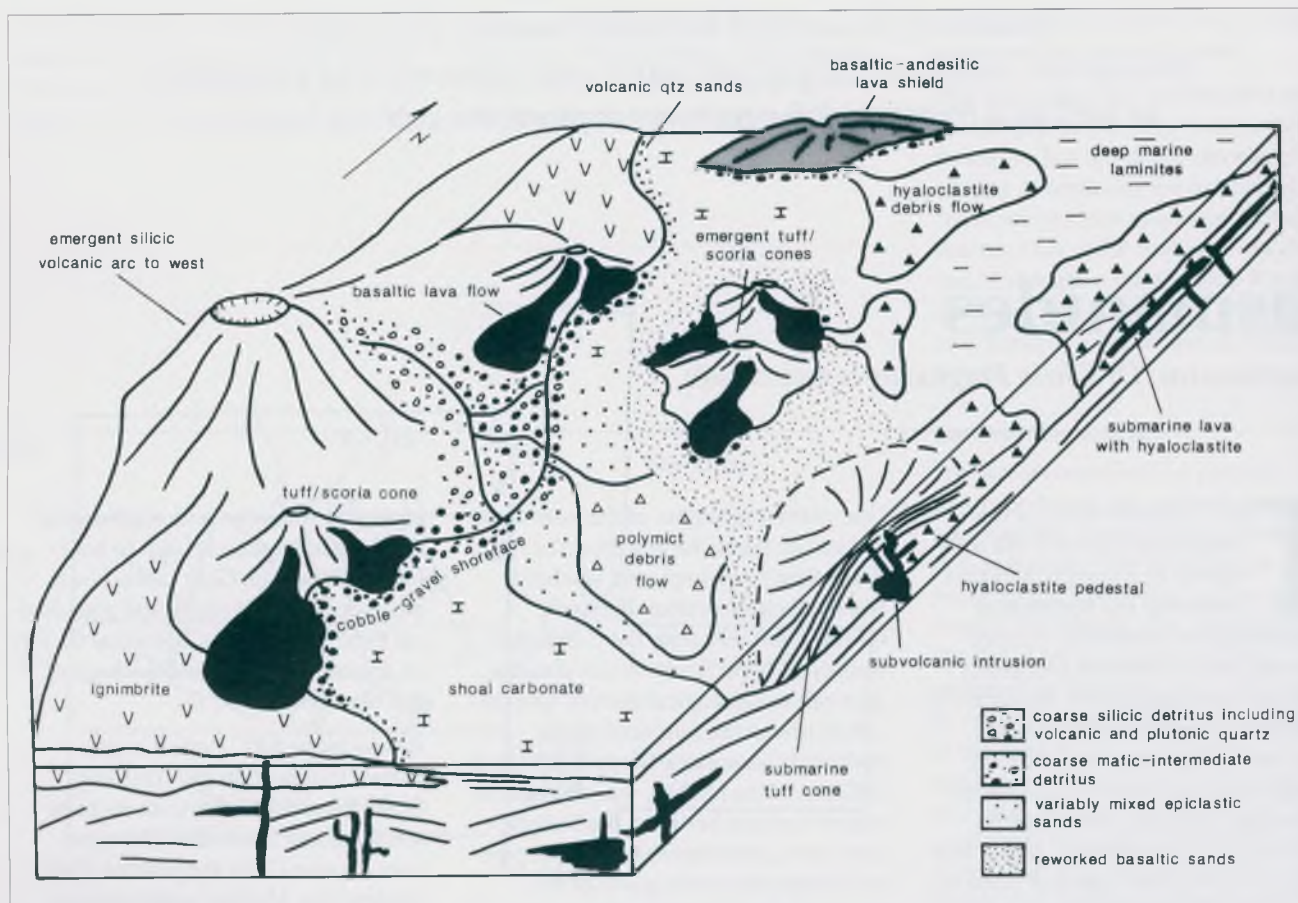
geology to the east and southeast of Mudgee has been revised. In May, John Pemberton, Gary Colquhoun, and Tony Wright organised a geological field trip for the Geological Society of Australia on the field geology of the Mudgee district.

A new large ARC project began earlier this year on the 'Tectonic Significance of Ordovician rocks in southeastern Australia' (Principal Investigator Chris Fergusson). PhD student Sue Murray began work in mid-year and has started detailed geological mapping of the Ordovician volcanic and sedimentary succession in the Oberon district as part of the NGMA (see above).

This was the final year of funding of the Anakie Inlier Large ARC Grant (Principal Investigators Paul Carr and Chris Fergusson with collaboration of Bryan Chenhall). Tim Green (PhD student) completed his field studies in the inlier and has since been concentrating on the laboratory component of the project. Age dating of the rocks continues to be a problem and is now being addressed with the collaboration of Mark Fanning at the Research School of Earth Sciences (Australian National University) using the SHRIMP (see above). Paul Carr and Bryan Chenhall have been working in the Centre for Isotope Studies (CIS) at CSIRO North Ryde, where sophisticated analytical equipment is available to the Group as members of an ARC-funded consortium.

Members

Dr Paul Carr, Dr Bryan Chenhall, Associate Professor Brian Jones, Dr John Pemberton, Associate Professor Tony Wright



Block diagram reconstruction of volcanic environments that existed along the ancient Queensland coastline (Mackay-Proserpine district) about 360 million years ago (from paper by Fergusson, Henderson and Wright, published in 1994)

Continuing joint research on Lachlan Fold Belt fossils includes studies of Silurian graptolites by Tony Wright and Dr Barrie Rickards, Cambridge. These graptolites are most important as they provide accurate age data for the rocks. Research is also continuing in the New England Fold Belt (see Figure 1). Surono has also submitted his PhD thesis on the stratigraphy and sedimentology of rocks in southeastern Sulawesi, Indonesia.

The Tasmanides Research Group continues to support research in the southern Sydney Basin. Stuart Tye (PhD student, scholarship funded by Tasmanides) is completing his study of the stratigraphy and sedimentology of the southern Sydney Basin. Kerrie Bann (PhD student) continues to study trace fossils in the same succession; and Mohammad Dehghani (PhD

student) has completed his thesis on the basin analysis of fluvial systems in the Triassic Narrabeen Group to the north of Wollongong. Earlier in the year Hossein Memarian (PhD student) completed his thesis on the fracture systems in the Sydney Basin along the coast to the north of Wollongong.

Research continues on aspects of the geology of Iran. Paul Carr visited Iran in May for three weeks and examined igneous rocks in various localities in the research areas of PhD students Abbas Moradian and Abolfazl Soltani, who are now carrying out detailed geochemical and isotopic studies of their rocks. Mohammad Mohajjel (PhD student) has been conducting field work in the Zagros region of Iran to investigate metamorphic rocks formed by the collision of Iran and the Arabian Peninsula about 60-70 Ma

ago. This work is in collaboration with the Geological Survey of Iran and a joint field trip to his PhD study area with Chris Fergusson was conducted in September. Ali Hamedei is completing his PhD thesis on the Early Palaeozoic stratigraphy of central Iran. Tony Wright and some overseas collaborators are studying new and exciting assemblages of fossils from east-central Iran. Stable isotope studies have been conducted by Mr Ahmad Mazaheri (PhD student) and Dr Bryan Chenhall on an economically important iron-rich skarn in Iran. Skarns form from the interaction of magmatic fluids and limestone host rocks.

In summary, 1994 was a highly successful and busy year for the Tasmanides Research Group.

*Large doctoral program expands Group research and
enhances its international reputation
Is 'creative accounting' dead?*

Accountability and Financial Reporting

Co-ordinator: Professor Michael Gaffikin (tel 042 21 3718)

ONCE AGAIN members of the Developmental Group travelled to many parts of the world to present papers at international conferences, reinforcing the Group's already significant reputation. Papers were presented in Sweden, Italy, the UK, the USA, the Netherlands, Indonesia, New Zealand and elsewhere.

As mentioned in last year's Report, the Group is departmental-based so yet again there have been some

changes in the membership. This year, however, we were strengthened by the addition of a new professor with a significant research profile – Professor David Johnstone. David was appointed to strengthen our finance offering and has been able to help colleagues develop their research programs as well as working on his own.

Another feature of our activities last year was that many doctoral students have now completed their degrees and are about to graduate or are in the process of submitting their theses for examination. Supervision of these students has been time-consuming but, hopefully, will be rewarded through enhanced recognition as publications flow from the projects.

The Public Sector Accountability project continues to grow in strength with Professor Michael Gaffikin and David Johnstone working on a program to determine the most appropriate basis of asset valuation for government trading enterprises (GTEs). The problem of asset valuation for GTEs is crucial because as they move towards commercial-type accounting (as opposed to the traditional government fund accounting) valuations will be a large determinant of the pricing of their service to the public. For example, the price consumers pay for electricity will be more

closely tied to the values placed on the generating facilities and the relevant sections of the national electricity grid. In the past a notional charge for the capitalised element has been a common method for GTEs in calculating their charge-out rates and this has been a major difference between government and commercial accounting. With the governments wanting to move towards commercial (accrual) accounting, issues such as valuation assume a gigantic proportion. It is not only the GTEs that will be involved but some of the bodies traditionally considered as offering services to the public – even museums, art galleries and botanical gardens!

Sudhir Lodh has completed his study of the change in a reporting system at a large Australian steel company. The company has now implemented the new system and it is hoped that Sudhir can investigate post-implication factors. A major project such as this certainly has a lot of implications for entities wishing to change their systems of internal reporting. The accounting considerations are the most significant of such business information systems as in the final analysis it is the financial considerations that will be the most relevant to decisions. Thus, any system will need to articulate with or have as a major component the accounting reporting.

Members

Mrs Anne Abraham, Mr Ari Ariyadasa, Mr Larry Blackett, Mr Anwar Chowdhury, Dr Kathie Cooper, Dr Barbara Cornelius, Dr Mary Day, Dr Warwick Funnell, Mr Adrian Gardiner, Mr Gerhard Gniewosz, Professor David Johnstone, Ms Mary Kaidonis, Associate Professor Gary Linnegar, Dr Sudhir Lodh, Associate Professor Michael McCrae, Mr George Mickhail, Ms Janet Moore, Mr Ron Perrin, Dr Hema Wijewardena and Mr Robert Williams

DEVELOPMENT GROUPS



Mrs Mary Kaidonis, Professor Michael Gaffikin and Professor David Johnstone consider the results of investigation into company financial reporting

Associate Professor Gary Linnegar travelled to Indonesia as part of his study leave and presented the case for modern management accounting techniques such as just-in-time and activity based costing to groups of interested students and business people. This continues the strong link the Department and Group have built up with Indonesia. Another example is the consulting editorial assistance provided in the setting up of a new Indonesian accounting journal – one which publishes the results of research but is also aimed at the practising arms of the profession.

The small business financial management section of the Group has continued its work. Barbara Cornelius's research interest is in venture capital, so it overlaps with this section and the finance section of the Group. She has presented papers at finance forums and small enterprise research groups. Her paper at a Swedish finance conference was considered of sufficient merit to be shortlisted for a best paper of the conference award and her paper to the SEANZ Conference in Auckland, New Zealand was well received. Hema Wijewardena also continues to have success with his research on international comparisons of education and small business.

The year 1994 was significant for accounting in that it marked the five hundredth year of modern bookkeeping so it was well marked by those with a historical interest. A major international conference was held in

Venice, Italy with four representations from the Group. Accounting history is a research interest of many of the members of the Group and we are committed to the belief that an understanding of our history is important for an understanding of our present. Bob Williams spent some months in the archives at Manchester, England uncovering the early development of cost and management accounting systems as evidence in some of the early industrial revolution organisations – Bolton and Watt and others. Janet Moore is concerned with the early colonial accounting records of Australia. Her papers on early colonial accounting have attracted the attention of many historically minded international scholars. One of the doctoral students has completed his thesis investigating similar characteristics in the development of accounting in Indonesia and the effect of the Dutch colonisation.

The Group was well represented at the Third Interdisciplinary Perspectives on Accounting conference at Manchester in the UK. Some members created considerable interest by expounding quite radical views of the processes of publishing research results and challenged the 'establishment'. Connie Spasich's paper on gender issues in accounting firms was very well received. The critical accounting issues section continued to challenge accepted wisdom in the hope of developing improved accounting.

The financial reporting of Australian companies project completed yet another edition of its publication examining extant practices of the top 150 companies in the country. This project is undertaken in collaboration with the University of Western Sydney Macarthur and Charles Sturt University, Wagga, but the greatest contribution comes from this University.

