THE UNIVERSITY FACULTIES

ARTS
Department of English
Department of History & Politics
Department of Languages
Department of Philosophy
Department of Psychology
Department of Science and Technology Studies
Department of Sociology
School of Creative Arts

COMMERCe
Department of Accountancy & Legal Studies
Department of Economics
Department of Management
School of Industrial & Administrative Studies

EDUCATION
School of Policy & Technology Studies in Education
School of Learning Studies

ENGINEERING
Department of Civil & Mining Engineering
Department of Electrical & Computer Engineering
Department of Mechanical Engineering
Department of Metallurgy & Materials Engineering

MATHEMATICAL SCIENCES
Department of Computing Science
Department of Mathematics

SCIENCE
Department of Biology
Department of Chemistry
Department of Geography
Department of Geology
Department of Physics
School of Health Sciences

THE CENTRES OF RESEARCH

Automation & Engineering Applications Centre
Centre for Applied Biology
Bulk Materials Handling Division
Microwave Applications Research Centre
Centre for Mining Research
New Literatures in English Research Centre
Centre for Multicultural Studies
Centre for Studies in Literacy
Centre for Technology & Social Change
Centre for Transport Policy Analysis
Centre for Work & Labour Market Studies
Arms of the University

The principal elements incorporated in the arms of the University are the blue of the sea, the gold of the sand and the red of the Illawarra flame tree. The open book often used for educational institutions is also included. The blazon is: Azure an open book proper bound gold on a chief wavy of three cinquefoils gules.

THE UNIVERSITY OF WOLLONGONG
Research Report
1987-88
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INTRODUCTION

A significant and dramatic upsurge in research activity at The University of Wollongong has highlighted the University's growth in recent years. From a relatively small institution in the early eighties to one that is now in the middle range of Australia's 21 universities, Wollongong has a current enrolment of around 8,000 students.

The growth in research activity can be seen in two examples: in the statistics, which show that the numbers of Doctor of Philosophy candidates enrolled at the University has more than doubled in the past five years, and in the accounts, which show that the amount of identifiable research expenditure by the University, its research centres and its associated consultancy companies has more than doubled in the past three years to an anticipated expenditure in 1988 of almost $6,000,000.

Much of the credit for stimulating this growth and for nurturing an appropriate environment for research must go to the Board of Research and Postgraduate Studies, which the University established in 1986. The policies put in place by the Board in recent times are beginning to pay dividends through the increased activity and the University's ability to be able to attract more and more funds for its research programs.

These policies, together with the calibre of the academic staff, who are highly qualified, energetic, enthusiastic and relatively young, will ensure that this growth will continue well into the future.

I am pleased to be able to present this Report of some of the research activities currently being undertaken at the University. Unfortunately, it has not been possible to include them all; there are, of course, many more.

I extend an invitation to readers to contact the University about any of the activities presented in this Report and to visit the campus, which is widely regarded as one of the most picturesque higher-education campuses in Australia.


Ken McKinnon,
Vice-Chancellor,
August 1988.
Research students – PhD/Doctorate

Enrolled students

Identifiable research expenditure

$'000s

(*) Figures for 1988 are estimates.

Associated Consultancy Company. Represents funds generated through the University's consulting arm, Wollongong Uniadvice Ltd.

Research Grants: Includes grants from Australian Research Grants Scheme; National Health & Medical Research Council; National Energy Research, Development & Demonstration Program; and other external sources. This figure does not include the University's own research funding.
Over the past few years The University of Wollongong has undergone a period of rapid expansion in student numbers. In the Faculty of Science this has coincided with the retirement of several staff members who joined the University in its early years. The filling of both these expansion and replacement positions at a time when other universities were contracting has seen the Faculty enjoy an influx of very-high-quality academic staff who are now becoming established and are beginning to display their real potential. Although this has strained the Faculty’s resources, the provision of shrewdly directed University seeding grants, coupled with substantial input of external finance, has enabled all the new scientists to get a high degree of research flowing.

SOME newcomers, such as Professor Helen Garnett, Professor of Biology, came with established international reputations and brought the nucleus of research groups with them. Professor Garnett has reorganised the Biology Department into a highly effective unit for both teaching and research and has begun industrial co-operative work in the area of cell and molecular biology, particularly applying these techniques to the detection of pathogens of man, animals and plants in the environment. Environmental biology is another area where contract research is currently being undertaken, particularly the effect of disturbance on water quality in the catchment areas near Wollongong.

The acquisition of space for an Organism Growth Facility at Campus East will give a much needed boost to research as well as teaching in the many areas which will use these facilities. This will enable not only Biology but also many other departments to undertake longer-term studies of plant and animal development, including aquatic organisms, often with industrial significance and interest.

Three important projects on marine organisms are currently underway. For the past three years, Dr David Ayre has been undertaking the first major study of genetic variation within and among coral reefs. This Marine Science and Technology (MST) funded project will have major implications for the
management of the Great Barrier Reef.

Associate Professor Ross Lilley, in collaboration with CSIRO Division of Fisheries Research in Hobart, has succeeded in unravelling, for the first time, some of the photosynthetic processes in two important phytoplankton, these organisms being the starting point of food chains in the ocean.

Dr Mary Garson (Chemistry) is collecting and studying particular types of sea organisms, such as limpets and sponges, which show the ability to produce defensive chemicals when under threat. These defensive agents are being identified and tested for anti-tumour and anti-viral activity.

It is envisaged that many more such studies will be undertaken now that the facilities will be available.

As the oil resources of this country diminish, the coal-mining industry will once again begin to make an increasingly important contribution to the economic stability of both Australia and the Illawarra region. In line with this the Department of Geology is concentrating its research effort into the areas of economic geology with a special emphasis on the geology and use of fossil fuels.

Studies of superconducting materials is another area which is not only of great significance but is one which captures the public imagination. It is pleasing to see the solid state research group of the Department of Physics researching in this area.

The Thermoluminescence laboratory of the Department of Geography has played a major role in the Department's investigations into the age of some of Australia's oldest locations of human
habitation. New appointments in remote-sensing techniques and the continuing work on river erosion and related problems have seen the emergence of a strong environmentally orientated Physical Geography section. This is expected to play an increasingly important role in the Faculty's research effort in the future, often in areas which have a high degree of community interest and on topics which get wide and popular coverage.

The outstanding example of self-starting co-operation with industry in this Faculty has to be the initiative shown by Dr Gordon Wallace who joined the Chemistry Department at the end of 1985. Since his arrival, Dr Wallace has attracted over half a million dollars in financial support from industry, commerce, and external funding agencies and at present his research group employs 14 people. This level of industrial support is normally given only to groups directly solving specific problems for particular industries but in this case it is the form of direct support for Dr Wallace's exciting work on the production and development of new 'intelligent materials' (see article on page 10).

Department of Biology

Molecular Biology

Understanding algae

The new projects initiated in the Department of Biology since the arrival of Professor Garnett—the pathobiology of human cytomegalovirus and studies on citrus greening—rely heavily on techniques of molecular biology. The development of facilities for molecular biology achieved during 1987 will benefit many of the other research projects in the Faculty of Science.

Photosynthesis in open ocean phytoplankton is poorly understood in comparison with land plants. This is largely because of difficulties in culturing both these organisms in the laboratory, and in extracting from them protein and membrane fractions that retain their biological activities.

Phytoplankton collectively are responsible for a significant proportion of global synthesis and are the starting point of a network of food chains that support fish and other marine organisms harvested by man.

In research supported by a joint CSIRO/University of Wollongong grant, Dr Ross Lilley and Mrs Kerry Gilmore of the Department of Biology, and Dr Grahame Kelly of CSIRO Division Fisheries research, Hobart, have selected two phytoplankton species, a dinoflagellate and a diatom, which are amenable to laboratory culture and experimentation. They developed a new method for extracting membranes and proteins from these cells. This has permitted, for the first time, photosynthetic electron transport to be studied in vitro with extracted membranes at rates similar to those of whole cells.

Under investigation is the unknown regulatory mechanism that links glycerol synthesis to the external salinity. The current research has now identified an enzyme, glycerol 3-phosphate dehydrogenase, as the probable site of this control mechanism. It has been demonstrated that this enzyme, which catalyses the first step of glycerol synthesis, is normally inhibited but this inhibition is released by salt stress resulting in an increase in the glycerol content of the cells. This research will contribute to industrial culture of algae.

Terrestrial Ecology

A six-year, ARGS-funded study of competition among Banksia species for pollination continues, with the setting up of large-scale field experiments. The study has involved two postgraduate students, Ms Sue Carthew and Mr Brian Copland. A research grant from the Australian Flora Foundation to Dr Rob Whelan and Mr Ross Goldingay, one of the Biology Department's PhD students, has permitted the expansion of this study to include Waratah, the NSW State floral emblem.

In 1988, an important expansion of
this research was made with ARGs funding for a Research Associate on a joint grant to Dr David Ayre (ecological genetics) and Dr Rob Whelan (ecology). This project aims to investigate the genetic consequences of different mating systems in plant populations. Also during 1987-88, ecological research expanded into the more applied field of environmental biology, with the establishment of a research project, conducted by Dr Ros Muston (CABR) and Dr Rob Whelan, investigating the ecological factors which have been inhibiting regeneration of native vegetation in the old orchard sites resumed by the Water Board many decades ago. This study has been supported by the Water Board and by a grant from The University of Wollongong. Research into the ecology of the Yellow-bellied Glider on the NSW south coast has been conducted by Mr Ross Goldingay. With support from the Edith and Joy London Foundation and the Forestry Commission, this study has involved radio tracking of gliders within their home ranges and detailed analyses of their diet choices and activity patterns. The results of the current studies at Kioloa will be contrasted with those of previous studies in the tall forests of the Bombala region.

Managing the Great Barrier Reef
During the 1987-88 period Dr David Ayre has completed most of the data collection and preliminary analyses for the first major study of genetic variation within and among coral reefs. This MST-funded project, to be completed in 1988, will have major implications for the management of the Great Barrier Reef.

Dr Ayre also initiated a series of long-term experiments designed to assess the factors determining the genetic structure of populations of a clonal sea anemone and has begun a collaborative study (with P. J. Whelan) of the genetic consequences of plasticity of mating systems in Banksia.

These ARGc funded projects will utilise a variety of genetic, ecological, behavioural and physiological approaches in order to investigate the evolution of two very different sets of life-histories.

Defining 'citrus greening'
A research project Professor Garnett had been involved with before coming to Wollongong has achieved considerable success over the past year. This research has been aimed at defining the aetiology of citrus greening, a severe disease of citrus in Africa and Asia. The disease has not been reported in Australia or the USA and it is important that rapid diagnostic procedures are developed to facilitate quarantine inspections in these countries. More importantly, rapidly diagnostic tests are required to determine the epidemiology of the disease in affected areas and hence limit its spread.

