Research Report No. 5

WOLLONGONG UNIVERSITY COLLEGE

THE UNIVERSITY OF NEW SOUTH WALES

Research Report

of the

Wollongong University College

1970

JANUARY, 1971
FOREWORD

With January 1, 1975 announced as the date on which the College will become autonomous there has been considerable growth in senior administrative and library staff. No new Chairs have been established since 1969 but it is hoped that a supplementary grant will be made to the College by the State Government so that before autonomy all established departments will be headed by a Professor.

In co-operation with the Commonwealth Bureau of Meteorology a weather station has been established on the campus. Routine observations commenced September 2, 1970 and it is intended that investigations will be undertaken on various aspects of local weather conditions. This is a joint project involving staff from the Departments of Mathematics and Mechanical, Civil and Mining Engineering.

A number of research projects attracted financial support. Grants and donations received during 1970 were:

1. A.R.G.C. - Substituent Effects in Acid Ionisation Processes. (Dr. P. Bolton, Dr. F. Hall) $800
2. A.R.G.C. - Determination of Plant Dynamics using Pseudo Random Test Signals. (A/Prof. A. Roberts, Mr. W. Charlton) $5500
4. Illawarra Regional Development Committee - Social and Economic Development of the Illawarra Region. (Professor K. Blakey) 2000

5. Wheat Industry Research Council - Bulk Handling of Granular Materials. (A/Prof. Roberts and Dr. P. Arnold) 3500

6. State Planning Authority of N.S.W. - Residential Patterns Structure and Post War Growth on the Illawarra Corridor. (Dr. R. Robinson) 1000

7. Electrical Research Board Grant - Electromechanical Energy Converters. (Professor B. Smith) 830

8. Water Research Foundation of Australia - An Engineering Investigation of the Irrigation Potential of Esturine Flats. (Professor C.A.M. Gray and Dr. R. Wheway) 1000

9. Water Research Foundation of Australia - Improvement of Flocculation and Settlement of Insoluble Materials in Process Water. (Professor C.A.M. Gray and Dr. R. Wheway) 1000

10. Anti Leukaemia Research (A/Prof. E. Gellert) 200

11. Social Science Research Council Grant - Pressure of the Cattle Population in India. (Dr. E. Dayal) 600

12. National Coal Research Advisory Committee - Electrostatic Precipitation of High Resistivity Fly Ash. (Mr. O. Tassicker) 4000

13. John Lysaght (Australia) Limited - Bulge Tester (Professor G. Brinson) 1650

22980

C.A.M. Gray
Warden
DIVISION OF BIOLOGICAL AND CHEMICAL SCIENCE

Acting Head of Division: Associate Professor E. Gellert,
Dr.Phil. (Basle), F.R.A.C.I.

ACADEMIC STAFF

Department of Chemistry

Professor
B. Halpern, B.Sc. (Syd), DIC (Imperial College London),
Ph.D. (Lond.), A.R.A.C.I., Member of New York
Academy of Science  (commenced September 1970)

Associate Professor
E. Gellert, Dr.Phil. (Basle), F.R.A.C.I.

Senior Lecturers
P.D. Bolton, B.Sc. (Exeter), Ph.D. (Lond.), A.R.I.C.,
A.R.A.C.I.

Lecturers
J. Ellis, B.Sc., (Syd.), Ph.D. (N.S.W.), A.R.A.C.I.
W.K. Hannan, M.Sc. (Syd.)
G.M. Mockler, B.Sc., Ph.D. (N.S.W.) A.R.A.C.I.

Senior Tutors
D.J. Campbell, B.Sc., Dip.Ed. (Tas.) (General Biology)
Phenanthroindolizidines and related compounds.
(B. Chauncy - enrolled 1967) (awarded 1970)

Magnetic Studies of Transition Metal Complex Compounds.
(G.J. Hamilton - enrolled 1967) (awarded 1970)

Substituent Effects on the Thermodynamic Functions of
Proton Ionization of Anilinium Ions.

Catalytic Deuterium Exchange Reactions Between Alkylbenzenes.
(W.K. Hannan - enrolled 1966)

Hydrolysis of Amides.
(G.L. Jackson - enrolled 1967) (awarded 1970)

Spectroscopic Studies of Molecular Interaction in Solution.
(I.H. Reece - enrolled 1963) (awarded 1970)

The Constituents of Boletus Species.
(R. Rudzats - enrolled 1966)

Alkaloidal Constituents of Australian Plants.
(R.E. Sumons - enrolled 1969)

Physiological Aspects of Acoustic Behaviour in Crickets.
(D.J. Campbell - registration transferred from M.Sc. to Ph.D. effective from 2nd term 1966)

Hydrolysis of Amides
(R.D. Frier - enrolled 1970)
Master of Science

Substituent Effects on Chemical Reactivity.
(K.A. Fleming - enrolled 1967)