The Australian Accounting Research Foundation includes the book as part of its research program so it is a well accepted project – in the commercial sector. The objective is to highlight both the good and the bad in company reporting in the hope that the level of financial reporting in the country will be lifted. There is evidence to show that reporting practices are improving so the 'creative accounting' of the 1980s may well be dead.

The Department has recently offered a finance specialisation in the bachelor of commerce degree, so much of the energy of those involved in the finance project has been directed to teaching. Nevertheless, members did meet regularly to debate their work in progress and no doubt from the heated debates some quality publications will emerge.

One very pleasing feature has been the award of research grants from the Australian Society of Certified Practising Accountants to Connie Spasich and Anne Abraham – Connie to further develop her work on gender issues in public accounting firms and Anne to investigate the financial reporting practices of some charitable bodies.

Overall we feel that there has been considerable energy devoted by members of the Group towards their research and we continually grow stronger. The success of a large doctoral program will certainly bear fruit as the results of the doctoral research are published. In addition we have had greater success at attracting research grants as the merits of our research become even better known.

*'Data! data! data!' he cried impatiently.
'I can't make bricks without clay'*

- Sherlock Holmes

Applied Statistics

Co-ordinator: Mr John Rayner (tel 042 21 4308)

IN 1994, the Group held its first planning day. In addition to presentation of individual research plans, strategies for collaboration and winning grants were discussed.

Project 1: Statistical Modelling

Researchers: Mr Wai Kong Chan, Dr Pam Davy, Mr Bernard Ellem, Professor David Griffiths, Dr Chandra Gulati, Dr Yan-Xia Lin and Mr John Rayner

Dr Chandra Gulati continued his research in the area of decision theory. The optimal reward for a non-communicating team is compared with the total optimal reward when individual members do not form a team. The results of this joint research (with Prof Prem Goel, Ohio State University) will be given in a paper 'To team or not to team'. A draft of this paper is nearly complete. Chandra is also carrying out a statisti-

cal analysis of agriculture data from Bangladesh, to identify regions of increased rice production.

Drs Pam Davy, Chandra Gulati and Yan-Xia Lin and Professor David Griffiths have had joint discussions with members of the Institute for Telecommunications Research concerning statistical modelling of Ethernet traffic. Some challenging problems are being considered, and a seminar describing some of these was given to the Department of Applied Statistics. Yan-Xia also did some work with researchers in the Computer Security Research Program.

Yan-Xia Lin had a successful year, with one paper published, a second accepted for publication, and several appearing as preprints. Joint research with Professor Gail Ivanoff (University of Ottawa, Canada) and Professor Ely Merzbach (Bar-Ilan University, Israel) was continued. Some important technical problems have been solved, and they yielded a joint paper titled 'Weak Convergence of Set-indexed Point Processes and the Poisson Process'. This paper suggests a method of attack on the central limit theory of general set-indexed processes, which will be examined in 1995.

Yan-Xia also undertook joint research with Dr Linhu Zhu, a visiting scholar from China. They considered an area between stochastic analysis and functional analysis, looking for a new theoretical system in stochastic

integration. A preliminary result has been obtained.

John Rayner also had a successful year, with one paper published and two accepted for publication. Joint work with John Best of the CSIRO IAPP Biometrics Unit continues. The current focus is extending non-parametric tests to assess not only location but also dispersion and other moment differences between treatments. Joint work with Wai Kong Chan, a PhD student in this Department, has resulted in a draft manuscript on the effect of model failure in testing for an exponential scale shift.

Bernard Ellem furthered his doctoral research in presenting a paper to the 12th Australian Statistical Conference at Monash University on 'Curvature Measures for Generalised Linear Models'. He also wrote a technical report on the same topic and another on 'The Exponential Connection and Canonical Links for Generalised Linear Models'.

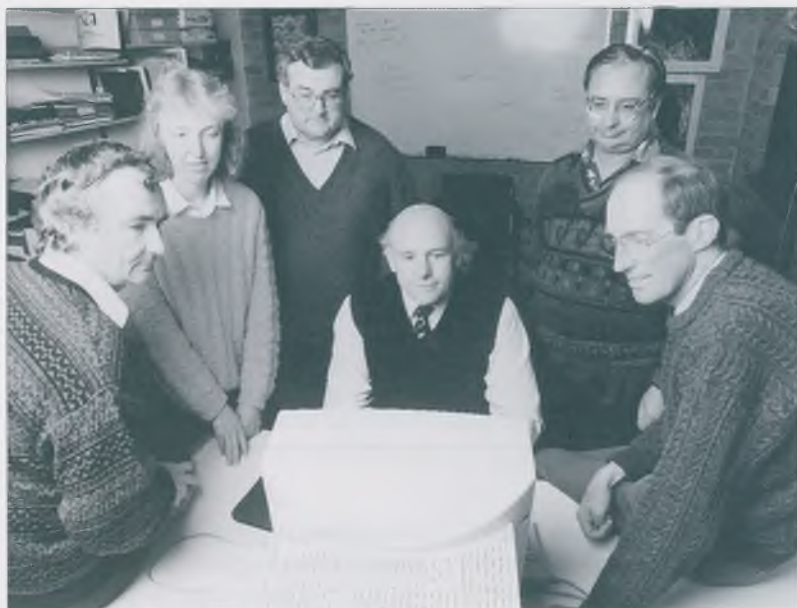
Project 2: Statistical Design and Analysis

Researchers: Professor David Griffiths, Dr Chandra Gulati, Dr Ken Russell, Dr David Steel

Dr Ken Russell continued his research into carry-over designs. These are plans for the conduct of experiments in which subjects receive a sequence of different treatments over consecutive time periods. In any time period,

Members

Mr Wai Kong Chan, Dr Pam Davy, Mr Bernard Ellem, Professor David Griffiths, Dr Chandra Gulati, Dr Yan-Xia Lin, Ms Anne Porter, Dr Ken Russell, Dr David Steel



From left, the researchers are Mr John Rayner, Dr Pam Davey, Dr David Steel, Professor David Griffiths, Dr Chandra Gulati and Dr Ken Russell

the subject is assumed to receive the direct effect of the treatment currently being administered and also the carry-over effect of the treatment applied in the previous period. Such experiments are used in areas as diverse as agriculture, telecommunications and psychology.

In late May, Ken visited Dr Sue Lewis at the University of Southampton to continue joint work that examines how to devise the best experimental plans when the direct effect of a treatment interacts with the carry-over effect of another treatment. At the end of the year, Dr Lewis visited Wollongong to begin further work that examines how resistant the common experimental plans are to departures from the standard assumptions about the variability associated with the data.

A research student, Sifa Mvoi, is also working on carry-over designs. He is seeking good designs when the treatments are combinations of several factors and there is interest in knowing the effects of each factor individually and in combination with others.

In a joint project with David Griffiths, Ken has derived various optimal

'near-balanced' incomplete block designs.

Dr David Steel continued his work on the analysis of aggregation effects in social data. Analysis of group level data is an option used widely in social and health research. However, these analyses are subject to the ecological fallacy, which occurs when spatially aggregated data are analysed and the results are incorrectly assumed to apply to relationships at the individual level. Dr Steel is developing the statistical theory and practical methods for adjusting the outcomes of the analyses based on spatially aggregated data to yield estimates of the underlying individual-level relationships. This will provide methods for researchers to avoid the ecological fallacy in their analysis of census and other small-area data. During the year Dr Steel presented papers on this topic at the Annual Research Conference of the US Bureau of the Census in Washington and at the annual meeting of the American Association of Geographers in San Francisco. He also visited the University of Southampton, where he is involved in a joint research project funded by the UK Economic and Social Research Council.

Project 3: Statistical Education Research

Researchers: Dr Pam Davy, Professor David Griffiths, Ms Anne Porter, Mr John Rayner, Dr Ken Russell, Dr David Steel

With her doctoral supervisors, Anne Porter presented three joint conference papers, the first two at the Bridging Mathematics Conference in Sydney and the third at the Deakin University symposium on Research in Mathematics, Science and Environmental Education: *A statistical and mathematical tertiary preparation course; The role of language and experience in the teaching of statistics; and (Re)constructing knowledge in statistics through reflection, articulation and language.* With John Rayner, Anne also presented a joint talk to Mathematics head teachers in the Metropolitan East (Sydney) area on *Teaching statistical concepts: Reflections on the school curriculum.*

During his study leave visits to the UK and Singapore, David Griffiths evaluated multimedia packages in Statistical education.

Statistical Consulting Service

Principal consultants: Dr Ken Russell and Dr David Steel

Under the aegis of the Graduate Faculty, the Department of Applied Statistics provides statistical consulting services to assist the research of the staff and postgraduate students of the University. Advice is given in the planning of investigations, the collection of data, data analysis, and the presentation and interpretation of the results.

More researchers were assisted in 1994 than in any previous year. Clients came from nearly every Faculty of the University. It continues to be the case that most investigators would gain more from the consultation process if they would visit the Service at the very beginning of their investigations.

*Exploring the conceptual underpinnings of clinical psychology
Evaluating services for clients and community members
Pioneering interventions to reduce AIDS*

Clinical Psychology

Co-ordinator: Associate Professor Linda L Viney (tel 042 21 3693)

THIS RESEARCH Group has achieved good external financial support, as well as high levels of participation in national and international conferences, links with national and international researchers, publications in top quality international journals, scholarly and professional books, and workshops.

Members continue to work towards six goals: to explore the often-ignored intellectual underpinnings of clinical psychology (achieved by Project A); to devise new methods of assessment for them (achieved by Projects B, C and D); to develop and evaluate better treatments in these areas (achieved by Projects D, E F and G); to liaise with local clinical, counselling and health services to conduct research relevant to their needs (achieved by Projects E, F and G); to provide channels of communication about research in these areas (Project H); and to evaluate postgraduate training programs in clinical psychology, to which this research is closely linked (Projects I and J).

Projects

These ten projects have been the main focus of the Group, and together fulfil the following objectives:

- A. Rationality and logic of explanation in clinical psychology, involving conceptual analysis of the existing literature (Nigel Mackay).
- B. Spread of social support and the development of close relationships (Beverly Walker and Professor L. Leitner, Miami University, Ohio). This work uses the Dependency Grid to assess dependency dispersion and an interview to assess intimacy.
- C. The link between confirmation of personal meanings and emotions (Linda Viney and Barbara Tooth, now at the Queensland Institute of Technology).
- D. Service delivery to people with developmental disabilities (Isla Bowen, Margaret Gerry and Barbara Tooth).
- E. Counselling services for survivors of sexual assault. The community need for these services and the appropriateness of the counsellors' responses to their sexually assaulted clients are both being assessed (Linda Viney and Rachael Henry). Funded by ARC (Industry) Award for three years, from 1994, with members of the Wollongong Counselling Interagency.
- F. The transition from HIV to AIDS, examining the psychosocial reaction of people who now know

that they have a life-threatening disease (Linda Viney and Professor B Raphael, University of Queensland).

- G. HIV prevention in adolescent offenders and school-based adolescents, using psychodynamic and constructivist group work. Group work strategies have been developed. The small groups are currently being conducted and supervised in high schools and Juvenile Justice Centres, together with the collection of data before and after the groups. Funded by CARG for 1994 and 1995. (Linda Viney and Rachael Henry).
- H. Editing selected Proceedings of the 10th International Personal Construct Psychology Congress, *Personal construct psychology: A psychology of the future* (Beverly Walker and Linda Viney). Funded by the Congress Committee.
- I. Supervision of personal construct therapy (Linda Viney and Larry Leitner).
- J. Evaluation of the objectives achieved in the training of clinical psychologists (Linda Viney and Rachael Henry).

Some of the outstanding achievements of this Group during the year included the publication of a book co-edited by Beverly Walker, *The construction of group realities: Culture, society and personal construct psychology*. Also, Linda Viney's recent book on psychotherapy for the elderly, *Life*

Members

Ms Isla Bowen, Mr John Free-stone, Ms Margaret Gerry, Dr Rachael Henry, Dr Nigel Mackay, Dr Barbara Tooth and Dr Beverly Walker

DEVELOPMENT GROUPS



From left are Dr Rachael Henry, Dr Beverly Walker and Associate Professor Linda L Viney

stories, has been translated into Italian and republished. This year Linda added to her membership of the New South Wales Psychologists' Registration Board and chairing of the Illawarra Area Health Service Department of Psychiatry Community Consultative Committee, membership of the New South Wales Institute of Psychiatry Research Committee. Linda Viney and Rachael Henry have been invited to run a number of training workshops in psychotherapy, Linda Viney on personal construct psychotherapy with the elderly, and Rachael Henry on psychoanalytically-based psychotherapy at the other end of the life span, the under-fives. Nigel Mackay published an important article on cognitive therapy, constructivist metatheory and rational explanation.