Professor Garnett's team has developed an antibody-based test, which is showing great promise to detect the pathogen in plant materials. In collaboration with scientists at the USDA in Beltsville, USA, and the University of Florida, long-term studies have been initiated under quarantine conditions in the USA to study the disease and to improve its diagnosis. The Food and Agriculture Organization of the United Nations (FAO) is funding this collaborative project.

In December 1987 Professor Garnett spent nine days in China and five days in Malaysia for the United Nations Development Program assisting scientists in these countries to establish research programs to study further the aetiological agent of 'greening'.

Department of Chemistry

Senile cataract
Senile cataract is a common disease in elderly people. It is characterised by a clouding of the lens of the eye. This impairs vision and can lead to blindness.

There is at present no known way of preventing cataract and no cure other than surgical removal of the lens.

Approximately 80 per cent of all people aged 65 and over have some form of cataract.

More than 500,000 cataract operations are performed each year in the USA. Each operation costs between $10,000 and $15,000.

The National Institute of Health (USA) estimates that if a therapy could be discovered which simply delayed the need for surgery by ten years, the cost saving would be in excess of US$600 million a year in medical costs alone.

With an increasing proportion of elderly people in the population this disease will assume even greater importance in the future.

Current research
Dr Truscott's laboratory in the Chemistry Department at Wollongong is the only one in Australia which is seeking to discover the cause of senile cataract. The basic approach is to compare normal and cataract human lenses at the molecular level. Some of the research is performed in collaboration with Dr Stephen Pyne's group in the Department of Chemistry. This group has expertise in Organic Synthesis and Structure elucidation by NMR — Nuclear Magnetic Resonance spectrometer.

Close links are maintained with the Department of Clinical Ophthalmology, The University of Sydney, and the Save Sight and Eye Health Institute headed by Professor Frank Billson.

Human lenses are provided by the Sydney Eye Hospital and the Illawarra Private Hospital.

The research on senile nuclear cataract is supported by a grant from the National Health and Medical Research Council (NHMRC) of Australia.
Dr Roger Truscott’s work in the Department of Chemistry on the improvement of the quality of rapeseed in China is a splendid example of co-operation with industry on an international scale. China is the world’s largest producer of rapeseed, which is primarily used as a basis for cooking oils.

Dr Truscott’s team has devised a chemical test for the presence of toxic materials in the rapeseed and then developed this, in co-operation with local industry, into a simple but effective measuring instrument.

This research has been funded by the Australian Centre for International Agricultural Research to the extent of $266,000 over a three-year period. Dr Truscott has now combined with other recent arrivals, Dr Mary Garson and Dr Stephen Pyne, in forming the Biological Organic Research group. We may confidently look forward to major advances in organic research from this coterie of dynamic young scientists.

Intelligent materials

A new material may be defined as a solid with unique chemical and/or physical properties. In recent years the engineering world has accelerated the search for stronger, lighter more corrosion-resistant materials. New materials for use in biotechnology and communications have also been vigorously sought.

As a result of this, a wealth of information on new materials has appeared in the scientific literature and at least two challenges to those involved in the analytical sciences have resulted. One involves the analytical characterisation of new materials; the other involves the utilisation of such materials in practical analytical devices.

The chemical analysis of new materials containing trace constituents remains a demanding area where the results are critical to the design of future materials. The design of intelligent materials, capable of operating as sensors, sample pretreatment devices, or chromatographic resins, is now feasible and the challenge to develop practical devices suitable for the marketplace is now in place.

In the course of research work in the Chemistry Department over recent years expertise in the synthesis characterisation and application of new materials has been developed.

We have, for example, synthesised a range of conductive and non-conductive coatings on substrates as diverse as platinum, plastic films, metal foams, quartz fibre optics and glass.

Polymeric materials containing enzymes, antibodies, electrocatalysts, corrosion inhibitors, complexing agents and other chemically active species have been prepared. Synthesis of polymeric layers or copolymers is easily achieved. Devices capable of releasing these reagents under chemical or electrochemical control have been developed.

The research group now has a range of facilities and the expertise necessary to carry out characterisation of these new materials.

These facilities include state-of-the-art electrochemical instrumentation, allowing voltammetric or potentiometric analyses to be carried out. Scanning electron microscopy and electron probe microanalysis are used routinely. Fourier Transform infra-red spectroscopy is available. So, too, is thermal gravimetric analysis.

A technique which enables direct insertion fast-atom bombardment mass spectrometry to be employed has been evolved.

A range of chemical sensors suitable for use in both the gas phase and in solution has been developed. The sensors containing intelligent materials are capable of recognising specific chemicals or biochemicals in the sample matrix. The sensors can then carry out a chemical derivatisation, if necessary, and generate an optical or electrochemical signal.

Devices capable of selective analyte preconcentration while retaining maximum chemical information, or suitable for electrochemically controlled release of reagents have also been developed.

A range of chromatographic stationary phases capable of reversed phase ion exchange and even gas chromatographic separation has been developed. The properties of the polymeric stationary phases can be reversibly altered during the chromatographic separation runs.

Ongoing research includes work which is aimed towards developing a range of intelligent materials for use as gas sensors, biosensors, water treatment, chemicals or corrosion inhibitors.

Developing anti-cancer AIDS-fighting drugs from the sea

A chemical found in a sea sponge has already provided the clue scientists needed to develop AZT, the anti-AIDS drug now being tested world-wide.

A Caribbean tunicate (or sea-squirt) has yielded a chemical which is now in its second phase of clinical trials in the USA as an anti-tumour agent.

Wollongong University lecturer in organic chemistry, Dr Mary Garson, believes the chances are high that a batch of specimens containing 116 simple sea creatures and plants, collected recently in the waters of the Illawarra, could contain the anti-cancer breakthrough researchers have been seeking to find why marine organisms appear to escape that most dreaded of diseases.

The Australian marine samples are among those the National Cancer Institute, Washington, is using (from all over the world) to carry out some 20 million preliminary tests annually.

A $3,000 grant from the Leo and Jenny Leukaemia and Cancer Foundation has been used specifically to try to track down possible AIDS and cancer-fighting chemicals.
Atmospheric Chemistry
Fourier Transform Infrared Spectroscopy

Issues such as the greenhouse effect and stratospheric ozone have recently drawn attention to the fact that our present understanding of atmospheric chemistry is not enough to judge reliably these issues and make reliable long-term assessments of man's impact on his environment. Understanding atmospheric chemistry requires a thorough knowledge of the composition of the atmosphere and of the budgets and chemistry of its constituent species. The Department of Chemistry's research effort is thus concentrated on measurements of atmospheric composition and of the sources of chemical species in the atmosphere.

While it has long been recognised that fossil fuel combustion—currently ca. 5 trillion (i.e. $5 \times 10^{12}$) tons per year—is responsible for the increasing atmospheric carbon dioxide levels, it has only recently been realised that the annual combustion of biomass other than fossil fuel consumes a comparable amount of matter, ca. 4 trillion tons a year. Among the major contributors are shifting agriculture and deforestation in the third world and the burning of agricultural wastes. It is thus essential to our knowledge of global atmospheric chemistry to characterise biomass fires in terms of their outputs of chemical species to the atmosphere and their effects on the global budgets of these species. On a more local scale, too, characterisation of bushfire emissions in Australia is important in assessing their environmental and ecological effects on the land and its inhabitants.

Studies of the trace gas composition of flames and plumes of biomass fires are made principally using a state-of-the-art Bomem DA3.26 Fourier transform infrared (FTIR) spectrometer installed in May 1987. The Department has developed a new analysis technique based on Matrix Isolation Spectroscopy, which is able to make simultaneous measurements of a wide range of species with detection limits of around 20 parts per trillion. Samples are collected and analysed cryogenically to prevent reactions in the sample mixture and to enhance sensitivity and selectivity.

Part of the thrust of the research is also to exhibit the high sensitivity and broad applicability of FTIR spectroscopy in new applications for trace gas analysis. To this end, the Department is also looking into FTIR emission spectroscopy for monitoring combustion processes remotely in flames and plumes (including biomass fires), and into its application in so-called 'hyphenated' techniques of FTIR with chromatography, thermal analysis and other analytical methods.

Department of Geography
Thermoluminescence (TL) dating

Complementing other types of late Quaternary dating, the dating reveals the enormous changes to Australia's climatic and fluvial environments in the past 300,000 years.

The Department's newly acquired TL laboratory is working closely with the low-radiation laboratory at Lucas Heights (ANSTO) to reveal Australia's history of climate and

Thermoluminescence dating by the Department of Geography has shown that humans were widely distributed throughout Australia some 40,000 years ago. With the new TL dating apparatus is Mr David Price
flow-regime changes, and to elucidate the processes and rates of soil formation on Quaternary landforms over the past 300,000 years. It has been shown that TL and uranium-thorium dating can together identify when climate in the past changed and whether these changes were in the direction of greater aridity or greater humidity. The research work has shown from TL dating and detailed stratigraphic work that river systems in the semi-arid Eyre Basin responded to the world’s major glacial episodes by forming vast sand-transporting channels 240,000 and 110,000 years ago. During the interglacials these systems switched to mud-transporting channels, indicative of more arid conditions.

**Catastrophism or gradualism?**

Recent work on the rivers of eastern Australia has shown that they are subject to catastrophic erosional events that are cataclysmic in terms of their impact on river valleys and floodplains. These events are largely beyond the comprehension of the continent’s European inhabitants who have a historical experience of only 200 years of natural events in this environment.

This research contradicts overseas work which argues that most rivers change gradually in response to many relatively small floods, each instituting incremental change over relatively long periods. These Australian rivers undergo enormous change in the course of one or two catastrophic events and then remain largely unchanged for thousands of years.

**The ‘greenhouse effect’**

A detailed quantitative study of world temperature and sea-level trends has shown that, while the level of CO₂ is definitely increasing in the atmosphere, there is no clear evidence that world temperatures and sea levels are rising in response. Indeed, it has been shown that for several decades sea levels have in many places been falling. Moreover, the temperate variations are known to be within the normal variations about a long-term steady-state average. While doomsday predictions of the ‘greenhouse effect’ may well be true, there is, as yet, no evidence to support them.

**Department of Physics**

**Astronomy and astrophysics**

Astronomy and astrophysics is one of the most internationally prestigious areas of research. It is a field in which Australia has made significant contributions. The instrumentation and techniques developed to carry out this type of research have application in many other areas. The Astronomy and Astrophysics group is active in observational and theoretical programs of research which utilise national and international facilities, and in the development of instrumentation.

**Instrument development**

The instrument development program is geared to the in-house research projects. These depend heavily on digital image analysis. To this end a PC-Vision image-digitising system has been installed. This forms the basis of an imaging facility which will have applications not only in astronomy but also in radiography, materials science and other semi-industrial areas. Use has already been made of the system for analysis of forest canopy images in work being carried out by Barry Harper for AICOA.