Thermodynamic Functions of Ionisation Processes.
(J. Kudynski - enrolled 1968)

Hydrolysis of Esters.
(K.J. McCarthy - enrolled 1967)

Substituent Effects in the Hydrolysis of Amides.
(P. Nancarrow - enrolled 1965)

Hydrolysis of Amides.
(J.D. Rees - enrolled 1968)

The Chemical and Magnetic Properties of Some Transition Metal Complexes.
(G.L. Sefton - enrolled 1969)

 Constituents of Plants of the Family Asclepiadaceae.
(A.G. Duff - enrolled 1970)

An Investigation of the Infra Red Spectra of Some Transition Metal Schiff Base Complexes.
(P. Gluchinsky - enrolled 1970)

Preparation of Isotopically Labelled Organic Nitrogenous Compounds
(J. Robson - enrolled 1970)

Desulphurization of Thiocarbonyl Compounds.
(R.A. Schibeci - enrolled 1970)

A Physico-Chemical Investigation of some Transition Metal Complexes.
(G.A. Ryder - enrolled 1968)
1. **Natural Products:** This field, which incorporates phytochemical investigations in conjunction with the Australian Phytochemical Survey and is helped by C.S.I.R.O. with plant collections, is concerned with the isolation of physiologically and pharmacologically active constituents.

Tylocrebrine, an alkaloid isolated from the North Queensland plant, Tylophora crebriflora, shows promising antileukaemia activity. A New Guinea Boletus, a mushroom species, is also of particular interest because it affects the human brain but the action observed is not identical with that of mescaline, LSD 25, or psilocybine.

2. **Synthetic Organic Chemistry:** The synthesis of Phenanthroindolizidines, Diphenylpiperidines and related material and the exploration of their antitumour activity is actively pursued in conjunction with efforts to correlate chemical structure with physiological activity.

3. **Physical-organic Chemistry:** (a) Kinetic studies of the acidic and alkaline hydrolysis of several series of aliphatic amides and ortho-substituted aryl esters have been made. Various linear free energy relationships are being used to assess the influence of substituents upon the rates, activation energies and entropies of these reactions.
(b) Thermodynamic acidity constants of a wide range of substituted phenols, anilinium ions and benzoic acids have been measured by a spectro-photometric technique over a range of temperature, and values of the enthalpy and entropy of these ionization processes computed. These values are also being assessed in terms of linear free energy relationships and certain molecular orbital calculations.

(c) Reaction mechanisms for the desulphurisation of organic sulphur compounds. The desulphurisation of thioamides by heavy metal salts is being studies by spectroscopic methods.

4. Chemistry of organic sulphur compounds: The chemistry and photochemistry of thionoesters and other organic sulphur compounds is being studies and their use as intermediates in organic synthesis is being examined.

5. Magneto- and Coordination Chemistry: (a) The antiferromagnetic exchange demagnetization of complexes of divalent copper with Schiff's bases and with certain nitrogen heterocyclic compounds is investigated. Temperature variation studies of the magnetic susceptibility of these new complexes indicate that the demagnetization observed is the result of exchange interactions between either two or a large number of paramagnetic centres. Structures consistent with such magnetic behaviour have been postulated for all complexes investigated and the programme is now extended to other complexes e.g. to some transition metal complexes of nitrogenous, oxygenous and sulphurous polydentate ligands.
(b) Spectra and the magnetic properties of first row transition metal complexes with (i) quadridentate oxygen donor ligands: (ii) Schiff Base ligands: and (iii) substituted pyridine ligands: are being investigated.

6. Catalytic Exchange Processes: Investigation into relative activities of Group 8 transition metals as heterogeneous catalysts in isotopic exchange reactions of a range of aromatic hydrocarbons, heavy water being used as a source of deuterium. The aim is to investigate the mechanisms of exchange reactions and in particular to test the worth of the π complex absorption mechanism.

7. Analytical Chemistry: (a) The determination of the configuration of asymmetric compounds by gas chromatography of Diastereoisomers is being studied.

(b) The use of gas chromatography in the screening for phenylketonuria in a new born population is being studied.

8. Physiology of Crickets: Techniques were developed for the location of crickets in the field and for the investigation of their singing behaviour. The analysis of the activity of natural populations of crickets is now extended to studies under controlled laboratory conditions.
PUBLICATIONS

Department of Chemistry

E. Gellert and R.E. Summons.

The major alkaloids of the bark of Cinnamomum sp. T.G.H. 13077 have been identified as the benzylisoquinolines (+)-1-(4'-hydroxybenzyl)-6,7-methylenedioxy-1,2,3,4-tetrahydroisoquinoline (norcinnamolaurine), (-)-cinnamolaurine, (+)-reticuline, and the aporphine (+)-corydine. The structure of norcinnamolaurine, a new alkaloid, was elucidated by n.m.r. and mass spectroscopy and was confirmed by conversion into cinnamolaurine and by synthesis of it racemate. O.r.d. spectra indicate that both (-)-cinnamolaurine and (+)-norcinnamolaurine belong to the D-series of benzylisoquinoline alkaloids.