*Working together in evaluation, development
and innovation in educational
theory and practice*

Curriculum Research

Co-ordinator: Dr Christine Fox (tel 042 21 3882)

RESearch, evaluation and professional development in teaching and learning are central to the work of staff and students in the Faculty of Education. The Curriculum Research Group (CRG) plays a vital role in fostering such research and development both nationally and internationally. The CRG undertakes research and evaluation at all levels of the education system, Kindergarten to Year 12, and from early childhood to adult education. Curriculum research and evaluation encompass a broad range of interests and issues in curriculum policy, planning and practice in formal and nonformal teaching and learning and professional training. Research and evaluation also focus on the social, environmental and economic contexts of learning, whether across systems, at an institutional level or in terms of the language of curriculum texts.

The Curriculum Research Group (CRG) has six full members and five associate members: Dr Grace Masselos, Brian Ferry, Neil McLaren, Stan Warren and Ray Crawford, with Dr Robyn Iredale to arrive in 1995 as an associate member. Each member of

the CRG brings to the Group a particular expertise in one or more curriculum areas or cross-curriculum interests, including music education, outdoor education, coaching/physical/health education, history education, environmental, science and social science education. Other important research interests include outcomes-based and competency-based curriculum, multicultural/international perspectives, Aboriginal education, contexts of learning, equity issues, and the management of curriculum change.

The growth of CRG over the last year is evidenced by its increased funding and research output:

Funding

As an infant 'development' group CRG was allocated \$7,000 by the University in 1992, \$11,500 in 1993 and \$10,000 in 1994. After its first year, Project monies were sought, and successful outcomes included funding from DEET (\$35,000 of the total \$140,000 History project 1993), BIPR (\$11,000 of the total \$59,000 1993-94), the Australian Sports Commission (\$2000); Dept Science (\$1,500 of \$40,000); DSE (\$35,000 for 1994-95); DSE (\$6,000 for Music Education); IMP (\$3,000 pa for Maths Project).

Research output

The number of publications has increased significantly. In terms of doctorates in progress and completed, the Group has two members whose

research is in progress (Gray, Ferry) with publications emanating from their research, and two members who completed their doctorates in the past two years (Fox, Temmerman) and are now increasing their publishing output. Research publication outputs now total 107, of which 40 were already published, in press or submitted in 1994; 39 in 1993, and 28 in 1991-92.

Research consultancies

Members have been successful in obtaining research and/or consultancy grants in these areas. In 1994, Dr Grace Masselos obtained a Small ARC Grant for 1995 to continue her research into children's socialisation patterns in early childhood educational contexts. Dr Michael Wilson has just completed a study of curriculum issues in competency based VET policy. Dr Nita Temmerman has been engaged to develop a music curriculum for early childhood. The main thrust of Tonia Gray's research involves two significant educational areas: the investigation of the effects of outdoor education in extended school settings and the AIDS-related behaviours of pre-service health educators. Her work in the Outdoor Education field is widely recognised and has generated a high degree of professional interest Australia-wide. Brian Ferry has continued to research and develop a Science Kit for Primary Schools. His other intensive research for the CRG, with Neil McLaren, is

Members

Dr Ted Booth, Tonia Gray,
Dr Nita Temmerman, Dr Paul
Webb, Dr Michael Wilson

DEVELOPMENT GROUPS

focused on environmental education; their work was presented at a national conference on sustainable development in 1994.

Other research consultancies include an investigation into the impact of immigration on education and training in NSW, funded by the Bureau of Immigration and Population Research (BIPR) with Project co-ordinator Dr Robyn Iredale (Centre for Multicultural Studies) and Dr Christine Fox as a Chief Investigator. The resulting report, *Immigration, Education and Training in NSW*, was launched by the NSW Minister of Education and Youth Affairs in September. A new research study funded by the NSW Department of School Education to be undertaken by Dr Christine Fox for 1994-95 is an investigation into the feasibility of a school-based teacher education project with Aboriginal educators in NSW.

Internationalisation

In a climate of internationalisation of universities, the CRG has been a forerunner in the Faculty for encouraging the participation of international doctoral students in its program, and setting up cross-cultural professional development programs and projects in the Pacific. Research by Fox, Booth and Wilson is progressing. Their comparative study of curriculum innovation in three Pacific states has now reached its next phase of the research timetable. Dr Michael Wilson has also been engaged in evaluating Science and Technology project proposals for Australian International Development Assistance Bureau (AIDAB). Booth undertook a further qualitative investigation into the professional development of teachers through an overseas practicum in Fiji in June 1993. Booth successfully conducted a three-month investigation of student retention in the Bangladesh education system for an Asian Development Bank funded project. In 1995, Fox will be undertaking research funded by AIDAB into female participation in education and employment in Papua New Guinea.



Members and associate members get together to plan the next three years. From left are Paul Webb, Brian Ferry, Michael Wilson, Christine Fox (Co-ordinator), Stan Warren, Nita Temmerman, Ted Booth, Neil McLaren and Ray Crawford

During the year, three CRG members (Temmerman, Fox and Gray) have been on study leave establishing key links with universities in the UK, Canada and the USA. Associate member Brian Ferry and full members Tonia Gray and Nita Temmerman in particular, have been successful in increasing their international publications profile.

Forward planning

After three years of developmental operation, 1995-97 will be a time of consolidation and expansion as a full Research Group at the University, with a new emphasis on curriculum evaluation. The Group's research aims over the next three years are, in summary:

- i. to foster collaborative research, innovation and evaluation in curriculum at all levels of education in a variety of contexts in Australia and internationally;
- ii. to promote innovation and reflection in pre-service and in-service practice and policy;
- iii. to work towards developing a Research Centre in curriculum and evaluation;

- iv. to develop initiatives and create a higher public profile for research in and evaluation of specific Key Learning Areas and specific curriculum issues;
- v. to work collaboratively to nurture and enhance individual members research and publication output and
- vi. to act as mentor and collaborator for an increasing number of research students in the Curriculum Post-Graduate Teaching Program.

The CRG plans to expand on its interdisciplinary work over the next three years. The Group has already developed links with the Centre for Multicultural Studies, with the Creative Arts Faculty, with the Environmental Research Institute and with the Aboriginal Education Centre. Some members of the Curriculum Program are part of the Asia-Pacific Research Network of the University. As part of a projected three-year plan, the new CRG will initiate discussions for further collaborative work both within the University of Wollongong and with other Australian and overseas universities.

*Probing the chemistry of air, water,
soil and fire, and the
impacts of chemical pollution*

Environmental Chemistry

Co-ordinator: Associate Professor David Griffith (tel 042 21 3515)

THE ENVIRONMENTAL Chemistry Research Group was formed in 1994 to co-ordinate University research on the behaviour of chemical species in the atmospheric, aquatic and soil environments. Several general themes underlie current research within the Group:

- sources and sinks of atmospheric trace gases, especially greenhouse gases
- temporal variations of trace gas concentrations in the atmosphere
- atmospheric ozone levels and UV radiation
- trace metals in water and soils
- trace organic pollutants
- pollution of estuaries and inland waters.

Research projects aim at both fundamental understanding of the chemical processes taking place in the environment, as well as specific studies of the release, transport, deposition and chemical degradation of chemical pollutants.

This report focuses on the atmospheric aspects of the Group's activities:

Atmospheric trace gases from landfills and agriculture

The National Greenhouse Gas Inventory, an integral part of Australia's response to the International Framework Convention on Climate Change and released during 1994, pointed out the large uncertainties in estimates of the sources and sinks of many atmospheric trace gases. This work is aimed at reducing these uncertainties. During the year, David Griffith, Honours student Fred Turatti, and new member Ian Jamie, took part in two extended field campaigns using a new mobile Fourier Transform Infrared (FTIR) spectrometer developed by the Research Group for high-precision trace-gas analysis. The first made measurements of the emissions of methane from municipal solid waste in a landfill (Mugga Lane, Canberra) for three weeks in August. The second was a part of OASIS '94, a co-ordinated campaign of measurements of energy, water and trace gas exchange between the agricultural environment and the atmosphere based at Wagga Wagga in south-central NSW in October. At OASIS, measurements were centred on exchange of the greenhouse gases methane, nitrous oxide and carbon dioxide. Both campaigns involved extensive collaboration with CSIRO and university research groups, particularly the CSIRO Centre for Environmental Mechanics and External Group members Dr Tom Denmead and Dr Ray Leuning. This

work was funded in large part by a new three-year grant from the ARC.

Precision measurements of trace gases in clean air

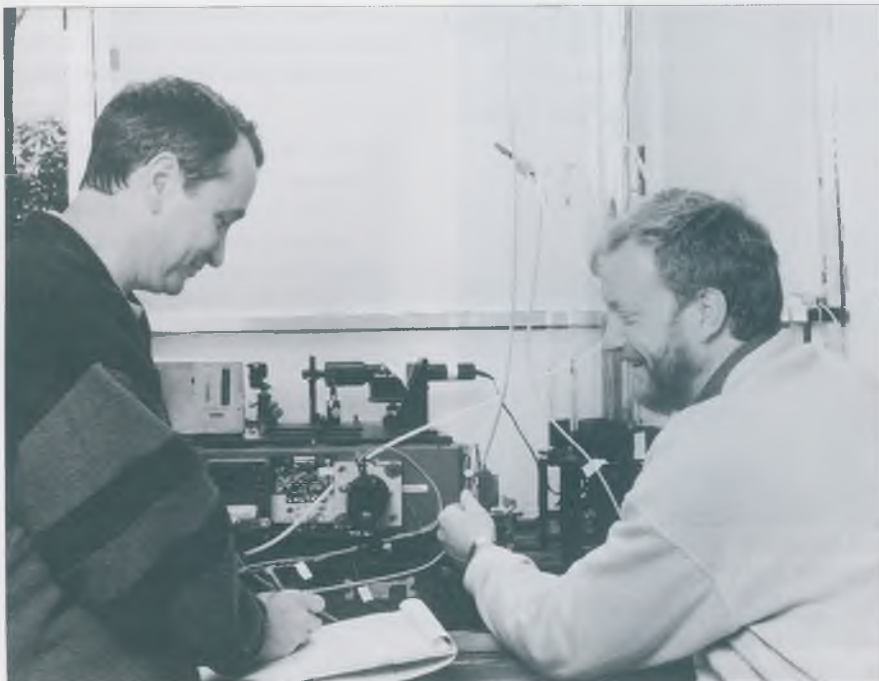
The daily, yearly and long-term variations in the concentration of an atmospheric trace gas tell us much about its sources, sinks and geochemistry, but to be useful measurements must be very precise and well calibrated. Michael Esler, a PhD student co-supervised by David Griffith, Stephen Wilson and Dr Paul Steele at the CSIRO Division of Atmospheric Research, has constructed a dedicated FTIR-based system which provides measurements of very high precision for several gases simultaneously. The system has been extensively tested against existing state-of-the-art techniques at CSIRO's GASLAB, and will shortly undergo field trials at the Cape Grim Baseline Air Pollution Station at Cape Grim in Tasmania.

Solar spectroscopy, atmospheric chemistry and UV-B radiation

The spectral analysis of sunlight transmitted through the atmosphere provides a wealth of information on the composition of the atmosphere and damaging UV-B radiation. There are two parts to Group research, focused on the infrared and ultraviolet/visible (UV/vis) parts of the sun's spectrum. David Griffith and German visitor Peter Müller have constructed an optical sun-tracker to collect and focus sunlight continuously into the

Members

Associate Professor John Ellis, Dr Ian Jamie, Professor John Morrison, Dr Stephen Wilson



Dr David Griffith (right) and Dr Ian Jamie are setting up a mobile Fourier Transform infrared spectrometer, used for obtaining measurements of emissions of greenhouse gases from soils

laboratory for spectral analysis. The tracker is currently coupled to a high resolution FTIR spectrometer for infrared analysis, with UV/visible analysis to be added in 1995.

A separate UV/visible spectrometer mounted on its own tracker was used by Stephen Wilson and Honours student Kaylene Atkinson to obtain low resolution UV/visible spectra

during 1994. Together, the solar spectroscopy projects aim to make parallel measurements of many trace gases as well as solar UV-B radiation. The measurement programs are co-ordinated with those of the Bureau of Meteorology (with external member Dr Bruce Forgan), Cape Grim (Stephen Wilson and Bruce Forgan), and the international Network for

Detection of Stratospheric Change. Active collaboration between David Griffith, Stephen Wilson and the National Institute for Water and Air Research, New Zealand (NIWA) continues, aided by a bilateral collaborative grant from the Federal Department of Industry, Science and Technology.