As part of a second phase of development, assembly has begun of a state-of-the-art CCD-based measuring machine. During the course of the electronics development for this system, a 1-D, 1024 pixel detector was integrated into a spectral analysis system suitable for laboratory use.

Four staff members and two postgraduate students are currently engaged in this work. The background of the Astronomy and Astrophysics group’s members has led to the establishment of a pool of expertise which spreads considerably beyond pure research. In particular the involvement in imaging and detector technology provides a basis for third-year and honours courses. A considerable background in image analysis software also exists.

**Stars, jets and shocks**

Young stars are born in dense, cold clouds of gas and dust. Much of the sun’s own primordial cloud may still be observed in the form of comets and asteroids. Before 1980 the collapse and heating of these clouds was thought to be an orderly and quiet affair. More recently, as astronomers have turned infrared, radio and x-ray telescopes towards these regions, our view of star formation has undergone a revolution.

Recent observations have shown that for their first 10,000 years stars...
produce giant, supersonic winds which blast out into surrounding space. In their early life they may lose as much as one tenth of their total mass. Such huge winds churn up the surroundings of the star, exciting gas in fast-moving shocks (ten times the speed of sound or greater). This excited gas emits very characteristic radiation which provides information on the temperature and conditions of the disturbed gas.

A complete study of the winds requires an understanding of the cooler, molecular material which makes up a large part of interstellar space. This requires making infrared observations of stellar nurseries.

For the first time, a group which includes astrophysicists from Wollongong, the United Kingdom and West Germany have mapped the stellar winds both in the visible and the infrared emission from molecular hydrogen. Using detailed maps and velocity information on the emission they have shown that almost all the infrared emission comes from the tip or working surface of the wind.

Molecules are shock heated as they are swept up by the working surface as it advances into the surrounding gas at velocities of up to 300,000 km/hr. Although this research is of purest sort, the techniques used in the observations, analysis and interpretation are directly applicable to day-by-day problems in industry. As such, astrophysics provides an exciting framework in which to set and provide a linking theme between many of the fundamental problems in Physics.

Solid state spectroscopy

Current high technology is heavily dependent on semiconductor physics. The solid-state activity in the Physics Department is almost entirely in this area. But apart from the technical importance of semiconductors, a significant amount of fundamental understanding of solids can be obtained by studying these materials. Six staff members, two research-funded staff, four PhD students and one Honours student are involved in this program.

Piezo-Zeeman and Piezospectroscopic Studies of Shallow Acceptors in Germanium

Observations have been made of the Zeeman effect of the stress-induced components of the spectral lines of group III impurities in germanium. Very detailed measurements have also been made of the effect of uniaxial compression on the prominent C line of gallium in germanium. This work has resolved a long-standing problem with the interpretation of the origin of this transition.

Photoluminescence and light scattering

Impurities and defects unintentionally incorporated into semiconductor materials, such as silicon and gallium arsenide, are well known to cause degradation in the performance of many types of electronic and opto-electronic devices. Using low-temperature photoluminescence spectroscopy, investigations on hydrogen plasma passivation of such impurities and defects are being carried out in collaboration with researchers at ANSTO, Lucas Heights Research Laboratories and at CSIRO, Division of Radiophysics. It has been possible to confirm substantial hydrogen-plasma-induced suppression of the activity of many distinct chemical and structural defect types which can be identified in the luminescence spectra.

Optical properties of semiconductor layered structures

A program recently begun uses luminescence spectroscopy and other optical techniques to study and characterise properties of special very-thin-layered semiconductor structures, such as those produced from gallium- and aluminium-arsenide by recently perfected molecular beam epitaxy. Electronic devices with almost any conceivable characteristic may be tailored. These 'engineered' new semiconductor materials, which may include quantum wells, barriers and sharp interfaces within the crystal, are finding application in devices for high performance electronics and for opto-electronics communications technology.
School of Health Sciences

In an area with a high degree of community involvement is that of Health Sciences. The development of a health atlas of the Illawarra region, the location of retirement villages, the standard of fitness of fire fighters, the minimisation of greater time for stopping. As in the shoe design and playing surfaces involved in landing has led to basketball studies, a video is being made to improve landing technique, specific recommendations being produced to educate coaches regarding the key factors to be considered in decreasing the potential of players for incurring lower limb injuries. The sports of rugby union and rugby league have also produced a number of unfortunate neck injuries, particularly during scrummaging. An analysis of the forces emanating from rugby union scrummaging shows that they can exceed the threshold for serious injury in the spine. It has been demonstrated by the research that adoption of a hip binding technique reduces the vertical forces acting on the front row and therefore reduces the likelihood of the scrum collapsing and injuring any of the participating players.

As a result of the close association between the Illawarra Academy of Sport and the centre, particular attention is also being given to devising suitable physiological tests for young athletes.

Community Health

Community Health and Health Promotion are high priorities within the health care system in the 1980s. A 'new public health' concept is increasingly employed to define the factors which influence a community's health status. The new public health recognises the importance of social, cultural and economic factors as well as personal and environmental factors as potential sources of ill-health or disease. Accompanying this recognition of a broadened definition of health is the recognition that maintaining a community's health is the responsibility not just of the individuals within the community or of the health care system but of all the groups and authorities within a community who constitute the social system.

The School of Health Sciences intends to adopt this concept of public and community health as the central philosophy of its teaching and research efforts in Community Health. Graduate degree programs in Community Health are being planned and a major research and development initiative is under way in collaboration with the Illawarra Area Health Service.

This initiative follows a model developed by the World Health Organization and piloted in Europe. It is called the Healthy Cities Project and its goals are to improve the health of cities through the operation of certain principles incorporating community participation and co-operation among various government, private and community agencies to promote health. This project will provide a context and a platform for teaching and research in community health.

Members of the School of Health Sciences who are responsible for developing these programs in Community Health are Professor Dennis Calvert, Head of the School, and Associate Professor Christine Ewan, who is the first conjoint appointee of the University and the Illawarra Area Health Service.
Members of Arts faculties have been traditionally concerned with beauty and truth, since they are what distinguish a civilised life from a mere existence. In the School of Creative Arts, staff members are currently concerned with musical composition, the construction of a large sculpture that symbolises images of flight, the production of an opera for children, and (in conjunction with the Department of English) the regular production of drama through Theatre South. In the Department of Languages a scholar researches the civilisation of Milan in the Renaissance of the 14th and 15th centuries. In the Departments of Psychology and Philosophy others speculate on the possibility of self-deception, and work on other problems relating to the philosophy of the mind.

In terms of research the division between the practical and the impractical is artificial and often deceptive. Research that is dismissed as impractical often becomes fertile in another context. The Department of Philosophy’s research on the philosophy of the mind links directly with the work on artificial intelligence, and thus with the theory by which the operation of the computer is improved. Other work on research into ethics relates directly to the urgently practical problems involved with technical advances in, for example, in-vitro fertilisation. Is this the kind of technology that should be applied, and if so, under what conditions? What are the human rights of donors, surrogates, and the child? From its own theoretical perspective, the Department of Sociology is also researching this problem.

So scholarship which draws on the impractical speculation of centuries now has an urgent application. The same is true of research done in other departments, and in the Centre for Multicultural Studies. These researchers draw on a variety of disciplines to advise on solving problems that have resulted from the vastly expanded multicultural programs of immigration of the past 40 years. The Faculty’s interest in the interaction between peoples of different cultures does not stop at the Australian shoreline. One of the most successful projects of the Department of English has been in research into the new literatures of the peoples in the countries to Australia’s north. This research is concerned not simply with the technical issues connected with the growth of national literatures but also with the development of insights into the changes that have occurred in the societies of our northern neighbours. In this sense, it is an important complement to research work in the Department of History and Politics. This Department has for some time had a national reputation for its research into labour history. That research continues vigorously. But in the past few years, the Department has begun to intensify its research into the history and politics of South-east Asia, and the developing nations of the south-west pacific. The Department looks forward to the melding of these two streams of research, and plans a practical outcome in the teaching of Australian studies to students from Asia and South-east Asia in a ‘Winter School’ it is preparing to organise for 1989.

Other Departments’ research programs have more immediate and directly applicable results. The Department of Psychology has concentrated some of its resources into resolving the mental and physical mechanisms of reading, especially as they relate to reading disability. Other scholars in the Department are working on the role of psychotherapy in physical illness, and on the way children learn to make moral judgments.

Research in the Department of Science and Technology Studies concentrates on bioscience and on the management of information and communication technology. In combination with the internationally known Centre for Study of Technological and Social

**Significant Research Project**

Dr J. Rolin Ianziti and Dr B. N. McCarthy in the Department of Languages have signed a contract with the publishers Holt, Rinehart and Winston to prepare an American edition of their second and third French textbook _Et a votre avis…?_ It is unusual for a major American publisher to adopt a methodology devised outside of the United States and indicates the importance of the authors’ research. _Et a votre avis…?_ was developed during a two-year research project funded by a University of Wollongong grant. It is based on the most current trends in applied linguistic methodology which emphasise the role of the student in the learning process. The Australian version is currently being used in several universities. It is expected that the American version will appear in 1989.
Change, the Department houses academics with the largest concentration of skills in the analysis of the effects of change on society in science and technology in the entire Asia-Pacific region. It meets a rapidly increasing demand from both public and private sectors for courses which will equip students with the skills necessary to manage scientific and technological innovation.

The Department of Sociology shares this interest and some of its research programs have had immediate and highly practical results. Not long ago, researchers in the Department conducted a program into the impact of technological change to the Australian insurance industry.

While the research demonstrated an immediate gain in real profit, it also showed that the changes had weakened the corporate culture of the organisation in a way that would lessen firms' ability to compete. The research helped companies to make decisions about immediately practical questions.

And that takes us back to our first theme, and a variation on it. The longer-term consequences of technological change in the insurance industry became predictable only because new work had been done on the theoretical relations between technology and cultural changes. It is not simply that the distinction between the practical and the impractical is deceptive; without continuing research on impractical matters like theory, practical application will itself yield deceptive results.

Research work in the Faculty of Arts does have immediate practical application. Its success depends on the continuation of research into theory and the unrestricted pursuit of ideas. The Faculty's size and its organisation are matched to encourage this union across Departments as well as within them. The Faculty has built a reputation for thoughtful innovation in research and looks forward to opportunities which it can take to add to its record.

IVF and Bioethics

In keeping with a Sociology Department priority on pairing theory development with practical application, Rebecca Albury published significant work on the IVF debate in Australia. Simultaneously, with members of the NSW Women's Advisory Council Working Party on Reproductive Technologies, she presented submissions on bioethics to the Australian Minister of Community Services and Health, and to the NSW Law Reform Commission. Furthermore, Ms Albury was nominated on to the prestigious National Bioethics Consultative Committee.