B. Chauncy and E. Gellert.

A new synthesis of the racemic forms of the phenanthroidolizidine alkaloids, tylocrebrine, tylophorine and antofine, together with the previously unknown 2,3-dimethoxyphenanthroidolizidine, is described. Some features of the n.m.r. spectra of the final products and certain of the synthetic intermediates are discussed.
P.D. Bolton.


A review and evaluation of the various mathematical procedures which may be used to calculate enthalpy values from measurements of equilibrium constants over a range of temperature. A new computer-oriented technique is discussed and tables of numerical values are given which enable the new technique to be used in a simplified form.

P.D. Bolton and F.M. Hall.


Thermodynamic acidity constants of 3,5-dimethylanilinium, 3,5-dimethoxyanilinium, 3,5-dichloroanilinium, 3,5-dibromoanilinium, 3,5-di-iodoanilinium, and 3,5-dinitroanilinium ions have been measured spectrophotometrically within the temperature range 5-60°C and the standard enthalpies and entropies of proton ionization have been calculated. These results in conjunction with others measured previously indicate that for this reaction series substituent effects on both the free energies and the enthalpies of proton ionization are precisely additive. A general hypothesis for additivity in such systems is formulated and the results are discussed in terms of Hepler’s dichotomy of thermodynamic functions into internal and external components.
P.D. Bolton, J. Ellis and F.M. Hall.

Thermodynamic acidity constants of 4-chloro 3-methylphenol, 4-chloro-3,5-dimethylphenol, 3,4-dichlorophenol, and 3,4,5-trichlorophenol have been measured spectrophotometrically within the temperature range 5-60°C and the standard enthalpies and entropies of proton ionization have been calculated. The results are discussed in terms of the general additivity hypothesis previously formulated and with reference to earlier studies of additive substituent effects.


Some earlier pKₐ results for fourteen phenols in methanol as a function of temperature have been fitted to the Clarke and Glew equations. Values of ΔG°, ΔH°, ΔS° and ΔC°ₐ are reported for the ionization of the phenols.

Previously established thermodynamic parameters for the ionization of weakly basic p-nitroanilines obtained by the overlap method have been shown to follow the same linear free-energy-enthalpy correlation governing ionization of strongly basic members of the series.


P.D. Bolton, J. Ellis and F.M. Hall.


A new theory concerning the additivity of substituent effects on the thermodynamic functions of chemical reactions of multiply-substituted aromatic molecules was presented. This was successfully applied to the results of some recent studies of the thermodynamic functions of ionization of some polysubstituted phenols and anilinium ions and shown to throw useful light on the nature of steric interactions of substituents far removed from the reaction centre.

9. Extractives of Australian Timbers. X. Autoxidation and Other Reactions of the Conjugated Side-Chain of Ebelin Lactone. Isolation of a New Isomer of Ebelin Lactone


The conjugated triene side-chain of ebelin lactone has been degraded in a stepwise manner using osmium tetroxide. A new isomer of ebeline lactone has been isolated from
the sapogenin mixture and has been assigned the structure in which the 25(26) double bond has the cis configuration. Autodidation of ebelin lactone in the solid state yields a mixture from which three compounds have been isolated and identified; all three arise from oxidation of the side-chain at the terminal double bond and methyl groups.

K. Ison and E. Kokot.

The magnetic susceptibilities in the temperature range 90-400°K are reported for copper (II) complexes of the general formula CuL, where L is a tridentate Schiff base. The magnetic behaviour of some of the complexes is interpreted in terms of pairwise antiferromagnetic interaction and of others in terms of linear antiferromagnetism involving infinite chains of copper atoms.

11. Cobalt (II) and Nickel (II) Complexes of Alka-\(\alpha\), \(\omega\)-Diyl Disalicylates.
G.M. Mookler and P.M. Geoghegan.

Nickel (II) and Cobalt (II) complexes of the type ML and MLB\(_2\) have been prepared where LH\(_2\) is a potentially quadridentate \(\alpha\) \(\omega\) disalicylate ligand and B is pyridine, isoquinoline and water. Spectral and magnetic measurements indicate that the complexes are high spin with an octahedral, tetragonal or square planar environment. The complexes are either dimeric or polymeric with the ligands acting as bridging bidentates.
12. Fluorescent Labelling of Psychoactive Drugs.


The presence of drug metabolites in tissues and biological fluids can be shown, by a reaction with Dansyl chloride followed by a fluorimetric measurement.


A computer-controlled mass spectrometer system has been developed. Signal integration and computer-managed data are provided.
DIVISION OF COMMERCE

Head of Division: Professor K.A. Blakey,
B.A. (N.Z.), M.Sc. Econ. (Lond.),
D.Phil. (Oxf.), M.Com. (Melb.)