Bushfires and atmospheric trace gases

ARC-funding of a project by David Griffith and collaborators on emissions of trace gases from bushfires came to an end in early 1994. The results from this work have been used extensively in the Australian National Greenhouse Gas Inventory, compiled and published during 1994. The work will continue in collaboration with the Northern Territory University in 1995.

External activities

Group members were involved in a number of professional activities both national and international.

Stephen Wilson was an invited speaker and session chair at the World Meteorological Organisation Regional Workshop on Clean-Air Monitoring in Beijing, China, and served as a member of the Atmospheric Reference Group of the Commonwealth State of the Environment assessment working group. He also took part in the Strategic Review of the Cape Grim Baseline Atmospheric Pollution Station.

David Griffith was accepted as Complementary Investigator of the Network for Detection of Stratospheric Change, took part in the second ESMOS (European Spectroscopy for Monitoring of the Stratosphere) intercomparison of algorithms for analysis of solar infrared spectra, and served on the working group 'Non-CO₂ gases from the biosphere' which compiled that part of the National Greenhouse Gas Inventory. John Morrison was chair of a technical review panel of the South Pacific Regional Environment Program and continues as technical adviser.

University of Wollongong nurses are involved in a variety of research projects reflecting local national and international issues in health care

Health Practices Research

Co-ordinator: Dr John Sibbald (tel 042 21 3471)

THE HEALTH Practices Research Group, located in the Department of Nursing, has completed its first year of existence. In the past year the emphasis has been on establishing various research projects, and developing research relationships with nurse clinicians in the local area Health Service.

Noteworthy projects completed during the year include that of Irene Stein, working in collaboration with Russell Gluck and Jan Hancock of the Aboriginal Studies Unit. They completed a study on the integration of university preparation and first year degree study for Aboriginal and Torres Strait Islander nursing students. In general terms the students demonstrated that there are positive outcomes to be obtained from a comprehensive program that addresses the literacy of learning in its broadest sense eg literacy of organisation patterns, literacy of practices and processes of academic contexts, as

well as specialised vocabularies and discourse demands of the content and pragmatics of specific disciplines. It is believed that through addressing the teaching and learning issues identified in Aboriginal learners' experiences, the learning of all students would be greatly enhanced and that there would be a greater likelihood of equity of learning outcomes.

Rhonda Griffiths, working in collaboration with Robert Moses, physician and VMO with IAHS, completed a study concerning the babies born to mothers with gestational diabetes mellitus (GDM). Specifically they investigated whether these babies require routine care in a Neonatal Unit. At the Wollongong Hospital it has been routine practice to admit all babies of mothers with GDM to the Neonatal Unit for observation for up to 24 hours. Separation of mother and baby is stressful to parents and imposes additional costs on the hospital. This study was undertaken to determine if these babies did have an increased risk of hypoglycaemia that warranted observation in a special care environment. It was supported by a grant of \$5,000 awarded by the IAHS. The results of the project suggest that there is no particular advantage in separating mother and baby.

Some projects were begun in 1994 and are still in progress. Annette Hoskins and John Sibbald are currently engaged in a study of the incidence

and treatment of chronic leg ulcers in the Illawarra area. This is being carried out in collaboration with Brenda Ramstadius who is Would Care Co-ordinator for the Illawarra Area Health Service (IAHS), and has \$1500 funding from the IAHS. Data being collected from a number of nursing homes, community health centres, hospitals and general practitioners, will provide information on types of ulcers encountered and treatments used for them. Worldwide, chronic leg ulcers are a costly health problem and it is hoped that the data obtained from this study will enable the IAHS to develop policies for more efficient and cost-effective treatment.

Jenny Fares and Marilyn Hales, in collaboration with Kathy Rhodes of IAHS, are currently engaged on a study of the hospital work environment and its impact on job satisfaction and retention of nursing professionals. This study, which is part of an international project involving similar studies in Canada and Israel, is being carried out in some IAHS institutions and has the full support of IAHS nursing administration. Nursing staff have been invited to attend an information session and fill in a detailed questionnaire. So far participation rates have been encouragingly high. The data this project yields will have an immediate local effect in that it will enable IAHS to review and, if necessary, improve its employment conditions for nursing staff. On a wider scale the data will also contrib-

Members

Ms Isla Bowen, Ms Jenny Fares, Ms Margaret Gerry, Associate Professor Rhonda Griffiths, Mr Brin Grenyer, Mr Bill Janes, Ms Tracey McDonald, Ms Irene Stein, Dr Felix Yuen

DEVELOPMENT GROUPS

ute to the international literature on the provision of health service personnel.

Jenny Fares is also involved, with Brin Grenyer, in a study of substance (drug) use among registered nurses. This project involves the assistance of the NSW Nurses Registration Board, who are compiling a random sample of 2000 registered nurses and mailing out questionnaires. This will be taking place in early and mid 1995.

Margaret Gerry and Isla Bowen are nearing completion of a longitudinal study of community attitudes to people with developmental disabilities. This project has been going since 1987 and involves a large amount of data, which was augmented in 1994 by the efforts of a B. Nursing Honours student. Currently data analysis is nearing completion. This study will show how community attitudes have developed over the study period. It will highlight areas in which further community education is required and will contribute to the future planning of developmental disability services.

Late in 1994 we held an evening seminar session designed to raise the research awareness of currently practising nurses and to attract potential clinical researchers. This evening, attended by more than 20 practising nurses, has resulted in the development of some potentially promising academic-clinical relationships. Currently the group is exploring research opportunities both in the medical institute of IAHS and with community health.

The group received two setbacks in 1994 with the resignation first of Dr Barbara Tooth and later in the year of Professor Carol Morse. Both were experienced researchers and their departures have meant the loss of two good research mentors. Drs Tooth and Morse will be carrying on their researches in Brisbane and Melbourne respectively and we wish them well for the future.



A blood sample is taken from a gestational diabetic

*Australian export trends and opportunities analysed
Imports, international investment and finance
First Australian International Conference on Islamic Banking*

International Business

Co-ordinator: Associate Professor Mokhtar M Metwally (tel 042 21 4017)

THE INTERNATIONAL Business Research Group (IBRG) was established in 1993 to consolidate and enhance research activities in the general field of international business with emphasis on trade and investment. The Group is interdisciplinary and covers theoretical and applied aspects in accounting, economics and management. However the Group concentrates on four specific areas:

1. International business practices and education and the impact of cultural aspects on international businesses
2. Export-import relationships and international marketing
3. International investment policy and relationships, money and capital markets
4. Global banking and finance.

The activities of the Group contribute towards the University's objectives of pursuing international distinction in research and providing an internationally-oriented intellectual environment in order to be known in Australia and

overseas as a university with an especially internationalised emphasis on research.

Research activities

The Group embarked on a major research topic in 1994 titled 'Export Australia' whose aims were to study future trends in Australian exports and market shares, identify market opportunities and needs through analysis of industry and consumer requirements, assess customers' attitudes and motivations towards Australian goods and services, analyse the impact of changes in international money and capital markets on investment in particular lines of production and evaluate the effectiveness of the industry's promotional activities and marketing strategies on the dynamics of international marketing.

The Group organised an International Conference on Islamic Banking which was the first conference of its kind to be held in Australia. It is recognised that Islamic banking is a new concept in finance which has important implications for international business. In an Islamic system, as interest is prohibited, banks are expected to operate solely on the basis of profit and risk sharing. The Conference was extremely successful in throwing some light on the theoretical foundation and practical experience of Islamic banking.

The conference attracted a great deal of publicity from the electronic media and the press. The conference hit the front page of the *Financial Review* on November.11 The article continued on page 39. As a result of this publicity dozens of calls have been coming to the University, inquiring about the outcome of the conference.

Members

Mr Anwar Chowdhury, Dr Barbara Cornelius, Mr Gerhard Gniewosz, Mr Kamel Michael, Dr Nelson Perera, Ms Liliana Vlachos

DEVELOPMENT GROUPS



Members from the International Business Development Group are, from left, Dr Muris Cicic, Mr Kamel Michael, Ms Ann Hodgkinson, Ms Barbara Cornelius, Associate Professor Mokhtar Metwally (Coordinator), Dr Nelson Perera and Mr Gerhard Gniewosz

Advanced Manufacturing and Industrial Automation (CAMIA)

Director: Professor Gunter Arndt (tel 042 21 3378)

Intelligent Manufacturing Systems (G Arndt)

THE TWO-YEAR IMS Feasibility Study of the Global IMS Program, in which Professor Arndt was member of the International Steering Committee, involving all six participating regions Australia, Canada, the European Union (EU), the European Free Trade Association (EFTA), Japan and the USA, was successfully completed in January 1994 with the sixth and final meeting of this steering committee. The feasibility study was based on projects involving clean manufacturing, global concurrent engineering, manufacturing in the 21st century, Holonic manufacturing systems, rapid product development, and the systemisation of manufacturing knowledge. The above meeting recommended that the full-scale ten-year program (estimated at US \$4Bn) be started at the beginning of 1995,

with Australia taking on the Chairmanship during 1997 and 1998.

While on study leave during 1994, Professor Arndt, apart from his research into TQM implementation, investigated IMS activities in the USA, Germany and Japan, with all countries presently preparing for this ten-year program, including Australia. Calls to Australian industry for participating in it are presently proceeding, with projects covering the following technical themes: total product life cycle issues, manufacturing processes, strategy/planning/design tools, human/organisational/social issues, and virtual/extended enterprise issues. Other themes are possible, and it is strongly recommended that Australian industry, research institutes and universities take advantage of this collaborative IMS research program.

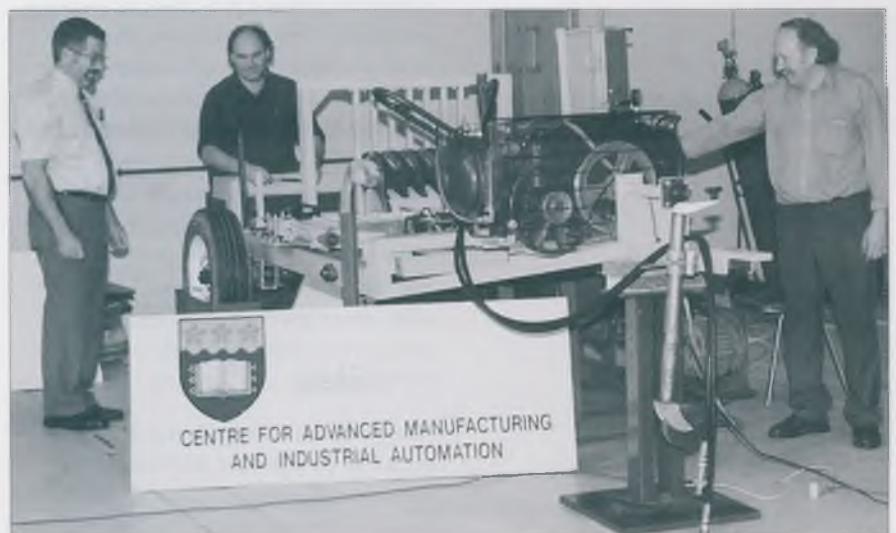
Further information can be obtained from Professor Arndt and/or from

DIST in Canberra (ph: 06-2761214). Apart from Professor Arndt's involvement in the organisational aspects of this program, the contribution of the University of Wollongong towards it is via the CRC in IMS&T, effectively the 'Australian Flagship' in this program, described elsewhere in this report.

Robotised Asparagus Harvester (Dr Richard Rudziewjewski and Associate Professor Victor Stewart)

Development of an advanced prototype of an automated selective asparagus harvester continued during 1994. The period saw major modifications being made to both the cutting units and the controller. Also, a test rig to conduct research and evaluate the harvester in a laboratory situation was designed, constructed and put into operation. Significant improvements in reliability were achieved with the modified prototype during field trials at Jugiong, NSW in late 1994.

Photograph showing the prototype harvester undergoing pre-field trial tests at the University of Wollongong



Centre for Court Policy and Administration

Directors: Professor Helen Gamble (tel 042 21 3638) and Dr Richard Mohr (tel 042 21 4632)

THE CENTRE for Court Policy and Administration was established in 1991 to foster research and teaching on the policy and practice of the management of courts and tribunals in Australia. The Centre conducts postgraduate courses for those employed in the management of courts, in both judicial and administrative positions. It also offers short courses and workshops.