Department of English

A new research interest in the Department of English is in the area of Cultural Studies in which Dr. Anne Cranny-Francis has been publishing articles on contemporary genre fiction (the work of S. M. Charnas, feminist science fiction; feminist detective fiction), on media (the interpretation of film and television), and on 19th century popular fiction (Bram Stoker, Arthur Conan Doyle). From this research base she has developed courses in Fantasy, Gender and Genre and Utopian and Anti-Utopian Literature.

Dr Cranny-Francis's work on the coding of gender in fiction is the basis of two books: Feminist Fiction, which analyses the feminist rewriting of popular fiction genres, and which will be published this year by Polity Press, Cambridge; and Engendered Fiction which analyses the coding of gender in a variety of cultural products, from comic books to film and literature, and which will be published in 1989 by the University of New South Wales Press. The terminology used by the medical profession in 16th century England is being researched by Mr. R. W. McConchie. The words used by a science determine to some extent the direction of the development of that science through the lexical circumscript of conceptualisation. The 16th century was particularly important in this respect, since the medical lexicon was expanding rapidly, and many of its technical terms were being assimilated into the general word-stock of early modern English. This work also has consequences for modern lexicography, and it has focused attention on the compilation of the Oxford English Dictionary. The reliability of this dictionary is usually taken for granted by scholars, but work on earlier periods in English has shown that as many as 100,000 of its main entries may be deficient in some respect. The nature of dictionaries and the role they play in our society as a database is insufficiently questioned. It is hoped that it will eventually become possible to offer a course in lexicography in the English department.

Department of Philosophy

Philosophy is inescapable. All social institutions, from the most highly organised and regimented State, to the most informally instituted day-by-day living arrangements of ordinary people, are in a sense, answer to philosophical questions. Bringing these questions to the surface, articulating them, and exploring other possible answers, are all part of the business of the philosopher.

In 1987 a major and original study of the theory that the State derives its legitimacy from the consent of
the governed was published by Aberdeen University Press. Entitled The Consent Theory of Political Obligation, its author is Dr Harry Beran, a Senior Lecturer in Philosophy. He is currently conducting research on separatism, one of the main causes of war, with the aim of developing a theory as to which groups have a moral right to self-determination. He is considering whether and how a coherent and plausible theory can be developed, consistent with democratic principles.

Social and political philosophical questions are inseparable from questions to do with the nature of the human person, and the justification of personal conduct. Many human failings are popularly attributed to 'weakness of will'. In 1987 Dr Robert Dunn's The Possibility of Weakness of Will was published by Hackett. This book embodies the work for which Dr Dunn was awarded the Johnsonian Prize in Philosophy, the first Australian to win this prestigious internationally competitive award, governed by the New York based Journal of Philosophy.

Dr Dunn is now conducting research for a sequel dealing with belief, and especially the question of the possibility of self-deception, a familiar notion which nonetheless generates obvious paradoxes. Dr Karen Neander is also probing the nature of mind, but her starting point is the birth of artificial intelligence. She is currently developing a three-year research project, which will culminate in a book exploring questions in the philosophy of mind posed by work in artificial intelligence. Does it mean we must revise our conception of what it is to be human?

The question of what it is to be human, and of what it is that is valuable about human life, is one of several posed with increasing urgency by the rapid expansion of research in the area of in vitro fertilisation. Many of the more controversial aspects of this research have been defended as leading to ways of overcoming the disappointment of couples otherwise unable to have children. But is there a right to reproduce? And if so, is it of such significance that scarce medical resources should be allocated to enabling all who would otherwise be unable to have children to do so? The question of whether there is a right to reproduce has been taken up by Ms Suzanne Uniacke, in an article in the first volume of the first internationally refereed learned journal to specialise in the newly emerging field of Bioethics. Philosophical questions are precisely those which cannot be answered by observation or experiment, and for that reason philosophers have a very special interest in analysis, and in theories of meaning, interpretation, implication, and support—or logic in the broadest sense. Dr Barbara Davidson's work on probability and evidentiary support has had considerable impact in the legal world, while Professor Lauchlan Chipman's work on deductive and non-deductive support in legal decision-making now forms part of the postgraduate coursework in the LL.M program at Sydney University Law School.

Questions of the interpretation of texts arise in all disciplines, but they have a special centrality in both the study of law and the study of fine literature, studies that traditionally would not have been placed together. Dr David Simpson has been investigating the relevance of the work of a selection of recent and contemporary philosophers outside the analytic tradition, for these studies.

Any comprehensive social philosophy will include a philosophy of education. Dr Laurance Splitter, who leaves The University of Wollongong this year (1988) after ten years' service, has been the Australian pioneer in the movement known as Philosophy for Children. Children can comprehend philosophical issues at a very young age. Philosophy for children aims to assist teachers in developing those conceptual and inferential skills which are highly articulated in working through philosophical problems, but which are also of inestimable value in dealing with any complex or opaque problems in any field, especially those involving a mixture of empirical and non-empirical issues.

During his tenure at Wollongong University Dr Splitter, a former Victorian Rhodes Scholar, was awarded a doctorate by Oxford University for his original work in the philosophy of biology. He was not only founder but first national director of the Australian Institute of Philosophy for Education, which will now come under the auspices of the Australian Council for Educational Research.
It is no exaggeration to say that Dr Splitter's work has already had a significant national impact on the way in which reasoning skills are taught in many primary schools, and the potential exists for this impact to become major.

Philosophical research, for two reasons, is a relatively low-cost activity. First, most of it has no empirical dimension. No special observations need be made and recorded, and no experiments designed, constructed, and replicated.

Second, although scholarship is an important preliminary step in most new philosophical research projects, just as it is in, e.g., physics, biology, or psychology, that is all it is. The primary ends of philosophy do not include the interpretation of documents or other cultural products, and constructing theories about them.

Philosophy is only incidentally and not essentially, a scholarly activity. In this it resembles the natural sciences far more than it does the other Humanities, while it resembles some of the other Humanities in the general irrelevance of observation and experiment in the formulating and testing of theories.

Since it needs neither the support for its systematic accumulation of observations and experimental results typical of the natural sciences, nor the wealth of documentation typical of the other Humanities, the relative costs of philosophical research are very low. Hence the cost; impact ratio of philosophical research is potentially very high.

Because philosophical questions touch every aspect of human existence, some philosophers attempt to impart that existence directly. There is a long and honourable tradition of the 'philosopher-gadfly' whose function is to disturb dogmatic slumbers and to question both the popular and the intellectual fashions, or the culture and the counter-cultures of the day. Prominent in this tradition were Socrates, Voltaire, John Stuart Mill, William James, Bertrand Russell, John Anderson and Michael Walzer.

But there is an equally long tradition of philosophical giants who have disdained publicism, notably including Aristotle, Leibniz, F. H. Bradley, Ludwig Wittgenstein, A. Boyce Gibson, and Sir Peter Strawson. Determining the most important role of the philosopher is itself a controversial philosophical question.

Both traditions are well represented at The University of Wollongong, and both make a considerable impact.

**Department of Science and Technology Studies**

The Department of Science and Technology Studies research focuses on the nature, dynamics, impact and management of science and technology in their social context. To focus this work the Department has chosen to concentrate on bioscience and information and communication technology as major case studies. Associate Professor Falk, Dr Badham, Mr Reinecke and Mr Aungles have now developed a substantial program dealing with artificial intelligence, telecommunications policy, the political economy of information, and CAD/CAM and new manufacturing technologies.

Among the work being carried out in bioscience, Dr Richards has completed a major series of papers comprising a major revaluation of the historical roots of contemporary evolutionary biology.

**Department of Sociology**

Significant results were achieved during 1987 and 1988 in Professor Hill's work on technology and culture. In a program that has extended over 25 years, research has been seeking major new theory development in parallel with practical application.

Professor Hill has during that period written a major work on the theory of technology and culture relations. Entitled, *The Tragedy of Technology—Human Liberation vs Domination in the Late 20th Century*, the book is to be published in London in 1988.

Professor Hill was invited to West Germany under the auspices of the Stifterverband Foundation to deliver a series of lectures on the theory. More specific application and test of the 'culture-technology alignment' theory developed in the book were embodied in research published in the United States on technology and organisation cultures.

On the practical side, Professor Hill was commissioned by UNESCO and the Foundation for International Training (Canada) to write two research monographs on technology policies for South Pacific nations, and by ESCAP to write a book-length review of Australia's technology strategies and consequences.

Practical application of academic work went considerably further. With the Australian and New Zealand National Commissions for UNESCO, Professor Hill organised and acted as technical convenor of a high-level inter-governmental meeting of South Pacific nations to plan regional technology policy strategies (on behalf of UNESCO and the South Pacific Bureau of Economic Co-operation). With other members of the Centre for Technology and Social Change (TASC), he directed a contracted two-month training program on science and technology policy for all the ASEAN nations.

He went to Tokyo to advise on ESCAP's 'Technology Atlas' program, to Paris to advise on UNESCO's South Pacific program, and to India (under the Australian-India Agreement) to lecture on the influences of colonial history on contemporary technology and culture.

Finally, he was contracted by UNESCO to establish a Co-ordinating Board for the Asian region on science and technology policy (STP) research and training. Meeting in Wollongong, this international board elected Professor Hill and TASC as the Regional Centre and gave a mandate for him and TASC to co-
'Four Dimensional Space'

During 1987 and 1988, Dr D'Allon and Dr Jagtenberg of the Department of Sociology were contracted by Harper and Row to produce an Australian resource book on Australian society for university social science programs. Entitled Four Dimensional Space, the book brings together empirical material on the impacts of class, gender, ethnicity and nature on the shape of contemporary Australian social life.

ordinate and develop all STP research and training throughout the Asian region. This International Network that is now based in Wollongong is named STEPAN (STP Asian Network).

In keeping with a general perspective throughout Wollongong’s Faculty of Arts, this amalgamation of theory and practical application represents the significant contributions that can be made simultaneously from Arts-based research to international scholarship and practice.

School of Creative Arts

New performance work
A Distant Shore

A current project being developed by staff of the School of Creative Arts is a musical composition entitled A Distant Shore—music by Dr Andrew Schultz, commissioned by Garrick Jones, opera singer, and lecturer in Vocal Studies for the School. Funds are provided by the Australia Council. The new libretto for this work is by Louis Nowra, Artist-in-residence for 2nd session with the School of Creative Arts.

Lawrence Hargraves sculpture project

An invitation sculpture competition for Illawarra sculptors was won by Mr Bert Flugelman. The project involved the design and engineering of a major sculpture to commemorate the work of Lawrence Hargraves, as a Bicentennial project.

Research in ceramics

Mr Lindsay Duncan, lecturer in ceramics, is heading a team of postgraduate students, working on two major themes in research in the area of ceramics in Australia. Kiln, glaze and clay technology

The design, construction and operation of wood-fired kilns.

Petro-carbon fuels for black-fired clay objects and post-firing reduction effects on clay.

Glaze technology in the areas of Arabian Lustre and low-fired lustre glazes.