ACADEMIC STAFF

Department of Economics

Professor
K.A. Blakey, B.A. (N.Z.), M.Sc. Econ. (Lond.),
D.Phil. (Oxf.), M.Com. (Melb.)

Lecturers
S. Ali, M.Com. (Melb.), D.Ec. (Hasanuddin)
J.C. Steinke, M.A. (Calif.)

Tutors
R.G. Castle, M.Ec. (Sydney) Appointed 1/3/70
Mrs. J. Irving, B.A. Hons. (N.S.W.)

Research Assistants
C. Fisher Appointed 9/3/70
Mrs. D. Schneid " 2/9/70
P. Wilson " 6/7/70
M. Ross " "

Department of Accountancy

Professor - Vacancy

Lecturers
C.T. Heazlewood, B.Com., Dip. Ed. (Melb.) A.A.S.A. (Senior)
E.D. Moore, B.Com. (Newcastle) A.A.S.A. (Senior) A.C.I.S.
retired due to ill health 7/5/70
R.K. Wilson, B.Com. (N.S.W.) Appointed 10/8/70
Vacancy
HIGHER DEGREE TOPICS

Department of Economics

Doctor of Philosophy

The Tertiary Sector in an Industrial Economy
(Mrs. J. Irving - enrolled 1969)

The Economics of the Australian Black Coal Industry
(B. Ross - enrolled 1969)

Decentralisation in Australia
(J. Steinke - enrolled 1965)

STAFF RESEARCH ACTIVITIES

Department of Economics

A group program of regional social and economic studies has been initiated. Preliminary reports on patterns of development of population, residential building and road transport have been completed. They will be combined in an analysis of factors determining the regional pattern of production and income distribution. Two reports were submitted to the Illawarra Regional Development Committee, viz:-

Main roads expenditure in the Illawarra in relation to Regional Development Needs and,

The employment of women and demand for pre-school education.

Both reports were prepared by Professor K.A. Blakey and Mr. C.H. Fisher.
Department of Accountancy

A detailed appraisal of the informational content and accounting procedures adopted in the corporate financial statements of public operating in the extractive industry.

PUBLICATIONS

Department of Economics

   R.R. Piggott.

2. Elasticity of Supply and the Incentive for Collusive Buying.
   R.R. Piggott.

Department of Accountancy

   C.T. Heazlewood.

   C.T. Heazlewood.

3. The Periodic (Physical) and Perpetual Inventory Systems.
   C.T. Heazlewood.
DIVISION OF ENGINEERING AND METALLURGY

Head of Division: G. Brinson,
M.Sc. (Melb.), Ph.D. (Sheff.),
F.I.M., M.Aus.I.M.M.

ACADEMIC STAFF

Department of Electrical Engineering

Professor

Senior Lecturers
K.J. McLean, M.E. (N.Z.), B.D. (Melb.), Ph.D. (N.S.W.),
M.I.E.Aust.

Lecturer

Department of Mechanical, Civil and Mining Engineering

Professor
A.M.I.C.E., M.I.E.Aust., Emeritus Professor,
University of Malaya.

Associate Professors
S.E. Bonamy, B.E. (Syd.), M.Sc. (Birm.) Ph.D. A.S.T.C.,

M.I.Mech.E.
Senior Lecturers

R.W. Upfold, M.E., Ph.D., A.St.C., M.I.E.Aust., M.I.Mech.E.
P. Van der Werf, M.E., Ph.D., A.St.C., M.I.E.Aust.

Lecturers

M.J. Lowrey, M.E., A.St.C., M.I.E.Aust.
   (Appointed 14/8/70)

Department of Metallurgy

Professor


Senior Lecturers

N. Standish, M.Sc. (N.S.W.), Ph.D. (Otago), A.St.C., A.M.Aus.I.M.M.

Lecturers

M. Atkinson, B.Sc. (Eng.) (Met.) (London)
T.W. Barnes, M.Sc., A.St.C., A.I.M.
N. Salasoo, B.Sc., A.St.C., A.M.Aus.I.M.M.
D.P. Dunne, B.Sc., Ph.D. (N.S.W.), A.I.M. (appointed Sept. 1970)

Research Assistant

E. Kohn, B.E.Sc. (W. Ontario)
Department of Electrical Engineering

Doctor of Philosophy

An Investigation of the Characteristics of Rotating Machines Operated on a Switched Mode.
(W.H. Charlton - enrolled 1967)

Electrical Characteristics of Contaminated Corona - Discharge Systems.
(Z. Herceg - enrolled 1966) (awarded 1970)

Electrical Conductivity in Particulate Solids.
(K.J. McLean - enrolled 1966) (awarded 1970)

Some Aspects of the Forces on Charged Particles in Electrostatic Precipitators.
(O.J. Tassicker - enrolled 1966)