The Centre has been responsible for three research projects in 1994:

Gender Bias and Women as Litigants in the Civil Legal System of New South Wales

Grant: Law Foundation of New South Wales \$45,000

Professor Helen Gamble (tel 042 21 3638), with Dr Richard Mohr and Ms Carol Carter from the NSW Department of Courts Administration

The project was one of three sponsored by the NSW Ministry for the Status and Advancement of Women and funded by the Law Foundation. The other two projects concerned Gender Bias and Women Working in the Legal Profession and Gender Bias and Women in the Criminal Justice System. One of the Centre's graduates (and a current Masters student), Ms Carol Carter, was seconded from the Department of Courts Administration to assist on the project.

The research centred on the District Court of New South Wales and asked the question whether assumptions about the nature and roles of women and men were influencing the conduct and outcomes of women's cases. Cases involving women as plaintiffs were observed in three courts and all involved in the litigation, the woman litigant, the judge, and the barrister and solicitor representing the woman, were interviewed. Women who did not have cases before the Court were also interviewed in a series of focus groups to determine their attitudes to the resolution of disputes.

The research resulted in a discussion paper to be used by the Ministry to assist in its public consultations on the issue of gender bias in the courts.

'The Appointed Place'

Grant: University Project (initial) \$2,000
Dr Richard Mohr, (tel 042 21 4632)

This study was supported in 1993 with a Small University Project Grant. It investigates the concept of 'place' within a legal context and examines whether courts are significant sites for ritual in secular white Australian society. Dr Mohr travelled to Phoenix, Arizona in June to deliver a paper, 'Appointed Place or Occupied Territory?' to the Law and Society Annual Meeting. The study continues and has formed the basis of an application for an initial Large ARC Grant in 1995.

Administrative Tribunals Research Project

Grant: ARC Small \$5,000 (1992)
Grant: ARC Small \$2,000 (1993)

Associate Professor Robin Handley, (tel 042 21 3726) with Professor John Goldring and Dr Richard Mohr

The background for this project is the continuing proliferation of tribunals in Australia, at both State and Federal levels. In recent years governments have set up an increasing number of tribunals to make primary administrative decisions, which might formerly have been reviewed by courts. The establishment of these tribunals seems to have been largely an ad hoc process and no attempt had been made to collect information about tribunals across Australia, nor to identify the models used. This project developed a research methodology by which such information may be gathered. The methodology was trialled in two New South Wales tribunals, the Guardianship Board and the Residential

Tenancies Tribunal and can now be applied in the establishment of a database for information about Australian tribunals.

Collaborative Research with the New South Wales Local Courts Board

Grant: ARC Collaborative \$80,000

Professor Helen Gamble (tel 042 21 3638) with Dr Richard Mohr and Associate Professor Ted Wright, Faculty of Law, University of New England, in collaboration with the Local Courts Board of the Department of Courts Administration, New South Wales. The Department has seconded a member of its staff, Mr Brendan Condie, to assist with the research. Mr Condie is a graduate from the Centre and is currently enrolled in a masters degree in Court Management at the Centre.

The project will be conducted in 1995. It is designed to research, test and develop methods of monitoring, evaluating and improving courts' service to their clientele. The project is seen as the first step towards the development of national standards for Australian magistrates' courts.

Visit by Singapore Courts

In June a delegation from the Singapore Subordinate and Supreme Courts visited the Centre to investigate possibilities of collaboration in the delivery of education programs. The delegation was led by Mr Richard Magnus, Senior District Judge of the Singapore Subordinate Courts and included judicial and administrative officers from the two courts. Plans were made for members of the Centre to visit Singapore in 1995 with a view to delivering training in court manage-

ment to members of the two courts.

Postgraduate Degrees and Diplomas, Seminars and Workshops

The Centre continues its program of postgraduate teaching and seminars and workshops for court managers in Australia and neighbouring countries. The courses have attracted students from Papua New Guinea, Vietnam and New Zealand and applications from Pakistan, Fiji and Croatia. There is a growing demand for delivery of courses in court management in countries beyond Australia and the Centre is investigating ways of cooperating with interested courts. Plans were made in 1994 to begin new Masters degree courses in court management, at pass and honours levels. Enrolments for those courses in 1995 have been good.

Key Centre for Mines

University of Wollongong Division

Director: Associate Professor Naj Aziz (tel 042 21 3449)

THE KEY Centre for Mines is a joint initiative between the University of Wollongong and the University of New South Wales, funded by the Federal Government to provide distant education to mining industry professionals through a combination of accredited short courses and industry based research work.

The Centre was very active in 1994, offering short courses for mining personnel and continuing its research activities.

Professional training

The Wollongong Division conducted five short courses, out of a total of 20 offered jointly by the Universities of Wollongong and New South Wales. The courses included Mine Water – Origin, Inflow Predictions and Control, Strata Control, Longwall Mining, Mining Law and Mine Tailings Disposal. They attracted 75 participants.

Thirty students are enrolled in the Key Centre for Mines (KCM) post-graduate degree program in both institutions. At the end of 1994 the first two KCM-enrolled students from Wollongong completed the Master of Mining Management. Their industry based theses were:

- 1) Removal of Anionic Surfactants from Mine Water Discharges
by Luca Rocchi
- 2) Eye Safety Awareness in Coal Mines
by Robert Grant

Academic staff from the University of Wollongong participate in the delivery of short courses offered by the Key Centre for Mines at both Universities.

Research

Dust control

Following the successful development of the longwall venturi scrubber, a project funded jointly by ACARP and the Joint Coal Board of NSW, research continued on modification of the system for dust control in the stage loader crusher. Accordingly, intensive fieldwork has been carried out at BHP Elouera mine with results so far confirming that the system can be effectively used for dust reduction in

various parts of the mine. In the wake of this initial success, further surveys are being conducted at various sites with negotiations in progress to have the product manufactured and marketed world-wide. The project is headed by Associate Professor Naj Aziz assisted by Dr Ernest Baafi. Findings of this project have been published in journals and conference proceedings as shown in the publication lists elsewhere in this Report. One PhD thesis and two undergraduate theses have been produced as a result of this work.

Longwall mining

This research is on floor failure induced by lateral stress ahead of longwall supports in coal mines. Floor failures at longwall faces have been traditionally associated with soft floors. Failure driven by the lateral displacements of strata is primarily associated with the in-situ stress relief and the displacement of yielded coal towards the goaf. The immediate roof and the coal at the face are laterally unconfined and both are free to move towards the goaf. Lateral movement of the floor can be inhibited by the existing floor in the goaf and the pinning action of the powered supports.

The main objective of this study is to present the principles and the model of the floor failure as it is influenced by the in-situ stress relief, vertical abutment, coal failure and the differences in Poisson's Ratios. Field observations and a theoretical approach, including a numerical model, will provide the mining industry with more versatile design solutions useful in evaluating the risks involved with floor failure at the longwall face.

Currently Mr Jan Nemcik, a PhD postgraduate student, is engaged on the project, which is jointly supervised by Dr Indraratna and Associate Professor Aziz.

Rock mechanics

A three-year research project was awarded to Mr A Herath by the KCM to work on the 'Stability of Jointed Rock-Mass Structures in Mining Engineering'. The project is concerned with the effect of joint surface features (geometry and distribution of asperities) on the shear behaviour of model discontinuities. Mathematical tools such as the Fouries approach are used to provide an alternative approach to the more common stochastic modelling. The project is in its second year of the study and has yielded significant results. Results of the initial work have been published, as shown in the publications pages. This research is jointly supervised by Dr Indraratna and Associate Professor Aziz of the Department of Civil and Mining Engineering.

Mine gases and outburst

This project is partly funded by the KCM and currently Mr Nihad Ridha is engaged in investigating the relationship between particle size distribution of drill cuttings and outburst proneness of coal. The project is jointly supervised by Associate Professor Naj Aziz and Dr Adrian Hutton. Mr Ridha will be submitting his thesis to attain a Master of Mining Management in 1995.

Feasibility Study of Sapan Dalam Coal Deposit of Indonesia

Mr Emil Milawarra has completed ME (Hons) project on Sapan Dalam Coal deposit of Indonesia. The project was supervised by Dr Ernest Baafi of the Department of Civil and Mining Engineering. Mr Milawarra used Gemcom Service Inc's suite of mine planning software (PC-XPLOR, GEO-MODEL, GEM-SOLID and PC-MINE) and WHITTLE 3D pit optimiser to evaluate the economic viability of the deposit.

Members of the Key Centre for Mines

The members of the Key Centre for Mines include Associate Professor Najdat I Aziz, Associate Professor in Mining Engineering and Deputy Director, Key Centre for Mines, Dr Ernest Baafi, Senior Lecturer in Mining Engineering, Dr Buddhima Indraratna, Lecturer in Mineral Processing, Dr Ian Porter, Lecturer in Mining Engineering, Professor Tibor Rozgonyi, Professor of Mining Engineering and Dean, Faculty of Engineering, and Professor Raghu N Singh, Professor and Co-ordinator of Mining Engineering, Department of Civil and Mining Engineering. Members from the Department of Geology are Dr Bryan Chenhall, Lecturer, Dr Paul Carr, Senior Lecturer, Dr Adrian Hutton, Senior Lecturer, Dr Chris Fergusson, Senior Lecturer, Associate Professor Brian Jones, Acting Joint Head of School of Geosciences and Associate Professor Anthony Wright, Senior Lecturer.

Centre for Multicultural Studies

Director: Professor Stephen Castles (tel 042 21 3779)

THE CENTRE for Multicultural Studies (CMS) carried out research and teaching on international migration, ethnic relations and social policy in a multicultural society. Operational since 1978, the Centre is funded partly by the University of Wollongong as a service to the community, and partly through consultancy work for the Federal government and other bodies. The projects listed below give some idea of the wide-ranging policy research carried out by the Centre. In addition, CMS staff play an active role in

policy-formation as members of government advisory committees and as consultants to international agencies such as the International Labour Organisation and the United Nations Population fund.

In recent years, CMS has increased its involvement in comparative work on global patterns of migration, cultural change and the emergence of new personal and political identities. An important focus is emerging patterns of migration in the Asia-Pacific region and their consequences for social, economic and political development.

However, independent academic research is also a central part of the objectives.

CMS staff are involved in a range of projects, often in co-operation with colleagues at other universities in Australia and overseas. Participation in local and international conferences is also an important part of the Centre's role. In 1993-94 CMS staff were responsible for many publications in the form of books, monographs and articles, as listed in the research publications section later in this report.

Centre for Natural Resources Law and Policy

Directors: *Professor David Farrier* (tel 042 21 3456) and *Professor Martin Tsamenyi* (tel 042 21 4120)

THE OBJECTIVES of the Centre for Natural Resources Law and Policy are: (a) to conduct interdisciplinary postgraduate courses in natural resources law and policy issues; (b) to conduct and promote research in the law relating to the development and conservation of natural resources; and (c) to publish material and disseminate information about the law relating to the development and conservation of natural resources and policy.

Since its establishment, the Centre has achieved remarkable success in its teaching and research activities. The Centre teaches courses leading to the Graduate Diploma and Master of Natural Resources Law and Policy. In 1994 the Centre also launched *The Australasian Journal of Natural Resources Law and Policy*, the first journal of its kind in Australia. The Centre has, within the first two years of its establishment, distinguished itself as a leader in natural resources law and policy research. Already, the Centre has received some industry funding and some of the staff of the Centre have been invited to present keynote addresses at international and national conferences.

The establishment of the Centre has helped to bring together the different perspective and research efforts in natural resources law currently being undertaken by different faculty members. The Centre has also promoted the concentration of research effort in the Faculty by encouraging the younger and less experienced members of staff to focus their

research activities on different aspects of natural resources law.

Research Activities

The following projects are being undertaken by members of the Centre

Fisheries Law and Policy

Researcher: Professor Martin Tsamenyi

This project is concerned with the law relating to fisheries conservation and management within the 200 nautical mile exclusive economic zones of Australia and those of countries in the South Pacific. The major focus has been on the following issues: (a) fisheries law relations between the Commonwealth, States and Territories and the implications of such relations for fisheries management; (b) the regulation of foreign fishing activities within Australia's fishing zone; (c) the management of common or straddling stocks by Australia and New Zealand, particularly bluefin tuna; and (d) the Torres Strait Treaty and the regulation of traditional fishing, and the law and policy aspects of fisheries law enforcement.

International Environmental Law and Natural Resources

Researcher: Professor Martin Tsamenyi

The aim of this project is to examine the implications of international environmental law for the management of different types of natural resources in Australia, with particular emphasis on fisheries, mining and petroleum.

Biodiversity Conservation on Private Land

Researcher: Professor David Farrier

This project is aimed at designing appropriate policy instruments,

particularly legal and fiscal instruments, to induce private land holders in Australia and the USA to retain and manage natural areas.