Socio-political survey of Australian culture and ceramics

• Aboriginal/white culture interface.
• Ceramic art in a materially abundant society.
• Memorial monoliths to a throw-away planet.
• Australian male imagery.

New performance work for young people

The Piper's Promise

An opera for young people, commissioned and funded by the Australian Bicentennial Authority with a grant of $20,000. Libretto by Ms Sue Rowley and Associate Professor James Falk. Music composed by Mr Andrew Ford.

Design by Mr Richard Hook.

The work was written for performance in the Wollongong Performing Arts Centre in October 1988.

The performance was directed by Mr Des Davis with musical direction by Mr David Vance, with an additional production grant. The production involved a large cast of young people from the Illawarra.

Special project art show

This show was commissioned from Mr Bert Flugelman as part of the Bicentennial Survey of Illawarra Art exhibition. The exhibition involves art works of the region from the early days to the present. It was opened by the Governor-General on 8 June 1988.

Mr Flugelman was selected as the individual project artist within this exhibition. His project features a series of works on paper and one large wood carving as a major central work.
Computers, computing science, mathematics and statistics play a dominant role in the intellectual and technological development of universities, industry, business and society at large. A significant change has come over computing, mathematics, statistics, engineering and science during the 1980s. That change arises from the ready access to computing facilities at the microcomputer, work station and supercomputer level, and advanced numerical, statistical and graphical software. At the core of the advent of these computing resources lies mathematics.

For the list of Research Publications from the Faculty of Mathematical Sciences please turn to page 50.
In the Department of Mathematics and Mechanical Engineering, a high-speed camera (20,000 frames per second) is used in research programs involving fluid modelling of liquids in cavitation bubble dynamics. The camera allows researchers to observe the growth and collapse of bubbles, occurring near boundaries, a factor which could be responsible for the highly expensive damage which occurs in the course of normal use to the tips of ships' propellers and other hydraulic devices.

Using the camera here is Professor John Blake.
'The advance and perfecting of mathematics are closely joined to the prosperity of a nation.'
—Napoleon Bonaparte

'When we entered the era of high technology, we entered the era of mathematics technology. Mathematics and computation are now forming a much larger place for themselves as an alternative to experimentation.'

And from a recent report on science policy from the Executive Office of the President of the United States.

'Another theme has come out of this report: within four decades, the field of computer science has moved from a service discipline to a pervasive technology with a rigorous scientific basis. Computer science has become important to our national security and to our industrial productivity, and as such it provides the United States with many opportunities and challenges.'

Mathematical modelling and computing often represent over half the research budget of major engineering projects (e.g., Hermes, the European space shuttle).

Indeed, Australian business and industry have recognised these developments and are increasingly moving towards automated production lines employing total quality control. These developments require computing equipment, software development, simulation and statistical analyses skills that are all to be found within the Faculty of Mathematical Sciences. In the near future a statistical consultant will be appointed to extend the role of the Faculty in assisting business and industry with statistical and quality control problems.

Academic staff in the Faculty of Mathematical Sciences possess a wide range of research and knowledge-based consulting skills in the areas of:

- Industrial and engineering mathematics
- Computational mathematics and statistics
- Beach and ocean systems
- Databases
- Artificial intelligence
- Software development
- Robotics
- Logic and analysis.

The Department of Mathematics provides advanced mathematical and statistical skills required for engineering design and development. It has a long record of collaboration with industry at all levels and has deliberately built up a strong research capacity in:

- applied mathematical modelling in the areas of heat transfer, fluid mechanics and solid mechanics which are of generic importance to Australian industry;
- applied and computational statistics.

Research interests in Applied Mathematics include problems associated with heat transfer, moving boundaries such as occur in melting or ablation problems, Newtonian and non-Newtonian fluid mechanics (polymer), multiphase flow, flow in porous media, non-linear water waves and the mechanics of non-linear, rubber-like materials such as occur in bridge bearings. In statistics the principal research interests include regression, stochastic processes, stereology, geometric probability, decision theory, inference and statistical computing.

Engineering and industrial mathematics

The Engineering and Industrial Mathematics group has a range of research and consulting interests in the areas of fluid mechanics, solid mechanics and heat transfer, including non-Newtonian fluid flow, fracture mechanics, antenna simulation and phase-change problems.

Fluid mechanical modelling of gas, liquid and solid phases has been developed in diverse areas ranging from sedimentation of industrial slurries through to cavitation bubble dynamics. Reynolds numbers range from very low to very high. Current major research activity is in the areas of cavitation bubble dynamics. Experimental facilities to observe the growth and collapse of cavitation bubbles near boundaries have been provided on loan from CSIRO. The recent purchase of a NAC high-speed camera which is capable of recording 20,000 frames per second will provide greater clarity of detail in further experiments or on studies of high-speed motion such as occurs on production lines.

The study of two-phase flow in porous media is motivated by the need to enhance the recovery of oil. The fluid mechanics and heat transfer processes involved with single and multi-layer coating technology are of direct relevance to local industry. Other research areas of medical and biological interest include mucociliary transport, gamete and protozoa locomotion and respiratory physiology (foetal 'breathing' and high frequency ventilation).

Research is being undertaken in moving boundaries associated with diffusion and heat conduction, diffusion in random laminated materials and problems in finite elasticity in bridge bearing design. Moving boundary problems occur in many practical fields. Casting of thermoplastics or metal, freezing or thawing of foods and production of ore are just some examples. Waves are ubiquitous phenomena in nature. Interest in wave propagation is motivated by applications to problems such as the interaction of a fluid flow with topography, the formation of shocks and undular bores as the semi-diurnal internal tide propagates up the Australian North West Shelf and the use of shock waves to remove kidney stones.
Statistics
The research and consulting activities of the Statistics group involve areas of statistical theory which include stochastic processes, regression, inference quality control and statistical computing. There is a strong emphasis on application in diverse fields including mineral processing, materials science, medicine, gambling and industrial quality control.
Research into the liberation of mineral ores is being undertaken in collaboration with industry, CSIRO and universities in Australia and Britain. An understanding of the process of liberation requires the solution of formidable mathematical problems in stereology and spatial stochastic processes. Another area of collaboration with materials scientists is the application of image analysis to metallurgical research.
Epidemiological studies in progress include assessment of risk factors for cardiovascular disease, evaluation of a clinical trial of a vascular surgery procedure for correcting impotence and a study of factors affecting susceptibility to Legionella infection. Two of these are specifically directed at the local Illawarra community. Statistical methods involved include the design of clinical trials and logistic regression analysis. Inference in small samples with dichotomous data cannot satisfactorily be based on standard asymptotic methods and alternative approaches are the subject of continuing research.
The major growth area of statistical theory in recent years has been the development of exploratory data analysis and the application of computer intensive procedures to extend the analytic tools available to provide sound analysis of statistical data. One important topic within this general area is nonparametric density estimation. Improved methods of finding nonparametric density estimates (which avoid parametric assumptions, e.g. of normality but at the same time provide a better indicator of the shape of a distribution than a histogram or stem and leaf plot) are under investigation. Areas of application include discriminant analysis and (potentially) quality control.

Software
Software of the type used by industrial mathematicians includes linear algebra, eigenvalue analysis, ordinary differential equation solvers, partial differential equation solvers, statistical packages and mathematical programming packages. Much of the development of software in these categories has been funded by government agencies in various countries with the result that versions of the programs are available for some computers for the cost of distribution only. The Department's proposal in the first instance is to distribute software using the netlib package described by Dongarra and Grosse of the Argonne National Laboratory, USA, and to make available such software as is already in the public domain from overseas and to become the Australian repository for locally developed public domain software.
Members of the Department of Computing Science and the Computer Centre have developed a plot package that works on a variety of computers including mainframes, with device drivers for plotters and a variety of display devices, and Apple Mac and IBM compatible personal computers.

Quality control is one of the key areas of interaction with local industry. Formal consulting arrangements have been established in two instances and the group is applying its statistical research to problems which industry does not have the resources to solve. With a view to fostering the development of statistics in the region, an Illawarra Statistics Group has also been founded.

Department of Computing Science
Current research and consulting activity in the Department of Computing Science are concentrated on:
• The methodology of knowledge-based systems, and the application of artificial intelligence techniques to chemical structure elucidation.
• The development of a comprehensive set of tools to support the design and maintenance of large databases. The first of these tools, which runs on the Apple Macintosh, is now available commercially.
• Environment sensing by echolocation, and robot path planning algorithms, are being developed. The echolocation work requires high-speed data acquisition and processing and research now involves a prototype board for a Mac II system. The path planning algorithm based on a quad treem representation of the robot environment has been published recently. A teaching package for robot kinematics has been developed for the Apple Mac and should be brought to a commercial presentation level shortly.
A Key Centre for Teaching and Research in Advanced Manufacturing and Industrial Automation (CAMIA) was founded within the Faculty in 1988. The rationale and impetus for the Key Centre arose from the knowledge that if Australia were to improve its position, vis-a-vis its major trading partners, the fullest possible advantage would have to be taken of the technology of automation; that industry, the teaching and research institutions and the trade unions would have to work collectively in the application of high technology.

COMPUTER-INTEGRATED Manufacturing (CIM) systems form a major part of the new technology. Its essential components include a data base, a computer-aided design facility, one or more computer numerically-controlled milling machines or turning centres, automated materials-handling systems, which might be robots or guided vehicles, assembly or packing stations and, finally, a quality-control program.

All this complexity would be under the control of a knowledge-based expert system which would determine overall strategy in the light of demand, stock availability, system capability and the state of readiness of individual elements of the system.

The Australian domestic market is small by international standards. Small volume batches in our factories are thus commonplace. For this reason (among others) factories

For the list of Research Publications from the Faculty of Engineering please turn to page 48.
to be competitive need to be able to change, within minutes, from the manufacture of one component to another.

To achieve this will require flexibility in the tooling and operation of the CNC machining centres, in the routing and assembly of components and oversight—by computer—of quality, inventories and packaging to an extent that design or inventory modifications, or a breakdown, automatically result in changes—instant changes—throughout the process. Much work has been done worldwide on CIM systems. A good deal more, however, remains to be done before what are essentially computer-aided manufacturing systems become knowledge-based and, in fact, fully CIM.

The CAMIA was born after 18 months of discussion among staffs of the Departments of Computing Science, Electrical and Computer Engineering and Mechanical Engineering. Also closely involved was the Automation and Engineering Applications Centre. The AEAC works in the related fields of manufacturing, robotics, process control, systems analysis and industrial automation. From the discussions among those groups the seeds were sown for the submission for the proposal to establish the Key Centre for Teaching and Research in Advanced Manufacturing and Industrial Automation.

The proposal was one of 15 which were successful. The CAMIA will receive $186,000 a year for three years from the Federal Government. The bulk of this grant will underwrite the teaching and training activities of the centre; some of the grant will be available for the purchase of equipment for use in the teaching and research programs.