Master of Engineering

Computer Control of the 140 Inch Plate Mill, Port Kembla.
(G.E. Wood - enrolled 1966)

A Study of the Identification and Optimal Control of a Reheat Furnace.
(T.S. Yang - enrolled 1965)

Department of Mechanical, Civil and Mining Engineering

Doctor of Philosophy

An Investigation of one and two Phase Forced Flow of Granular Materials.
(D. Roach - enrolled 1970)
Master of Engineering Science

An Investigation of the stiffnesses of a plate web girder under eccentric loads applied to a flange.
(R.J. Derrington - enrolled 1967)

Investigation of Stress Distribution at Changes of Section of Members under Two Dimensional Bending and Direct Stress.
(K. Forbes - enrolled 1966)

Analysis of Non Linear Effects in Control System Performance.
(D.A. Hodges - enrolled 1966)

Investigation of Failure of Crane Runway Rails.
(D.C. Smith - enrolled 1966)

Study of Moments in Orthotropic Shells Using More Method.
(R.S. Windsor - enrolled 1966)

An Investigation of Equivalent Properties of Perforated Sheets.
(B.J. Anger - enrolled 1967)

Control System Identification Utilizing Fluidic Components.
(D.C. Crook - enrolled 1967)

Investigation of Design Methods for Bulk Transport Containers.
(J.T. Devine - enrolled 1967)

Dynamic Analysis of the Motion of Linkages with Relation to the Upper Extremity Limb.
(N.T. Hodkinson - enrolled 1967)

Performance Analysis of Multiple Conveyor Combinations.

Photoelastic Investigation of Surface Stress Distributions in a Cylinder loaded in Compressor.
(F. Finch - enrolled 1967)

Creep Testing Using Cantilever Bending.
(B.R. Visser - enrolled 1967)
An Investigation of Sheet total Formability.
(R.J. Graham - enrolled 1968)

Fatigue Behaviour of Ferrous Alloys
(J.S. Ward - enrolled 1969)

A Study of Two-Dimensional Heat Flow under Abnormal Boundary Conditions.
(R. Hall - enrolled 1969)

An Investigation of three Dimensional Heat Flow in Non Isotropic Bodies.
(I. Bekker - enrolled 1968)

Heat Transfer across a Gaseous Interface during the Propagation of a Shock Wave in a Tube.

**Department of Metallurgy**

**Doctor of Philosophy**

The Solidification of Iron Sulphur Alloys.
(S. Marich - conferred 1970)

Assessment of Sheet Metal Formability.
(M. Atkinson - enrolled 1970)

Creep in Zirconium.
(E. Kohn - enrolment changed to Ph.D. 1970)

Creep in Ferrous Alloys.
(R.L. Player - enrolment changed to Ph.D. 1969)

Studies in the Distribution of Non-Metallic Inclusion in Metal Ingots.
(I.D. Simpson - enrolment changed to Ph.D. 1970)

High Temperature Fracture in Zirconium and its Alloys.
(K. Veevers - enrolled 1970)
Master of Science

The Development of a Commercial Grade of Stabilised Drawing Steel.
(D.V. Allen - enrolled 1970)

Studies in Flooding Phenomena in Packed Beds.
(J.B. Drinkwater - enrolled 1968)

Isothermal Transformations in Austenite at Temperatures near $M_s$.
(R.H. Edwards - enrolled 1968)

A Study of the Influence of Titanium on the Structure of Alloy Steels.
(T.J. George - enrolled 1968)

Segregation Phenomena in Metal Ingots.
(G.G. Lang - enrolled 1970)

The Influence of Electron Concentration on the Structure and Morphology of Martensite.
(T. Miller - enrolled 1970)

Raceway Flow and Allied Phenomena in Packed Beds.
(R. Newell - enrolled 1970)

The Solidification of Silver-Oxygen Alloys.
(N. Salasoo - enrolled 1965)

Factors Involved in Hot-Topping of Ingots.
(J. Wilson - enrolled 1970)

The Effect of Crystallographic Orientation of the Electrochemical Properties of Tin.
(N.D. Wiltshire - enrolled 1965)
STAFF RESEARCH ACTIVITIES

Department of Electrical Engineering

1. **Automatic Control**: Investigation of computer control of furnaces and rolling mills in the steel industry; investigation of various methods of switched operation of machines; identification of systems using 2-level chain codes and correlation techniques.


3. **Processes in Electrostatic Precipitation**: Interpretation of field testing on precipitators; the performance of full scale plant when operated with high resistivity particles; the formation of reverse ionisation and its effect on precipitator performance; forces of adhesion in agglomerated layers; mechanism of current conduction in the precipitated layer; the effect of emitter geometry on current density and field strength.