Local Government and Resources

Researcher: Andrew Kelly

The aim of this project is to examine the powers of Local Government to regulate natural resources development and conservation. The following issues are of immediate concern: (a) the attitudinal change by Local Government towards the natural environment; (b) the historical role and functions of Local Government in relation to natural resources extraction; (c) the integration of Local Government's role in environmental legislation; (d) the reach of the planning legislation to attain environmental objectives; and (e) Local Government initiatives in conserving the natural environment.

Legal Reasoning under Uncertainty in Environmental Law

Researcher: Associate Professor Ricci

This project focuses on ways to deal with scientific uncertainty and data variability in environmental decision-making and in the resolution of environmental disputes.

Indigenous Autonomy and Natural Resources Management

Researcher: Luke McNamara

Following the High Court's decision in *Mabo* and the enactment of the *Native Title Act 1993*, the relationship between Aboriginal rights (including autonomy rights) and the use of natural resources has become crucial and in need of further examination. In the next three years, attention will be focused on the implications of the

Native Title Act for the management of different types of resources and the policy implications of such management regimes. Comparisons will be made with the US, Canada and New Zealand, which have all dealt with different aspects of the issue.

Taxation Law and Environmental Protection

Researcher: Penelope Watson

This project examines the extent to which tax law can be used to change corporate behaviour to incorporate environmentally sensible approaches. The project also focuses on current initiatives in other overseas jurisdictions such as Canada, the US and the European Community.

Tort Law as a Vehicle for Environmental Protection

Researcher: Penelope Watson

The aim of this project is to examine the traditional areas of tort law which could apply in the environmental context. It will examine the efficacy of tort law in providing a remedy for environmental damage.

Expert evidence in Environmental Law

Researcher: Patricia Blazey-Ayoub

The project examines the relevance of current rules of evidence, in particular the use of expert evidence in relation

to the prosecution of environmental offences. The project reviews developments in other common law countries with a view to making recommendations for policy change.

Business Entities in the Natural Resources Sector

Researcher: Damien Considine

With a range of environmental law statutes in place, it is clear that the choice of 'persons' to be prosecuted is important in assessing the effect of the different regulatory regimes. 'Persons' to be prosecuted range from individuals as individuals, individuals as directors and individuals as members of partnerships or trusts, to corporations which may or may not be part of, or be controlled by, other corporations. This project constitutes the first stage of a long-term project which will examine the choice of business vehicles in the natural resource, agriculture and other industries which impact on the environment and which are the subject of environmental regulation.

External impacts on Protected Areas

Researcher: Professor John Whitehouse

The aim of this project is to evaluate external impacts on protected areas; to examine the current legal regime for the protection of such areas and to canvass alternative models for the protection of such areas.

Centre for Research Policy

Director: Professor Stephen Hill (tel 042 21 3256)

THE CENTRE for Research Policy is a national centre for research on policy and management of science and technology and the officially endorsed international centre for STEPAN, the UNESCO-based Science and Technology Policy Asian Network, as well as for APEC's human resource development and industrial technology (HURDIT) programs. The Centre was supported through 1994 under Special Research Centre funding of the Australian Research Council (ARC) and through contract income, earning a total direct external income of \$1.05 million for the year.

Nineteen ninety four was the year when the Centre brought together the results of its previous three-year program into a series of major final outcomes – both empirical and theoretical. Over this period the Centre had undertaken the task of 'mapping' the organisation and direction of the research system of Australia, providing critical missing information about the major transformation that have been occurring since the mid-1980s. By 1994 separate major studies had been completed of, for example, university research infrastructure, planning and research management across the university

system, all 888 university research centres, the organisation of new universities, quality strategies across a range of campuses, university-industry linkages across the whole system, and the entire output of publications (for 1991) from Australian universities.

In addition, the Centre had studied the development of the Cooperative Research Centres since their inception, completed a major in-depth study of four divisions of CSIRO, and conducted comparative work internationally across the Asian region on many of these same issues. By 1994

Professor Stephen Hill, left, Director of the Centre for Research Policy, formally handing over the chair of STEPAN, the UNESCO science technology policy ASEAN network from Australia to Indonesia, to Rahardi Ramelan, deputy chairman of Indonesia's economic development planning council at the end of 1994



the Centre therefore had a very strong platform of knowledge about what is happening in research organisation both in Australia and internationally. As 1994 arrived, the Australian Research Council officially released two major products of this work, the first a three-volume monograph entitled 'Crossing Innovation Boundaries: the Formation and Maintenance of Research Links between Industry and Universities in Australia', and the second a monograph entitled 'A Study of Quantitative Indicators of Research'. Both documents have been formative in subsequent government policy.

What the Centre has been able to show by such a comprehensive empirical data base is that a 'New Order of Science' has emerged over the past decade. Significant changes have occurred – world wide – in the way that research is performed and communicated. Globally, the leading edge of research is set increasingly in an industrial application context so it is very hard to identify any clear dividing line between basic and applied research; disciplines have given way to multidisciplinary teams in the driving of research agenda; tacit or informal knowledge transfers are of equal significance to formal technical knowledge; networking and personal relationships are at the core of research breakthroughs and innovation. Through 1994 the Centre has therefore been invited to many international fora to present these findings – to Mexico City by the University of Mexico in February, to Seoul by the Korean government as the keynote message inaugurating the founding of Korean-ASEAN S&T relations, to Manchester by the Manchester Business School in August, to Paris by the Government

of France and UNESCO in September, to Wellington, New Zealand by the New Zealand Government in October, to Jakarta by UNESCO in November, to Manila to address the Association for Science Cooperation in Asia in early November and, finally, the Director of the Centre was invited by Perez de Cueller, ex-Secretary General of the United Nations, to address the Global Commission on Culture and Development on this work in Manila in late November. Numerous presentations were also made around Australia, for example, to business audiences in Perth, to the Pro Vice-Chancellors (Research), CSIRO, and a variety of university seminars. The Centre also embarked on the development of workshop series for universities in Australia feeding back its findings and assisting research staff to develop new management strategies. These were inaugurated in Murdoch University and followed through at Macquarie, Newcastle and Wollongong Universities.

The empirical work of the Centre through 1994 built on these basic premises. Two internationally tendered projects were won from the ARC, one on links between basic research and socio-economic objectives, the other on ecologically sustainable development (ESD) indicators in research. Both projects were completed during the second half of 1994, and monographs reporting the results were committed for publication in early 1995. Both projects were also conducted on an international collaborative basis. The ESD project was complemented by an Asia-wide survey of ESD indicators conducted for UNESCO and by invited presentation of the findings to a United Nations conference on Practical Applications of Ecological

Economics in Costa Rica in October and an international conference held in Wollongong in December. The basic research project involved collaborators from the USA, UK and the Netherlands, international missions were supported by Australia's Department of Industry, Science and Technology (DIST) – to allow collaboration, and the project was linked with a major OECD workshop held in Paris during September.

The Centre's wider international program – as international centre for UNESCO and APEC – also continued with overview of a dozen international collaborative projects, the chairing of international APEC meetings in Canada (January), Korea (June), and STEPAN in New Zealand (October), representation on UNESCO's Advisory Board for Asia and the Pacific; completion of the building of Malaysia's Science and Technology Information Centre (MASTIC), the completion of an international survey of intellectual property rights legislation across Asia, and the development (with DIST) of the first international conference on S&T indicators that brought together OECD national experts with those from Asia (April). The Centre was able to use its international role to fund two of the University of Wollongong's other centres, Multicultural Studies and MITOC, in Asian-orientated programs on skill development and organisation best practice. At the end of 1994 the Centre successfully tendered – with Monash University and UNSW – for recognition and funding as Australia's official APEC Study Centre Consortium; from 1995 CRP will have specific responsibility for Australia's S&T and human resource development programs under APEC.

Faculty of Arts

Department of History and Politics

Dr Stephen Brown
(tel 042 21 3619)

I spent much of 1994 writing up the results of my research in recently-opened Soviet archives in Moscow the previous year. I am researching the origins of Communist rule in Russia, focusing upon the Russian Civil War of 1917-20 and the formation of the Red Army during that period.

**Associate Professor
Colm Kiernan**
(tel 042 21 4385)

I completed work on Voltaire's *Les Serfs du Mont Jura* which was published in *Dictionnaire de Voltaire*, ed. Raymond Trousson, Jerom Vercruysse and Jacques Lemaire, Brussels 1994, pp 214-215. The *Dictionnaire* was compiled by an international group of Voltaire scholars to commemorate the 300th year since Voltaire was born in 1694. The editors are members of the Free University of Brussels.

I have been contracted to complete the entry on 'Peter Lalor' for the New Dictionary of National Biography, to be published by Oxford University Press. This is to update the original Dictionary of National Biography, first published in 1904, and is a major project requiring great accuracy, as it is often where research on a historical character begins. As a result of my research for the project, I have embarked on a book, 'Peter Lalor and Rebellion', which will incorporate new material I have discovered in the National Archives in Ireland.

So far I have written 40,000 words on 'Peter Lalor and Rebellion'. The claim is being made that the Eureka rebellion, 1854, was important for the establishment of democracy in

Victoria: manhood suffrage, essential for democracy, came in Victoria in 1856, long before it was conceded in Britain or in any other British colony. Having achieved a democratic regime, Lalor followed on to sit in the Victorian Legislative Assembly, where he worked hard to ensure that democracy was firmly established without impediment. In particular, during his last seven years, as Speaker of the Victorian Legislative Assembly from 1880 to 1887, he put in place procedures that were to protect the democratic achievement. Rather than run the risk of a rebellion, the squatters who controlled the other colonial parliaments made democratic concessions which ensured the survival of democracy in Australia.

Dr Gregory Melleuish
(tel 042 21 4395)

During 1994 Dr Melleuish pursued his research in the following areas: Australian intellectual history and political thought, contemporary Australian history and political and cultural theory.

In the first area he completed the revisions of his manuscript *Cultural Liberalism in Australia*, which will be published by Cambridge University Press in October 1995. As well, he signed contracts with University of New South Wales Press to co-edit two volumes, the first a reader in Australian political thought and the second a collection of essays entitled *Australian Political Thinkers*. He also began work on a study of Australian conservatism, also to be published by UNSW Press.

In the second area Dr Melleuish continued work on his manuscript, currently entitled *A Post-modern Australia?* which was completed in early 1995. A paper from the book was delivered at the 1994 Australasian Political Studies Association conference held at Wollongong.

In the third area Dr Melleuish wrote two papers, one on cultural studies

and cultural policy and the other on liberalism and identity in Australia, both of which will be published during 1995. He also delivered a paper on culture, humanism and the university to a colloquium of the Sydney Society of Literature and Aesthetics; that, too will be published in 1995.

Department of Modern Languages

**Associate Professor
Brian McCarthy**
(tel 042 21 3720)

My research activities over the past year have been closely linked to the development of computer-aided language learning software. The main focuses have been:

- integration of CALL software into university teaching programs,
- the transferability to other languages of templates designed for a specific foreign language,
- the effect on software design of competing influences: language system, teaching methodology and computer logic,
- the adaptation of the linguistics of real-life communication to linguistic realism in computer-assisted language learning activities and
- the sequencing of micro activities within CALL modules designed to provide a comprehensive review of a given language feature.

Professor Brian Moloney
(tel 042 21 3676)

Brian Moloney has continued to collect material for his projected history of the novel in Italy and for the production of a *Repertorio bibliografico dell' Ottocento*. He is collaborating in this latter project with scholars based in England and Italy. He has also made further progress on his book, *Italian Novels of Peasant Crisis*, which is nearing completion,

and on a critical edition of tales by Italo Svevo, to be published in the series *Piccola biblioteca di letteratura italiana. Inediti e rari*, which will include unpublished early redactions of the tales.

He has also written further articles on Svevo, Silone and Vittorini, and is developing an interest in the publishing history and textual revisions of Silone's *Fontamara*.

The originality of his work was recognised by invitations to lecture in Florence and Trieste, and by the award of an ARC major grant for the three years 1995-6-7.

Dr Susan Yates
(tel 042 21 3636)

Dr Yates continued her interdisciplinary research on the role of the doctor in 19th century French society and his relations with the bourgeois wife. She investigated the theme of the *médecin des dames*, or ladies' doctor, whose success with women patients is attributed not to his medical competence but to his charm and wit in the salon or to his collusion with his patients in covering up their shameful secrets — illicit love affairs, miscarriages, abortions, etc. Despite this seeming alliance with the female patient, the doctor is essentially an ally of bourgeois male patriarchy, providing 'scientific' rationalisation for traditional religious beliefs about female inferiority and, by his opposition to birth control, increasing the sexual prerogatives of the male within the couple. This phenomenon of expanding male control of female sexuality is, in turn, part of the process of the medicalisation of the family and sexualisation of women and children which is so brilliantly illuminated for us by Foucault and which Dr Yates hopes to trace, as far as possible, in the realist and naturalist fiction of the period and in particular in the novels of Balzac.