Of course much of the equipment needed is already available either within the AEAC or the Faculty. Strands which will be researched and taught will include investigations of the problems surrounding the implementation of fully integrated CAD/CAM systems leading to a flexible manufacturing system, the development of software for manufacturing control and planning resources, the development of systems monitoring the process and quality control, and the investigation of problems associated with the development of specific robotic components and systems. But there are other factors of the CAMIA that are important. Examples of this are that funds provided by the National Industry Extension Service will enable the establishment of a training and retraining program for apprentices, tradesmen and sub-professionals. It is anticipated that at least 1,000 from these categories will make use of the equipment each year. Some manufacturers have already made a commitment to supply equipment, either as gifts or on long-term loan.
The field of materials is another area of development and consolidation within the Faculty. This is a result of the filling of the foundation chair in Materials Engineering. Two broad areas of specialisation expected to become more focused under market forces have been identified. These are in the mechanical behaviour of engineering materials and materials processing.

The first category includes hot and cold deformation, recrystallisation, plasticity, fracture, fatigue, creep, toughness and crack growth in a wide range of materials. The general philosophy is to monitor and understand mechanical behaviour with a view to predicting performance or developing better materials.

Materials processing includes analysis of blast-furnace performance, studies of coal and coke structure and fundamental investigations into the porosity of particulates. In fabrication, several aspects of welding and galvanising are being examined. Recent findings concerning galvanising treatments offer great potential for commercial producers. The identification of just two broad areas of specialisation is somewhat artificial since much interaction takes place between the two fields. For example, the activities in galvanising have expanded to include other forms of surface coating, such as polymers on metals and ceramics on metals. Subsequently, the necessary tests to evaluate performance of coated materials have brought in mechanical property assessments. It is important that the circle between Process-Property and Application is complete.

Within a Faculty comprising four Departments, some 1300 students, 60 academic and 50 support staff, and which offers six individual courses leading to a Bachelor of Engineering, it is inevitable that research covering a wide range of topics has traditionally been undertaken. Co-ordination and consolidation of such disparate activity is fully under way.

Department of Civil and Mining Engineering

Building bricks have been made with roughly the same materials and with the same techniques since the time of the Romans. This is something that could change, when research by the Department of Civil and Mining Engineering is completed. The Department is conducting research into several projects involving materials used for building.

Six main areas are under scrutiny. One—a joint venture between the Department, Austen Butta Ltd and Boral Bricks (and with NERDDC funding of $57,000)—concerns brick manufacture using crushed coal ash as feed stock. Bricks have already been made successfully using crushed coal in place of the conventional shale. Present indications are that the new type of brick will be comparable in terms of quality to the bricks we know.

Another area of research has attracted funding of nearly $10,000 from the Department of Energy for a pilot study. It concerns the use of fluidised bed-combusted byproducts as ingredients in concrete. Coal waste can be burnt in such a 'combustor' to produce an energy source—in this case heat. During burning, the material reduces in volume and yields a coarse fraction, and a fine ash. This ash, it has been found, has the potential for use as an aggregate in concrete. Concrete is being researched in another way, too. These days, as most people will be aware, concrete is often put into position by means of a pump. The system is both mobile and efficient. A disadvantage, however, is that pumpable concrete requires good quality control of the materials used. It is for this reason that low-grade materials have had to be bypassed.

Current research indicates, however, that with the development of new cements and modified internal pipe-line pressures, the use of marginal or even low-grade materials could result in good-quality, pumpable concrete. Funding of $21,000 is being provided by the University, with donations in the form of materials and equipment from industry of $12,000.

Yet another field of study into concrete is an investigation of its durability when it contains flyash. The research is looking particularly at aggregate-alkali reactivity. Conflicting results have appeared in the literature. A pilot study is under way.

Another field of study in the Department is related, in that it is concerned with road-base materials and their behaviour under repeated wheel loads. A simulator has been built, and tested, for the work. A major emphasis is placed on the use of blast-furnace slag as a base material as compared with that of crushed rock. Funding from industry, in terms of equipment and materials, is valued at $10,000.

Dynamic Behavioural Structures

The understanding of the dynamic behaviour of structures has advanced considerably in recent years. The reason for this acceleration is in principle twofold: first, advancements in computing provide facilities to calculate theoretical results in reasonable time (computing time requirements are several orders of magnitude larger than those for the static analysis of the same structure) and, second, advances in the measuring devices and techniques make it possible to measure real structures. Current research supports progress towards the better utilisation of a material used in designs. The applications will be in the area of fatigue for dynamically loaded structures as well as their service performance problems.

The dynamic analysis of frames has been a research interest in the Department of Civil and Mining Engineering for some years. With the support of BHP and the Aeronautical Research Laboratories, Melbourne, the testing of a full-scale frame to verify theoretical results is in progress. Some properties of framed structures not previously understood can now be analysed and used in an improved design of framed structures subjected to dynamic forces.
Department of Electrical and Computer Engineering

Industry-related research

An exciting project, initiated early in 1987 by Associate Professor T. S. Ng, was the development of a fault-diagnosis expert system for faulty shapes of steel plates at the Plate Mill, BHP Steel International Group, Port Kembla Steelworks. The project was undertaken through a research contract with BHP. It has now been successfully completed. The system, DESPLATE, is displayed at three locations in the Plate Mill and is used daily by operators. Research in this area is now directed towards automatic knowledge acquisition.

In other projects associated with BHP, Dr G. W. Trott spent three months of 1987 at the Port Kembla Steelworks tuning the software on the new hydraulic automatic gauge control system on the Two Stand 3500 mm Plate Mill. Investigations on a similar system on the Five Stand Cold Mill were also undertaken. A study, which involves modelling the dynamics and control system for the Roughing Mill of the Hot Strip Mill to counteract an oscillating problem occurring in that Mill, is now in progress.

BHP has initiated a joint investigation with the Power Systems Research Group (Doctors M. A. Magdy and D. Platt, Associate Professor K. J. McLean and Mr J. F. Chicharo) into the source of low-frequency oscillations experienced in the steelworks' power supply. Different approaches to the analysis are being studied. Simulation studies have been carried out to evaluate and predict the magnitude of oscillations under a variety of operating conditions.

Another project involving industry, which began in 1987, requires the building for the Electricity Commission of New South Wales (ECNSW) of a device which will travel along high-voltage power lines and examine joints in the cables for misalignments in construction. The impetus for this work evolved from the fact that the misalignments could lead to permanent failure. The Department of Power Systems Investigation within ECNSW and the Power Systems Research Group are investigating the tuning of power-system stabilising devices. Results of on-site measurements from Wallerawang Power Station are being studied.

Since 1986 Associate Professor F. J. Paoloni, in a co-operative effort with staff at the Australian Nuclear Science and Technology Organisation (ANSTO), has been investigating the ability of a vacuum-arc centrifuge to enrich desired isotopes from common naturally occurring metals such as copper, zinc, nickel and iron. Stable isotopes are used in industry, science and medicine as traces for diagnostic applications and are also source materials for the production of radionuclides. There are today no Australian suppliers of such materials. All are purchased overseas.

The project involves the construction of a magnetised vacuum-arc device and an investigation of the mass distribution of material deposited on collector surfaces in the vicinity of the arc. Results show that isotope separation does occur in the rapidly rotating metal plasma produced by the arc, and that enriched materials can be gathered for further recirculation and concentration.

Staff-initiated research

Use of permanent magnets

Development of new permanent magnetic materials has already revolutionised the design, construction and operation of electrical machines. The axial-flux permanent magnet machine is one example. Among the variations possible, the single-phase axial-flux permanent-magnet machine has potential applications in domestic appliances. In contrast to the conventional induction type single-phase machine, the permanent magnet unit possesses numerous advantages—for example, an improved efficiency and power factor.

With these neodymium-iron boride permanent magnets, there is the possibility of constructing servo-motors more powerful than ever before. The prime requirement of servo-motors is a low inertia rotor. This has been achieved, in the past, in two ways. The first is by a sandwich construction with a thin disc for the rotor between two heavier stator discs. The second is by using a long, thin rotor in an otherwise conventional motor.

A project undertaken by Dr D. Platt follows the first method and has resulted in the construction of a machine for laboratory testing. After confirming the analysis with...
laboratory tests, the task will be that of optimising the dimensions of the machine to give the lowest possible inertia for a given rated output.

**Automatic control of drug administration systems used in anaesthesia**

The use of muscle relaxants to induce paralysis is a vital aspect of modern anaesthesia. It enables the anaesthetist to provide suitable operating conditions for the surgeon, since an involuntary muscle movement could in some circumstances be disastrous. It has been shown that if the reaction of the relaxed patient to muscle stimulation is compared to that of the unparalysed patient, then it is desirable to maintain paralysis at a level such that the relaxed response is not less than ten per cent of the unparalysed response. At the same time there is a conflicting requirement to induce muscle relaxation as rapidly as possible, without overshooting this setpoint. While it is possible to achieve this manually, it makes undue demands on the anaesthetist's time and skill. It is for these reasons that a system to control muscle relaxation automatically in a clinical situation has been developed. While the system works well, further development to its user interface is required to make it more 'user-friendly'. In addition, by re-engineering the device to make use of a standard commercial personal computer, considerable cost and performance benefits can be achieved.

**Implements in memory test algorithms**

The failure mechanisms which exist in modern VLSI design, particularly in memory devices, using improvements in memory test algorithms, are being studied. The cost of testing large-scale memories is increasing and can today account for a large part (up to 80 per cent) of the total chip cost. Research therefore is concentrated on memory test algorithms by studying the mechanisms by which memories fail. This should result in better fault coverage and less costly test routines.

**Robot control**

While working with Professor R. Paul, Department of Computers and Information Science at the University of Pennsylvania in 1987, Dr G. W. Trot investigated a multiprocessor system to control a robot arm. Development of a similar system at Wollongong, in conjunction with the Automation and Engineering Applications Centre (AEAC), is proposed, as also is an extension of the project aimed at adapting a wheelchair controller to be used as a mobile robot.

**Electrical power systems dynamics and control**

Doctors M. A. Magdy, D. Platt and Associate Professor K. J. McLean are conducting research into experimental identification of low-frequency modes. Their work is aimed at developing an on-line adaptive technique to estimate the number, magnitude and frequency of low-frequency modes in interconnected electric power systems. The application of adaptive notch filtering techniques are under investigation.

Meanwhile, Mr J. F. Chicharo is undertaking research aimed at finding the optimal filter structures and investigating the estimation accuracy and tracking performance of various adaptive algorithms. The objective is to develop a robust and simple filter to implement adaptive notch filter.

**Bulk solids handling**

The Bulk Solids Handling Group completed two NERDDP projects in 1987:

- Long Distance Pneumatic Conveying of Fly Ash and Pulverised Coal, and Feeding of Coal from Mass Flow Hopper Outlets.
- The Pneumatic Conveying project was also funded by the Electrical Research Board.