4. **Insulating Materials**: The complex dielectric permittivity of powders as a function of frequency and temperature; ionic and electronic conduction in insulators with special reference to the effect of metal electrodes (one Ph.D. thesis completed); the force of adhesion between small diameter insulating particles in the presence of an ionic field.

5. **Gaseous Discharges**: Generation and transport of gaseous ions in a corona discharge system with special reference to the influence of the electrode surface condition (one Ph.D. thesis completed); feasibility of operation with controlled pulsed a.c. energisation; the complex dielectric permittivity of an ionised gas at various temperatures and frequencies; the measurement of the electric fields in a corona discharge by means of a special boundary micro area probe.
1. Indicated Power Compressors
The influence of indicator passage geometry on the power input to a reciprocating air compressor has been examined, revealing a major source of error in measurement. Errors are introduced mainly by a phase shift of indicator diagram resulting from a time delay in recording. This delay is found to be independent of compressor speed and discharge pressure. An almost linear reduction of 3 per cent of measured power per degree of phase shift has been observed from a hypothetical diagram and larger errors are apparent from experimental diagrams.

2. Two-dimensional heat flow by conduction
An examination is being made of the temperature distribution in rectangular plates subject to linear temperature gradients on opposite boundaries. Generalized computer programmes applicable to various L/D ratios are being investigated.

3. Load Distribution in Orthotropic Bridge Decks
A computer programme has been written for the analysis of right orthotropic bridge decks for various load conditions using a Levy-type matrix progression technique. This is being utilized in attempts to develop improved design procedures for such structures.

4. Analysis of Cellular Folded Plate Structures
A stiffness formulation of the matrix progression technique has been programmed for the analysis of folded plate structures with particular reference to box girder bridges. The method is exact in the sense that it is based on elasticity theory and takes into account any orthotropic properties which may be possessed by individual components of the structure.
5. **Bulk Handling of Granular Materials**

The Bulk Handling Research has been supported financially by the Commonwealth Wheat Industry Research Council and the Commonwealth Rural Credits Development Fund; the total grants received to date amounts to $55,500. The research programme is dealing with a number of problems broadly embraced by the analysis of conveyor performance, physical properties of agricultural products, and the mechanics of bulk material flow.

(i) **Conveyor Performance Studies**

The investigation of multiple length auger conveyors has continued. The computer analysis which has been undertaken has brought out two important factors which have previously received little attention. The first concerns the effect of auger length/diameter ratio on output; for a screw flight of given diameter and pitch, an increase in flight length causes a slight reduction in output. The second concerns both the magnitude and variation of the power losses due to the frictional drag on the flight on the casing. The power losses of long augers, in particular, are extremely high in relation to the power required to convey the grain.

Further performance tests have been conducted on the 20ft tubular belt conveyor. Generally speaking the conveyor performance characteristics are satisfactory for angles of elevation up to 30°, while lower power consumption and higher efficiency can be obtained by operating the conveyor at belt speeds of about 400 ft/min.

(ii) **Physical Properties of Agricultural Products**

During 1970 this research was concentrated in two main areas
Development of Recommended Techniques for the Testing of Convex-Shaped Agricultural Products.

To reduce the variability which currently exists in results of axial compression tests on intact, convex-shaped bodies such as grains and fruits, the testing techniques employed by various investigators was critically reviewed and some of the experiments repeated. It was found that the variability of the information resulting from this type of test can be reduced by using the Hertz theory, or, to a lesser extent the Boussinesq theory as the basis for the analysis of the data.


In recent years there have been several attempts to study the behaviour of agricultural products under impact conditions. Some data are available on force-deformation characteristics but in general these determinations have been hampered by the influence of inertia. Most of the data collected have been expressed in terms of energy absorbed by the specimen, but the high rates of loading have made accurate energy balances difficult. The problem of impact loading of wheat grains has been approached from a different point of view. Working from the concept of dynamic hardness as used in the impact testing of metals, a modified dynamic hardness and a dynamic elastic constant have been developed. Results from a small pendulum impactor are presently being analysed.

(iii) Flow of Granular Materials

Work is continuing on the optimization analysis of the chute flow problem. The recent emphasis in this work
has been directed to "flow synthesis", the aim being to establish the form of the chute profile to achieve certain prescribed optimum conditions such as minimum travel or maximum exit velocity. Pseudo-random test signals are being used as a means of obtaining a detailed knowledge of the dynamic characteristics of the system.

In the area of forced flow of granular materials a theoretical model of a single phase column of granular material elevated vertically is being developed to determine the required conveying force and pressure distribution throughout the granular column. Experiments have also been conducted on two phase flows with air as a fluidizing medium. A theory to describe this type of flow is being developed and the feasibility of a solids pump operating at fluidization investigated.

6. **Design Data for Coastal Engineering Structures on the N.S.W. Coast**

As there are no records of wave history for the N.S.W. Coast an analysis is being made of all hindcast wave data available in order to formalise design data for coastal engineering structures. This information is to be compared with wave records which will be obtained from wave recorders to be installed on the breakwater and Five Islands at Port Kembla.