Faculty of Commerce

Department of Economics

Professor Dudley Jackson
(tel 042 21 4016)

Study leave research continued the research program for a textbook on the microeconomics of production and of costs and profit, intended for students of management, accountancy and engineering. This involved study leave research in the libraries of Cambridge University Faculty of Engineering and Cambridge University Faculty of Chemical Engineering as well as Cambridge University library itself, to gather relevant illustrative case studies. The intended textbook will use 'real world' data drawn from collected cases to assist in a better understanding of basic micro-economic concepts and principles.

Mr Frank Neri
(tel 042 21 4671)

I joined the Economics Department in January 1994 as an Associate Lecturer. At that time I was completing my MComm(Hons) from the University of New South Wales. So for the most part 1994 was spent completing the requisite coursework and writing up my research report. I successfully completed my degree in January 1995 and will graduate shortly. My research report investigates the idea of convergence of real per capita gross domestic product between the states and territories of Australia since 1861. Part of my research involved the construction of estimates of state and territory real per capita GDP for various years since 1861 and I believe that these are the first such estimates constructed for Australia. I am currently in the process of writing a final draft paper based on my report which I hope to have published. On another tangent, I have for some time also been interested in the economic

rationale for the prohibition of certain commodities such as cannabis and heroin. In particular I am interested in whether the existing prohibition maximises social welfare. In order to examine such a question I have adapted an existing theoretical model for alcohol which I have subsequently estimated. This work is about to be presented in the form of a Departmental working paper.

Faculty of Creative Arts

Dr Frances Dyson
(tel 042 21 4623)

Frances Dyson's current research is focused on developments in new media and communications technologies, with particular attention to their impact across culture and the arts. In addition, Dyson is preparing her PhD dissertation 'The Silencing of Sound: Philosophy, Media, Technology' for publication, editing a new refereed journal *Sound Culture*, and collaborating with Canadian composer Michael Century on a reading/performance piece for the 1995 International Symposium on Electronic Arts.

Mr Richard Hook
(tel 042 21 4271)

Richard Hook held a joint exhibition of paintings and screenprints with a Thai colleague in the Silpakorn University Art Gallery, Bangkok, from December 9 to 24. The exhibition then transferred to the Australian Embassy from February 13 to 28.

The work shown was a response to aspects of the Illawarra environment, especially the contrasting structures of the industrial landscape and the rainforests.

A more recent project investigates, via drawing and painting, the expressive potential of the dot-screen matrix, utilising newsphoto images of war casualties.

Ms Liz Jeneid

(tel 042 21 3048)

Liz Jeneid, in association with Dr Mehmet Saclioglu from the Faculty of Fine Arts, Marmara University, Istanbul, Turkey, worked on a project which included an exchange exhibition of student textile work and an exchange of lecturers in 1994. Liz travelled to Turkey to work with students at Marmara University and to hang the exhibition, which was shown in two venues in Istanbul, at the State Gallery in Beyoglu and at the Marmara University Gallery. Student work from the Faculty of Fine Arts at Marmara University was subsequently shown in the Long Gallery at the University of Wollongong.

Funds from the Department of Foreign Affairs and Trade were used for freighting work from Australia to Turkey and for producing a catalogue. Support from the International Department of the University of Wollongong made the exhibition of local artists possible.

The second part of this project occurred in August when Dr Mehmet Saclioglu came to the Faculty of Creative Arts as lecturer in residence and brought an exhibition of Turkish student work with him which was shown in the Long Gallery. An exhibition of work by Turkish artists living in Australia, curated by Liz Jeneid, was shown in the Long Gallery at the same time.

From April to June 1994, Liz Jeneid took up a residency at the Cite Internationale des Arts, Paris and showed two works in 'Exposition Collective', an exhibition at the Cite Gallery in Paris. While working in the studio she was researching and preparing for an exhibition at the City Gallery in Wollongong in 1995. The

preparatory work included visiting prehistoric, Celtic and Roman sites where onsite drawings and notes were made.

Artist books made in Paris were shown in 'Passages of Time', a group exhibition of artist books and works on paper shown at the Long Gallery in July 1994.

In September Liz exhibited her own and students' work at the first Artist Book Fair to be held in Australia, at the State Library of Queensland.

Faculty of Education

Associate Professor

Philip de Lacey

(tel 042 21 3728)

Research undertaken during 1994 has included:

1. Enquiries into the effects of early-childhood, enrichment education, based largely on the Bourke experimental preschool, for whose program the writer is responsible. Follow-up data show that there has been a steady rise in both entry and exit levels of verbal performance over the past 25 years, though the encouraging results might be a little overstated owing to subject-mortality effects. Antecedents of the finding are under further investigation. A monograph describing enrichment preschooling in some detail is with the publisher, and two papers have been presented on this subject at conferences.
2. Implications of the relationship of locus-of-control characteristics of ESB and NESB children in primary schools are being studied, in Australia and Iran, especially consequent on encouraging and discouraging feedback, with a former PhD student, whom the writer supervised. A paper reporting this research is under consideration for publication.
3. Problems of English usage, particularly writing, are being studied

in universities, in collaboration with the Head of Student Services, Dr Allen Barlow, of Western Sydney University, Nepean, and Dr Denise Buch, of Canberra University. A survey of academics' judgements about students' English writing competence at the University of Wollongong has been completed, and a paper based on it has been presented at an Australian and an international conference, and is under consideration for publication.

Professor Ron King

(tel 042 21 3575)

Research includes:

1. Learning and cognition. The most recent output from this work deals with a long-standing impasse in theory of learning and knowledge; namely the lack of convincing logical explanation as to how we acquire knowledge. It challenges aspects of the so-called mechanical theories of learning underpinning the transmission view of teaching that permeates much of education and schooling. A neuroscientific basis for resolution of the impasse has now been proposed and is being progressively published (see *Science Education* 78[3]). Current activity includes the location of sites, such as problem-based medical education and training, to establish an evidential base against which the newer forms of constructivist theory may be tested in practical ways. This work is being carried out in collaboration with Dr G D Hendry (Faculty of Medicine, Sydney University).
2. Policy in higher education. This research continues and consolidates policy formulation activities undertaken during a lengthy secondment as Counsellor to the Higher Education Council. It incorporates work on alternative modes of delivery in higher education, cross-sectoral and intra-sectoral articulation and transfer of credit, and the strengthening of cognitive skills in workplace performance improvement programs.

3. Family and community history. Undertaken in collaboration with Professor N J Kyle from Queensland University of Technology, this work covers the issues of how family and community history are done and, from this researcher's viewpoint, psychological aspects of the construction of history. A linkage has also been established with the earlier mentioned educational policy research through a study of government reports on education over the past century. In particular, the relationship between the effectiveness/adoption of report recommendations and the inclusion of historical and social context in reports appears to be significant.

Faculty of Health and Behavioural Sciences

Department of Nursing

Ms Irene Stein

(tel 042 21 3766)

Inter-institutional relocation of the aged

This study examines the effects of a forced inter-institutional relocation of the aged. It details the individuals' reactions to the relocation from one nursing home to another by measuring stress-related indices. A General Health Questionnaire and Affectometer 2 were used to gauge well-being both before and after the relocation took place. The results are being processed.

Faculty of Informatics

Department of Computer Science/Mathematics

Dr Keith Tognetti

(tel 042 21 3826)

Project A

With graduate student B Bates 'On the Periodic Points and Symmetries Of Iterates of the Gauss Map'. The Gauss map is fundamental to the process of division and underlies the operation of evaluating continued fractions. Considered as a chaotic map iterates have been shown to have very rich symmetries.

Project B

With honours student R Janssen 'Equitable Sequences and the Stick Breaking Problem'.

We place points 'evenly' around a circle, one at a time at each instant in the hope that, whenever we stop, the gaps between points as we go around the circle will be about the same size. The unconstrained version of this problem leads us into the stick breaking model of resource allocation and things logarithmic. The stick represents the total resources to be shared evenly among recipients who arrive individually. On each arrival the stick must be broken in such a way that each recipient gets an equitable share. (This relates to the well-known Lorenz curve, which is often used to highlight iniquities such as the top five per cent of the population capturing 48 per cent of the wealth).

The sequences of points as we go around the circumference is found to have properties which occur widely in folding structures. In particular it has been shown that the number representation implied by the Sarkovskii ordering may characterise folding even in structures which are not chaotic.

Project C

Work has begun on re-examining the

nature of scholarly publications as a result of the many new options opened up now that electronic publication has become economically feasible. The key question to be asked is just what is the structure of the most suitable hierarchy which will best satisfy the conflicting needs of the writer, the reader and the many levels of scholars.

Faculty of Law

Ms Margaret Bond

(tel 042 21 4378)

Margaret Bond is examining the appropriate test or standard to be applied by judicial officers in determining whether they are disqualified from sitting in proceedings by reason of bias or apprehended bias. The actual or apprehended bias or prejudice of mind can arise from conflicts of interest and duty, or as a consequence of prejudgment. The question of disqualification for bias has received a considerable amount of judicial attention (not all of it consistent) in the recent past. On a related matter, Margaret is considering the appropriate test or standard to be applied by officers of the Independent Commission Against Corruption in NSW (including the Commissioner) in determining whether they are disqualified from conducting an investigation by reason of bias or apprehended bias.

Mr Charles Chew

(tel 042 21 4379)

One of Charles Chew's major research projects is concerned with a comparison between the investment laws in Australia and Indonesia. Such a comparative study is useful pedagogically in throwing the outlines and details of our legal

system into sharper relief. It shows the limits Australian law sets in respect of a number of initiatives and guidelines in our foreign investment policies. It enables us to understand our own foreign investment laws and indeed our own legal system more objectively and encourages us to realise that the rules of our jurisdiction are not necessarily god-ordained and the inevitable embodiment of reason.

The other major study involves an investigation of the law of guarantee in our banking system. Much has been written about guarantees generally in our financial system but little research has focused on the banker's guarantee. There is an investigation of the effect of the recent Consumer Credit Code on bankers' guarantees in terms of disclosure requirements and indemnity against a minor. Avoidance of liability, misrepresentation and undue influence in connection with bankers' guarantees are other issues being looked at.

Mr Damien Considine (tel 042 21 3629)

The first stage of Damien Considine's research project involving investigation into the relationship between legal forms of business enterprise and specific sectors of the economy has resulted in articles in both international and national journals.

The second stage of this project is under way and will involve manipulation of ABS data and consideration of similar data from other countries. It is hoped that the outcome of these investigations will result in a better understanding of the process of choice when choosing a legal structure for a business enterprise. The third stage of this project will involve considerations of the relationship between the forms of association discussed in the first two stages. An example of this is to consider how a company deals with a partnership in legal terms.

Professor John Goldring (tel 042 21 3382)

Professor John Goldring, Foundation Dean and Professor of Law, has been examining the possible changes in methods of teaching law that may be needed as a result of changes in the structure and financing of Universities and changing demands for legal education. In an article, 'Coping with the Virtual Campus', to be published shortly in the *Legal Education Review*, he questions some assumptions about the use of technology in encouraging 'deep' approaches to learning.

Future students may 'telecommute' to a 'virtual campus'. New technologies already have a significant effect on opportunities for people to learn. While policies concentrate on providing places to school leavers and members of 'equity-targeted' groups, high demand for places in LLB courses means that many students with good school results cannot study law. Other potential law students do not decide to study law until late in life. Opportunities for part-time on-campus study are declining.

Open or distance learning courses may provide the only opportunity for many Australians to study law. Fees may be introduced for all second degrees, so graduates who wish to study law must find a mode of study which will allow them to stay in paid work.

A central question is whether open or distance learning delivers the same or similar learning outcomes of similar quality to full-time, on-campus, traditional legal education. Once the desired outcomes are articulated, some questions may be asked about the appropriateness of traditional styles and techniques of teaching and learning. If the traditional techniques and approaches are not yielding the desired outcomes as well as might be hoped, it is necessary to ask what changes might result from new approaches and techniques. Some techniques of distance education may improve on-campus learning.

Professor Goldring explores a number of related issues in this article.