The group was awarded two further projects to be carried out over the period 1988-1990, namely:

- Optimal Design of Long Distance Pneumatic Conveying Pipeline Transporting Fly Ash and other Related Products
- Design of Conveyor Chutes with Special Attention to Blockage, Wear and Conveyor Direction Change.

The group has also undertaken contracts and consultancies to the value of over $180,000 in the past year. Currently seven support staff (four professional, three technical) are employed on bulk solids handling projects.
Finally there is the Low-velocity Rig which transports friable products at speeds less than 0.5 metres per second. This has been installed in the Department as part of a joint Research and Development project with CSR and NEI John Thompson for a specification intended to contain sugar. The system is felt at this stage to have potential for other products, including those used in the chemical and food industries.

**Department of Metallurgy and Materials Engineering**

**Porosity of granular mixtures**

A box packed with solid particles contains both solid particles and empty space or voids between the particles. The percentage of the box volume consisting of voids is termed porosity. This is a very important parameter in all industries processing, manufacturing or using mixtures of granular materials either as such or as compacts, e.g., concrete, bricks and advanced ceramic components for super-duty applications.

The prediction of the porosity of granular mixtures has been a longstanding problem. Early work, mainly by the civil engineers, motivated by the practical questions of the compactness of soils, aggregates, mortars and the like, led to the establishment of some practical rules of what to mix with what, and in what proportions; and were in most part adequate for the intended purposes. Later work, mainly by geologists seeking an understanding of the porosity and permeability of rocks and plastic sediments, involved a geometric inquiry of the packing of spheres in the study of the problem. Later, this approach was used by the physicists in the study of the structure and the viscosity of liquids. It is of interest to mention that it was Einstein \( E = mc^2 \) who first derived an equation for the viscosity of suspensions as a function of the porosity of the system.

Recent work overseas, in the past ten to 15 years, has been concentrated on developing mathematical models for the porosity of granular mixtures based on the geometrical considerations. Unfortunately, the predictability of these models has not been close enough and general enough to meet the needs of current industrial requirements of tolerance and quality in the wide range of products and processes, particularly in the high-tech applications.

In the same period the work in the Department of Metallurgy and Materials Engineering focused on an analytical-parametric approach in solving the problem of porosity prediction that would both be
general and accurate enough for the immediate needs of industry. That goal has been achieved and successfully tested in practice. The secret of success is not difficult to appreciate if it is noted that the predictive calculations require a small number of actual measurements as the input data. The Department is confident that any inconvenience that may be associated with the making of the few measurements is more than compensated by the confidence that the predicted porosities of all mixtures using the same industrial materials will not be different.

Metallic glasses

Metallic glasses are a new and potentially important group of materials, which are prepared by cooling from the liquid state at rates sufficiently high to suppress the crystallisation processes that normally occur during freezing. These materials with their 'frozen-in' liquid structure have unusual and attractive characteristics including high strength corrosion resistance and outstanding magnetic properties compared to conventional crystalline alloys. The cooling rates necessary—in excess of one million degrees per second for most iron-based materials—are achieved by ejecting a stream of the molten alloy through a narrow slot at the base of a refractory crucible on to the surface of a steel drum rotating at high speed; if the operating conditions are closely controlled, the melt forms a stable puddle and a solid ribbon peels off the drum surface.

Research in the Department of Metallurgy and Materials Engineering is concerned with two major aspects of these alloys. First, because the alloys are metastable with respect to the crystalline state—they are essentially supercooled liquids like ordinary window glass—they crystallise on heating to temperatures of a few hundred degrees Celsius. Once crystallised, the alloys are usually brittle and lose their attractive properties and this places a limit on their use at other than modest temperatures. For some applications, though, controlled transformation to a few per cent of fine crystals may improve the overall properties—for instance by refining magnetic domain size leading to reduced core losses in high-frequency electrical transformers. It is clearly important to understand the crystallisation process, not only because of the practical problems of thermal stability in service, but also because of the fundamental interest in studying nucleation and growth processes in highly undercooled liquids.

The second main area of research at Wollongong is concerned with the possible uses of metallic glasses for biomedical applications. Collaborative work with Bioquest Ltd has shown that some of these materials are capable of supporting the adhesion and growth of a wide range of different cells, including bone and nerve cells. Coupled with their high strength and excellent corrosion resistance, this makes them potentially suited for a range of applications, including sensors, transducers and also as substrates for high-density mass-cell culture.

Evaluation of advanced materials

Much is heard about the developments in new, or improved, materials which are expected to contribute significantly to the Australian economy. 'Wonder' materials are really of benefit only when they are used and their properties exploited. The world abounds with useless laboratory curiosities! The Department of Metallurgy and Materials Engineering is actively engaged in a realistic appraisal exercise with the longer-term objective of establishing reliable design rules so that engineers may select new and often novel materials with confidence.

Typical properties under examination are those relating to potential service conditions such as toughness, environmental behaviour, fatigue, creep, wear and surface integrity.

High-strength, low-alloy steels

Stimulated by rapidly increasing costs of equipment, labour and energy, a revolution has taken place in the steel industry during the past decade. The pressures have resulted in the widespread adoption of 'continuous' processing methods to conserve energy and operating costs.

A notable change has been the development of various types of high-strength, low alloy (HSLA) steels, which retain the excellent malleability and weldability of conventional structural steels but which have considerably more strength.

This improvement has been effected by a combination of controlled rolling and changes in steel chemistry which involve the addition of small amounts (less than two per cent) of titanium, niobium, vanadium and boron, singly or in combination.

Since the strength per unit weight is increased in the presence of these alloying elements over conventional steels, smaller sections and lighter gauges may be used, especially in automobile components, frames for buildings, and pressure vessels, offshore platforms and notably in oil and gas pipelines. Since 1975, demand for HSLA steels in Australia has risen tenfold and this is expected to increase at a rate of 20 per cent each year for the next decade.

For the past eight years extensive (applied) research has been carried out by the Department of Metallurgy and Materials Engineering by Dr Tara Chandra and Associate Professor Druce Dunne. Valuable information has been provided to BHP Steel International, which has supported the research program.

Dr Chandra is currently involved in research on copper-bearing HSLA steels—a new generation of materials, which, because of their high corrosion resistance, toughness and strength, have considerable potential in ships and other marine applications. The University of Wollongong is the sole institution in Australia involved in the mechanical processing of these new steels.
In the Department of Metallurgy and Materials Engineering, Dr Gordon Delamore and his PhD student, Mark Gibson, are producing metallic glass, which is being centrifuged at 30 metres a second from a stainless-steel drum spinning at 2,000 revolutions per minute.
A major initiative in the Commerce Faculty has been the establishment of the Centre for Work and Labour Market Studies. CWALMS is organised on an inter-institutional basis, involving staff of The University of Wollongong and the Riverina-Murray Institute of Higher Education. The Wollongong Directors are Doctors Ray Markey and John Mangan of the Department of Economics. Associates of the Centre are drawn from a range of Departments and Schools at both institutions, covering labour economics, industrial sociology, industrial relations, industrial psychology, management and administration. The Centre has a full-time research and consulting staff of five.

Research projects by CWALMS are wide ranging. Currently they involve the South Coast Employment Development Project, investigation of work practices in the steel industry, enhancement of skills in the heavy-engineering industry workforce, development of the secondary-school curriculum on work studies, investigation of industrial democracy in the Illawarra, and an analysis of patterns of industrial disputes in the Illawarra. CWALMS has conducted, too, workforce surveys on attitudes to technological change and industrial democracy. It publishes a monograph series under the title of Work Studies recording many of the results of its projects, as well as the proceedings of regular seminars.

The international Ericsson Company has agreed to sponsor, to the extent of $80,000, a joint research venture between Wollongong's Department of Management, the Australian Graduate School of Management and the international consultancy Price Waterhouse Urwick. The project seeks to gain an understanding of the decision-making processes which occur when organisations purchase high-cost technological product such as PABXs. The research utilises a new research methodology developed by Mr Phillip Dawes of Wollongong's Management Department. The methodology incorporates a 'snowball' sampling technique which helps to identify all organisational members who took part in the decision-making process.

For the list of Research Publications from the Faculty of Commerce please turn to page 44

Department of Management

The Department of Management has active research programs in such areas as organisational buying behaviour, turnaround strategies for firms in declining industries, management training, technology development and acquisition, Islamic banking, and organisation and design of innovative teams.

Doctoral students in the Department are working in a variety of areas. Examples are the adoption of Japanese manufacturing policies in Australian firms; the role of planning in the performance of Malaysian firms; strategies for companies in declining industries; management style and decision making in the local health service; Japanese technology transfer to Indonesia; the impact of information technology on the competitive strategy of banks.

The Department's research involves close collaboration with industry. The research into organisational buying behaviour is financially supported by Ericsson, the electronics company, while work on
management training has received support from the Australian Institute of Management. An ARGC-funded project on some of the managerial implications of new office technology has received follow-on support from firms in the insurance industry. Financial support has also been gained for a full-time research student working on the marketing of industrial products.

Technology development and acquisition

Technology acquisition through licensing agreements and collaborative ventures can often be a complementary strategy as well as a substitute for in-house development. The problems perceived, or actually faced, by firms concern technological dependency and their ability to understand, receive and enhance technology developed elsewhere. These barriers will vary in the impact between industries and technologies as well as between firms of different sizes. However, evidence from the Wollongong research suggests that many of the not-invented-here (NTH) fears are overstated and that companies of all sizes can benefit from imported technology in their own development process. Firms like BHP Coated Products (with the Zincalume process) and James Hardie Industries (with Hobas pipes) have successfully imported ideas from overseas, enhanced the technology significantly and become world leaders in those fields. There appears to be a number of important organisational and technological characteristics which facilitate this profitable exploitation of acquired technology and the Wollongong research is now focusing on these.

Management training in Australia

Management training is undertaken by Australian companies using a number of in-company and external programs. Preliminary research by the Department under an Australian Institute of Management Grant suggests that while many companies have training policies, few have any firm understanding of the linkages between training and organisational effectiveness in terms of both internal efficiency and control and external competitiveness. Using a sample of 50 firms stratified for structural and organisational factors, the research is now evaluating how the return to investment in training can be measured and whether firms in the light of this are under- or over-investing.
RESEARCH CENTRES

Centre for Applied Biology Research

AIMS of the Centre for Applied Biology Research are to undertake specific projects that are likely to be of direct benefit to the community at large. The Centre operates under the direction of Professor Helen Garnett. It is staffed by a multi-disciplinary team from the Department of Biology and from other units in the University.