7. **Engineering Feasibility Study of Kiama Breakwater**

An investigation is continuing for the Illawarra Regional Development Committee into the feasibility of a breakwater at Kiama. This breakwater would provide safe anchorage for fishing trawlers as well as pleasure craft. It is anticipated that the initial theoretical investigation and results will be tested by a model study.
8. **The Effect of the Coastal Range on Wind**
A climatological station has been established at Wollongong University College in conjunction with the Bureau of Meteorology. In addition to the more usual measurements of wet and dry bulb temperature, rainfall, cloud cover and wind direction, it is intended to obtain a continuous record of wind speed. By comparison with data metered at Port Kembla and Lake Illawarra, a detailed analysis of the effect of topography on wind will be made.

9. **The Effect of Cloud Cover on Solar Insolation**
From pyrheliometers which are still to be installed at the Climatological station and visual records of cloud type, density and percentage sky covered, an analysis is to be made of the depletion of radiation by cloud.

10. **Calculation of Transient Heat Flow Into Buildings**
A computer programme has been developed which enables the calculation of external air conditioning loads to be calculated. This programme takes into account shading and reflection as well as day to day storage effects. It is proposed to analyse the results obtained from a wide range of variables and examine the influences of these variables on air conditioning plant capacity.

11. **Design of a High-Volume Irrigation and Drainage Pump**
A very definite need exists for a simple relatively inexpensive pump for both the removal of floodwaters and the irrigation of large areas of land adjacent to rivers. Such a pump has been designed, the design features including portability and the provision to be driven from a tractor. This design is to be tested under both laboratory and field conditions.
12. **An Engineering Investigation of the Irrigation Potential of Estuarine Flats**

This research project has been approved by the Water Research Foundation of Australia and is being carried out using the Shoalhaven River Flats as a pilot study with eight other Councils invited to participate in the study.

The project is aimed at formulating a course of action which will result in the optimum agricultural use of some 5,600,000 acres of estuarine land which has been protected from flood waters at a cost of $10,794,000.

13. **Improvement of Flocculation and Settlement of Insoluble Solids in Process Waters**

This research project has been approved by the Water Research Foundation of Australia and is initially "a detailed survey and report on industrial water treatment and waste water disposal problems". Some fifteen industrial concerns have already taken part in the survey which is aimed at establishing a priority list for further research into water treatment problems.

14. **Quantitative Survey of Water Quality in the Illawarra and Shoalhaven Regions**

As a consequence of the previous research project, it is intended to initiate a detailed survey of the deterioration of water quality in both the Illawarra and Shoalhaven Regions. This survey is to include a study of both fresh and salt water.

15. **Cooling Tower Design Data for the Illawarra Region**

It is felt that the present design method for cooling towers is unsatisfactory because of the lack of local climatological data. It is proposed to carry out a survey of present design methods and then, if necessary, establish a set of local design conditions.
16. **Road Materials Research - Skid Resistance**

An extensive and intensive study is being made into the frictional characteristics of road pavements. The investigation covers both natural and artificial materials available locally. Also within this study is the design of cement concrete and asphalt mixes with a view to making possible the use of aggregates currently rejected because of their poor wearing quality or their tendency to take a high polish.

British Standard equipment is being used to compile data on skid properties of local pavement surfaces. This data will be useful for the following purposes:

1. Accident studies and prevention.
2. Design of horizontal and vertical alignment and design of superelevations on rural and urban roads.
3. Design and determination of highway capacity.
4. Traffic engineering and control.

A "moving pavement" polishing and skidding simulator is currently being developed to study a broad range of pavement and tyre characteristics at various speeds and under various environmental conditions. Also being developed is a test trailer for full scale field measurement of skid characteristics in order that the simulated work in the laboratory will be supplemented and correlated.

17. **Materials Research Projects**

A number of problems dealing with the strength and properties of materials are under investigation. Tests are being conducted to determine the bond strength of steel and concrete for various coatings and finishes on the steel, including deformation size and geometry.
Further work undertaken includes concrete and aggregate testing, unconfined and compaction tests of soils, triaxial tests, testing of failures in concrete, detailed testing of corings from various mines, testing of ferro-cement panels for use in boat building.

18. The C.C.T.V. Camera as a Research Tool
Techniques are being developed using the vidicon tube as an image multiplier for photoelastic work. For large scale display of Moire patterns produced in stress analysis work, the C.C.T.V. is being used to give immediate patterns.

19. The Analysis of Stress Distribution Produced at Abrupt Changes in Section
The application of the complex variable to the analysis of two dimensional stress systems produced at abrupt changes in section on axially loaded members is being investigated. This method leads to a set of infinite equations in an infinite number of unknowns. Methods for the solution of these equations have been investigated using the College computer.