Mr Scott Grattan (tel 042 21 4423)

Scott Grattan is examining the jurisdiction-selecting methodology employed in Australia, England and Canada in the resolution of multistate disputes. The focus is on choice of law tort and contract. A comparison is being made between the philosophical foundations of jurisdiction-selection and those of the American rule-selection methodologies of governmental interest analysis and the substantive law technique. The influence of rule-selection on judicial, legislative and law reform developments in the jurisdiction-selection tradition is being explored.

The purpose of the research is to ascertain the extent to which jurisdiction-selection is a viable and principled approach to the resolution of disputes arising from multistate activity.

Associate Professor Ken Hale (tel 042 21 3730)

Associate Professor Ken Hale was invited to prepare an entry on Human Rights and the Workplace for inclusion in the Human Rights volume of the *Law of Australia* which is scheduled for publication in early 1995. Work was substantially completed on this project, which arises out of the *Industrial Relations Reform Act 1993* (Commonwealth). It examines the use of International Instruments (International Labour Organisation and United Nations Conventions and Covenants) in Australian domestic law utilising the external affairs power in the Australian constitution.

Work continued on the Sex Discrimination in Employment Project, which is designed to identify and analyse the impacts discernible in the implemen-

INDIVIDUAL RESEARCHERS

tation and application of this relatively new law in the employment context.

Work also continued on the enhancement of the technology associated with The Australian Corporate Law Data Base Project. This research project was created and is maintained by Associate Professor Hale and Professor Jim Jackson (previously of the University of Wollongong and now Professor of Law and Foundation Dean of Law at Southern Cross University). It involves the application of computer technology to law and enables sophisticated research into the increasingly complex area of Australian corporate law. The data base contains an analysis of over 2500 cases and over 1000 articles on corporate law from all Australian jurisdictions. This covers all reported cases and all published journal articles on Australian corporate law since 1961. Selected cases and journal articles prior to 1961 which are still relevant and important are also included. The project has produced several major outcomes including books, journal articles and, importantly, an on-line computerised database of Australian corporate law. Once the new technology is in place, work will proceed towards the next edition of *The Australian Corporate Law Reference*.

**Associate Professor
Robin Handley**
(tel 042 21 3726)

Associate Professor Robin Handley, in conjunction with Ms Penny Pether (Law School, University of Sydney), is developing *A Critical Bibliography of Law and Literature*. This includes devising appropriate classifications, searching for relevant material, and preparation of a critical commentary.

Ms Jane Innes
(tel 042 21 4121)

Ms Jane Innes has been examining the legal response to social and technological change brought with the expanding use of broadcasting, computer and telecommunications technology. It looks at global responses to technological change and at international measures developed as a result of this change. It concentrates on the copyright aspects of intellectual property ownership and the general regulatory framework provided by the law in respect of ownership and control of information.

Ms Innes is also involved in a joint project with Professor Tim Turpin of the Centre for Research Studies which is partly funded by UNESCO. The legal component of the work involves a summary and compilation of the various intellectual property laws of China, the Philippines, Thailand and Korea. Existing legislation and legal systems are being examined in the context of the World Trade Agreement and obligations arising under the Trade Related Intellectual Property Agreement (the TRIPS). The policy implications of the new regulatory approach adopted under the TRIPS and the impact of this change on the various countries is being explored.

Mr Luke McNamara
(tel 042 21 4415)

Luke McNamara's major research project is a comparative study of racial vilification laws in Australia and Canada. This research examines the different approaches to the legal regulation of racial hatred which have been adopted in two 'multicultural' countries, with a view to assessing the adequacy of current responses to racially-motivated vilification, harassment, intimidation and violence.

The project compares the impact of criminal sanctions (drawing on the

Canadian experience) with the results achieved by other forms of intervention such as informal conciliation and determination by human rights tribunals. It also considers the relationship between racial vilification laws and official policies of multiculturalism.

An investigation of the operation of hate propaganda laws in Canada (including interviews with relevant departments, agencies and interest groups) was carried out in 1994 with the support of a Canadian Studies Faculty Research Award and a grant from the Law Foundation of New South Wales.

The current phase of the project focuses on the operation of racial vilification laws in New South Wales, as administered by the New South Wales Anti-Discrimination Board.

Other activities include continuing research on legal frameworks for Indigenous autonomy and co-editing (with Gerry Turcotte, Department of English) the multidisciplinary journal, *Australian-Canadian Studies*.

Ms Sandra Mercado
(tel 042 21 4291)

Sandra Mercado is currently exploring the content and scope of the right of political discussion in Australian law, particularly in relation to defamation and vilification laws, and in the context of a wider enquiry into access to information generally in the electronic age.

Dr Thomas Musgrave
(tel 042 21 4633)

Dr Thomas Musgrave is currently working on two pieces of research. The first involves a chapter on the status of refugees in International and Australian Law, which is to be published in a forthcoming text, entitled *International Law in the Australian Context*, edited by Professor

M Tsamenyi, Associate Professor S Blay and Dr R Piotrowicz. Secondly, Dr Musgrave has recently completed his PhD thesis, entitled 'Self-Determination and National Minorities', which has been accepted for publication by Oxford University Press, and he is now in the process of transforming the thesis into book form.

Faculty of Science

Department of Chemistry

Dr Audrey H Wilson
(tel 042 21 3155)

Chemical education

Interests include investigations of cognitive functioning in relation to performance in chemistry, effects of mode of presentation on successful problem-solving, methods of improving teaching and learning in a chemical context, gender-associated problems in science study and the improvement of University teaching quality.

Innovative interactive multimedia materials for pre-laboratory instruction were produced for use with first-year chemistry students as a result of a first-round CAUT grant. These provide an alternative to the more traditional print mode of presentation and submission. They were used during 1994 and evaluations carried out which involved soliciting student attitudes to the materials and student-favoured presentation mode and comparing teaching and learning outcomes from these two methods.

Investigations of gender-associated problems in science study have involved both first-year chemistry students at the University of Wollongong and high-school students in all states of Australia. They have resulted in data relating performance in

chemistry to student gender and gender of peers and of instructors. Work on this collected material is continuing. The high-school investigations are part of collaborative research with Charles Sturt University and the University of Western Sydney.

Some months during 1994 were spent on sabbatical leave in the United Kingdom. Many universities were visited and the interactive multimedia materials produced at the University of Wollongong were shared with them.

Department of Physics

Dr Jagdish Narain Mathur
(tel 042 21 3507)

In 1990 a Neutron Capture Therapy research group came into existence within the Physics Department. At present it consists of two postgraduate students, Martin Carolan and Steven Wallace, and myself. It was formed in collaboration with the Biomedicine and Health Program at Ansto. In 1993 the collaboration of Commission of the European Communities, Joint Research Centre, Petten, The Netherlands, and Paul Scherrer Institute, Villigen, Switzerland, was established. In my study leave in 1993, I visited both the research centres for about three weeks each.

Direct result of this collaboration was that MC and SW went to Petten in 1994 to do some vital measurements connected with Boron Neutron Capture Therapy (BNCT) using three phantoms. The best treatment of cancer would be a method in which all cancerous cells are killed without damaging the normal healthy tissues.

The BNCT is a treatment of cancer that comes very close to the above-mentioned goal. It also offers significant promise for the treatment of previously intractable cancers. The principle of BNCT is based upon the nuclear reaction between boron¹⁰, a non-radioactive isotope of boron, and

thermal (0.025 eV) or epithermal (2 -20 keV) neutrons. When a neutron is captured by boron¹⁰, the nucleus so formed fissions instantaneously into two fragments – lithium⁷ and an alpha particle. These fragments have a range in human tissue of approximately 10 micro meter, which is of the order of one cell diameter, with high linear energy transfer (LET). The treatment starts with first localising boron compounds in the tumour cells, then bombarding it with neutrons. The cells that have accumulated the boron compound will be destroyed and normal cells with low concentration of boron¹⁰ would be spared.

Boron Neutron Capture Therapy (BNCT) is still in experimental stage for the treatment of cancer. Activation foil measurements on existing filtered and unfiltered neutron beams have been made in preparation for the development of a beam suitable for normal tissue dose tolerance studies. Further measurement techniques for the characterisation of neutron beam energy spectra are under development.

Also under development is a treatment planning package, based on patient CT scans, utilising Monte Carlo neutron transport techniques on the Fujitsu super computer facility of Australian Numerical Simulation and Modelling Services (ANSAMS). Prototype models have already been installed and successfully run, computing dose distributions throughout the brain. Monte Carlo micro dosimetric simulations of radiation damage to microvasculature also make use of the ANSAMS supercomputer. This code when complete will enable clinicians to plan therapeutic neutron irradiations and determine dose distributions.

The ultimate goal is to develop filtered epithermal neutron beams and eventually design a patient treatment facility using the High Flux Australian Reactor at Lucas Heights or its replacement.

Dr Paul Nulsen

(tel 042 21 3523)

Clusters of galaxies consist of as many as several thousand galaxies plus hot gas, often exceeding the galaxies in total mass, bound together by gravity. A new technique to determine the distribution of mass in clusters was developed and applied by Dr H Boehringer (MPE Munich) and Nulsen to data from the ROSAT X-ray satellite to find the mass distribution of the Virgo cluster.

Gas near to the centres of many clusters cools by emitting X-rays, causing surrounding gas to move inward in a 'cooling flow'. Much is known about the structure of cooling flows in clusters, groups and, to a lesser extent, isolated elliptical galaxies. Professor A Fabian (Institute of Astronomy, Cambridge) and Nulsen showed that cooling flows can also occur during the formation of galaxies like our own. More recently, they have shown that a cooling flow forms major components of galaxies comparable in size to the Milky Way or larger.

The gas within clusters of galaxies is more extended than other cluster constituents, requiring that it be heated more than they are during cluster formation. P Maguire and Nulsen showed that the additional heat in a given mass of gas is about the same for a wide range of clusters.

Boehringer, Nulsen, Fabian and Dr R Braun (NFRA, Dwingeloo) compared radio structure near the centre of the giant elliptical galaxy M87 to the X-ray emission from there. The X-ray emission is strongest close to regions of strong radio emission. They showed that the enhanced emission is due to gas that is cooler and more dense than other gas nearby. The cool gas is produced when hot gas mixes with radio plasma, forming light bubbles which float up through the remaining gas. This process has important implication for the formation of the radio source.

Astronomy and Astrophysics

Associate Professor

Bill Zealey

(tel 042 21 3522)

Protostars and Jets

Mass outflow plays a major role in the early life of most Young Stellar Objects [YSOs]. Because YSOs are usually deeply embedded in molecular clouds, there is considerable interaction between their supersonic outflows and the ambient interstellar medium. The current understanding of the dynamics and emission mechanisms of outflows is rudimentary and is largely dominated by observations at visible wavelengths.

We are making a major contribution to the study of outflows by concentrating on infrared and radio mapping of outflows.

- **Survey and Image Catalogue of Outflows**

ESO/SERC Sky survey plates in J R and I bands were digitised by Stacy Mader, using our video digitising system. These images will form the basis of a catalogue of HH objects.

- **Large Field H₂ Survey and the mapping of low-velocity shocks**

The AAO's IRIS infrared imaging system is ideally suited to imaging four-arc-minute fields around outflows in infrared emission lines. We have now imaged more than 20 major outflow complexes in the southern sky in molecular emission. This survey is providing information on the molecular content and morphology of southern outflows considerably faster than could be achieved at millimetre wavelengths.

- **Radio Observations of Neutral Hydrogen Winds [21cm radio]**

HI emission has been observed in only a few flows. During 1994 we observed HI profiles from three outflows, using the Parkes radio telescope. We have observed features in HH46/HH47 and B335 consistent with neutral HI outflows

and have been scheduled time on the Australia Telescope National Facility's Compact Array in mid 1995 to obtain high-resolution maps of these neutral flows.

- **Millimetre observations**

During 1995 millimetre wave observations will begin on the ATNF's Mopra radio telescope. Observations of CO emission, planned for mid 1995, will provide a more complete view of neutral and low excitation material in and around the flows.

Experience gained with this single dish system will allow us to utilise similar receivers when they become available on the AT Compact Array.

Studies of the Surface of Venus

In 1990 NASA's Magellan spacecraft began to image Venus using radar. The availability of radar images on CD ROM and access to PC-based image analysis systems has allowed us to engage in planetary physics projects at an early stage of the Magellan mission. Graeme Melville completed his MSc on lava tubes in early 1994.

Work on identifying and modelling impact structures associated with oblique impacts on Mars and Venus is continuing. The Department of Physics now houses a complete set of CD ROMs containing radar imaging and altimetry data from the Magellan mission, and imagery from the Viking missions to Mars.

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