In order to bridge the gap between long-term fundamental research undertaken by the University, and applied research required by business, industry, and indeed by the community, 11 Research Centres have been set up by the University. These Centres are:
- Automation & Engineering Applications Centre
- Centre for Applied Biology
- Bulk Materials Handling Division
- Microwave Applications Research Centre
- Centre for Mining Research
- New Literatures in English Research Centre
- Centre for Multicultural Studies
- Centre for Studies in Literacy
- Centre for Technology & Social Change
- Centre for Transport Policy Analysis
- Centre for Work & Labour Market Studies

The Centre’s expertise lies in two major areas of modern biology—Biotechnology and Ecotechnology. Specific areas on which the Centre can advise, and ecological research may be undertaken, include the ways in which urban and rural development might be accommodated without seriously damaging water and soil quality and our native flora and fauna; the impact/influence of native plants and animals on food crops; and reforestation.

By using its expertise in understanding biological systems and how these react to perturbation, the staff aims to predict how Australia can accommodate the continuing use of its living resources without irreversibly degrading them.

The Centre works closely with industry in research into the detection, control and eradication of troublesome micro-organisms—and particularly Legionella bacteria.

These projects utilise the Centre’s skills in molecular biology. Other biotechnological projects include the degradation of industrial waste and genetic manipulation and culture of algae.

Microwave Applications Research Centre

THE Microwave Applications Research Centre at The University of Wollongong has received a $1 million investment for research. This is the largest single investment for research so far made by industry to the University.

Sir Russel Madigan, executive chairman of Muswellbrook Energy and Minerals Ltd, announced the investment on March 29. (The investment came almost exactly a year—missing by just two days—after the official opening of the centre.) Sir Russel said that the sum was part of a program to invest in processes that would add to the value of Australian minerals.

Muswellbrook’s gold exploration company had made the investment through its minerals processing division.

The $1 m contract with Uniadvice is to be spread over three years and will allow MEM to share in the outcome of the research. Precise details as to the type of work in which MEM was investing are not forthcoming. Because of the potential value of the intellectual properties involved they are, for the time being at any rate, marked confidential.

Muswellbrook are clearly impressed with the Wollongong research. Mr Jackson described the team as a world leader, headed by the distinguished industrial scientist Professor Howard Worner CBE, a former chief of research at BHP and CSR. A point Mr Jackson made was that Professor Worner and his colleagues had discovered some surprising applications for microwaves which could prove to be of revolutionary significance to industry.

When the centre was opened in March 1987 it was envisaged that a large part of the research would be devoted to the drying of materials and to achieving temperatures not much higher than are involved in the cooking of foods. However, Professor Worner brought with him
ideas and experimental data which pointed to the potential applications of microwave energy in the smelting of metals and sintering of some ceramics.

The centre has rapidly expanded in research activities to cover not only the low-temperature applications of microwave energy but to use this field of electro-magnet energy to generate temperatures even higher than are normally involved in the smelting of metals including iron. It now appears that there is hardly an area of chemical, metallurgical, ceramic and even biological engineering where microwave energy cannot play some useful role. Among the fields already explored are:

- The drying of cereals, fruits, wool, coals, minerals;
- 'Excitation' of different coals prior to charging to boilers;
- New uses for activated carbons;
- Precursor treatment of minerals ahead of leaching and smelting;
- Processing of rare earths;
- Processing of components of superconductors and super magnets;
- Sterilisation;
- Polymerisation.

The centre was funded initially by allocations from The University of Wollongong, through Uniadvice, and contributions from the other two partners: Illawarra County Council and Industrial Microwave Applications Pty Ltd whose major initial contribution was in the form of a 40KW continuous microwave drive.

**Mining Research Centre**

*RAPID FACE BOLTING* is a term not much used outside the coal-mining community. Inside the community, however, it is recognised as a life-saving measure in the hazardous work of mining coal. *A Rapid Face Bolting System is for use in roof support in underground mines.*

Excellent progress is being made. The supporting consortium has contributed $16,000 over four years. A Research Fellow, Mr P. Standish, and two technical assistants are at work on the project. Their goal is for completion at the end of 1991. Another research task concerns mine safety. Funded by NERDDC ($400,000) and code named Failsafe Suppression of Mine Explosions, the work investigates at both prototype and half scale, the suppression of the start of explosions by immersing the entire area threatened in a water mist or water curtain. Initial tests at the University show that when small amounts of gas are ignited and the flame travel is recorded on the Department’s high-speed camera, valuable information is fed back on the size and density of the mist and its effect on flame suppression. The results will be used in near-full-scale tests at the Londonderry Safety Centre towards the end of 1988. Tests at Londonderry, where there is a 2
metre by 100 metre explosion gallery, will start by lighting some 15 cubic metres of air-methane mixture and suppressing the flame travel by forcing it through mists of varying densities.

New Literatures Research Centre

THE Centre was established in 1987 to focus interests within the English Department and to promote the writing, teaching and study of post-colonial literatures. For the next three years it houses the Secretariat of the South Pacific Association for Commonwealth Language and Literature Studies, for which it publishes a bi-annual newsletter and Span, the bi-annual journal. The NLRC now also houses the journal New Literatures Review, and plans to publish an annual working papers series. The first edition of this series will be papers from the Olga Masters Memorial Conference held in July 1988.

The centre has become known internationally, and has attracted visits from scholars and writers such as Aritha van Herk and Rudy Wiebe (Canada), Patricia Grace and Bub Bridger (New Zealand), Bernard Hickey (University of Venice), Kirpal Singh and John Kwan-Terry (National University of Singapore) and Albert Wertheim (Indiana University). Gifts to the University Library from the diplomatic agencies of Canada, the USA, and New Zealand have been arranged through the NLRC. The centre is especially interested in building a collection of research materials in literatures from the immediate geographical regions of the Pacific and Southeast Asia.

As part of its program, the NLRC hopes to serve as a base for postgraduate studies in post-colonial literatures, and has already had several applications from interstate and abroad. Two students are currently attached to the centre and working on the fiction of the New Zealand writer Janet Frame, and Australian literary treatments of South-east Asia.

Current research interests of members of the centre include the writing of Russell Soaba (PNG), First World War writing (Australia), Indian writing in English, the writing of C. J. Koch, Black theatre, and the preparation of an annotated bibliography and critical anthology of non-indigenous literary representations of the Pacific.

The Centre for Technology and Social Change

The Centre for Technology and Social Change (TASC) is a highly entrepreneurial centre of the University. Its team of 13 carries out research, consultancy and training on issues of technology and science strategy, management and policy.

TASC's goals are to provide an informed analysis of the issues and problems associated with contemporary technological developments; to raise the level of educational and technological skills in Australia required to deal with technological change; and to enhance the understanding and social control of technological change.

The Centre's research program is aimed particularly at equipping Australian industry to survive today's fierce international competition in technology-based products and processes. Emphasis has been on the practical aspects of establishing appropriate mechanisms in both the public and private sectors. This activity has produced 84 published works.

A main activity has been the development and application of methods to improve management performance, keep abreast of technological advances, capture business opportunities, identify technology-based changes in industry, tailor research objectives and enhance international competitiveness.

TASC is also a major provider of research and advice to government bodies on issues of innovation and technology policy. The Centre has developed new techniques for the identification of technological opportunities which have been employed in both the public and private sectors. Techniques have also been developed to assess the adequacy of and gaps in government infrastructure, through studies undertaken for the Queensland and New South Wales Science and Technology Councils.

Research undertaken as part of a three-year contract for the Commonwealth Department of Industry, Technology and Commerce has concentrated on a wide-ranging review of innovation studies; a survey of strategic alliances between Australian and foreign firms; a study of technology strategies in Australian industry; and the implications for Australian companies of the Offsets and Partnerships policies.

Keeping abreast of technological advances means having access to strategic information on a timely basis. TASC has the capability to identify quickly researchers and equipment in highly specialised areas, and through its detailed databases on R&D capability in the public and private sector in Australia and access to international scientific literature and patent data, to provide decision-makers with an analysis of key advances in science and technology.

In its research evaluation program TASC has developed a research-assessment package based on techniques of literature and citation analysis, patent-data and licence evaluation, and structured peer and formal assessment. This package enables organisations to ensure that their research programs are both effective and cost efficient. Among the first to benefit from this work have been The University of Wollongong and the National Building Technology Centre.

TASC has also continued to pioneer the development and application of
science and technology indicators in Australia. These indicators assist decision making in the private and public sectors and can also be used to identify research areas of significant commercial potential. Initial work in this area was carried out on behalf of the Department of Industry, Technology and Commerce in Canberra.

TASC's technology assimilation program is specifically concerned with interactions between people and new technology. Research has concentrated on information technology and its effects on business management, structures and communications and the implementations on flexible manufacturing systems.

The management development program draws on TASC's expertise in technology strategy, policy and analysis. In an era when only the most innovative firms are likely to survive, managers must be able to take a strategic view. They need to know where their future technology advantages will lie, and how to get there. They need the confidence to attack international markets, the competence to develop new technologies, and the credibility to attract partners and customers.

To this end TASC has developed and implemented training programs for industry on all aspects of innovation culture and the management of technological change. Customised action learning programs dealing with organisational culture and technological change have been a feature of this program. TASC has also organised and run workshops and conferences on technology policy issues, including innovation, entrepreneurship, and human resource development. 'Innovation Outlook '87' was a highly successful conference held at the Regent Hotel in Sydney in which leading industrial and government analysts projected the future for innovation in Australia.

The prime objective of the International S&T Policy (STP) Program is to develop training, research and consultancy to be employed in the developing countries of the Asian and Pacific region.

TASC has been commissioned by UNESCO to establish a Board of Asian national representatives to co-ordinate and develop STP training and research throughout the region. TASC has been appointed the Regional Centre for the official STP network established at the meeting (STEPAN), and has been given an official mandate to take action on behalf of participating nations. In addition, TASC has prepared the Australian section of the Asian-Pacific Technology Atlas under contract to ESCAP and the Department of Foreign Affairs and Trade.

TASC actively maintains links with an international network of overseas policy research groups and international science and technology organisations. To provide expertise in technology policy, and address international gatherings, TASC staff have travelled to China, India, Western Samoa, West Germany, Great Britain, the Netherlands, United States, New Zealand, Sri Lanka, the Philippines, and Indonesia.

STEPAN—a new network for the Asian region

A CONFERENCE at The University of Wollongong of senior Asian representatives agreed to establish a network designed to draw all agencies and people involved in science and technology policy in the Asian region together and to develop a strategy for training and research.

The network will be called STEPAN (Science and Technology Policy Asian Network). The Centre for Technology and Social Change (TASC) at The University of Wollongong will be the Regional Network Centre and will have a supervising and initiating role in line with the direction and interest of the participating institutions. Professor Stephen Hill from TASC, and chairman of STEPAN, said that the meeting, which was convened by UNESCO and attended by Asian representatives who were all prime movers in the area of science and technology policy, turned an idea that has been incubating for six years into an operational reality.

The network will limit its activities to practical objectives at first. The immediate activities in the first three years will be to:

1. Co-ordinate resources and the dissemination of information about STP seminars, training programs and research projects.
2. Identify STP training and research needs.
3. Take initiatives in generating information for defining regional and sub-regional priorities in training, research and information provision.
BOOKS


BOOKS EDITED


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