20. Investigation of the Failure of Crane Runway Rails
Photoelastic methods have been used to investigate the stress distribution produced within the head of crane runway rails. Verification of the results are being obtained by load tests.

21. The Investigation of Curvature Produced in Plates with Edge Loading using Moire Fringe Techniques
The curvature of plates under varying types of loads and edge fixations is being investigated by interpreting Moire fringe patterns. These patterns are produced from a double exposure of reflected line patterns. A large scale apparatus, suitable for large plates, has been constructed and is being used for the study of the orthotropic properties of rolled materials.
22. **The Analysis of Whole Stress Fields under Impact Conditions**

Using Moiré fringe techniques and high speed photographic equipment, deflections in beams and plates over large areas are being studied. This work is being carried out for impact loading and also cyclic loading.

23. **The Development of High Speed Photographic Techniques**

Various photographic techniques are being developed for the recording on film of dynamic phenomena. Techniques are developed using combinations of ultra high speed cine cameras, high intensity stroboscopes, and single shot cameras.

**Department of Metallurgy**

1. **Fracture at Elevated Temperatures**

   (i) The high temperature fracture of iron

   The ductility of iron at elevated temperatures and at low strain rates is markedly effected by traces of carbon and oxygen in solid solution. It appears from the present work that this effect is due to the influence of these elements on the development of triple-point cracks at the grain boundaries. The elements are segregated at the grain boundaries and it seems likely that their main influence on crack formation arises through their effect on intergranular energy.

   (ii) The fracture of zirconium alloys at elevated temperatures

   Work has recently begun on the influence of structure on the fracture toughness of zirconium alloys at elevated temperatures. The investigation is being carried out in collaboration with the Australian Atomic Energy Research Establishment and will include
studies of the effect of neutron irradiation on fracture behaviour.

(iii) The creep of zirconium
The creep behaviour of zirconium at temperatures in the range of 250-350°C is markedly affected by traces of interstitial impurities. The present work, together with work overseas, has made it clear that variations in impurity content of less than 10 p.p.m. can have important effects. Solid-state zone refining is being used to produce a very low total interstitial content so that the separate effects of impurities can be investigated.

2. Solidification

(i) The distribution of inclusions in ingots
A new approach to the statistical analysis of inclusion distributions in ingots has been developed and applied to both laboratory and industrial ingots. It is intended to apply this analysis to a study of the kinetics of inclusion growth and segregation.

(ii) Solute segregation in ingots
Studies of solute segregation in solidified salt solutions have shown effects thought to be associated with systems that expand on solidification. These effects are being further investigated using Bi-Zn alloys. A separate study is concerned with the influence of hot-topping on solute segregation.
3. **Properties of Low Alloy Steels:**

The effects of composition and thermomechanical treatment on the structure and therefore the properties and potential commercial utilization of low alloy steels are being investigated by determining the influence of:

(i) deformation, before transformation, on the development of high strength in bainitic steels,

(ii) steel making and rolling mill practices on the drawing qualities of stabilized low carbon steels,

(iii) titanium and nitrogen additions on the resistance to grain coarsening at elevated temperatures of low alloy engineering steels.

4. **Structure and Properties of Welds:**

Welding operations produce changes in the structure of the base metal adjacent to the weld deposit. These structures are being simulated by transforming carbon steels during continuous cooling so that an understanding of their origin may be gained and thereby ways of controlling the properties of welded metals and alloys may be developed.

5. **The Plastic Behaviour of Sheet Metals at Large Strains:**

(i) **Hydraulic bulge testing:**

Procedures are being developed for the study of stress-strain relationships under balanced biaxial tensile stress. The first step is the design of a control system to ensure constant strain rate throughout a test at the pole of the bulge.

(ii) **Work hardening of low carbon steels:**

The stress-strain relations of soft steels are usually described by an equation of the Ludwick type,
but definite transitions in work hardening behaviour have been previously observed and confirmed in the present work. The occurrence of at least one transition at conventional testing speeds appears to depend on both grain size and carbon content; the inter-relationship of these factors is being studied.

6. **Packed Beds**

Studies in these systems are intended to clarify some aspects of hanging and gas distribution in blast furnaces. One aspect of the flooding work has now been completed, the results of which have led to the formulation of a new correlation for flooding which takes into account particle shape, wettability and froth formation.

The study of pressure drop with melting has emphasized the importance of packing arrangement and these results will be taken into account in work now in progress on flow distribution in a scale model of a copper blast furnace.

7. **Martensitic Transformations**

The further development of the geometrical theory of martensitic transformations is being studied using accurate measurements of the crystallographic properties of ferrous and non-ferrous martensites.

Other work concerning the factors which influence the structure and formation of martensite plates is also in progress.
PUBLICATIONS

Department of Electrical Engineering

1. "Matrix approach to the Steady-State analysis of inverter-fed induction motors".
W. Charlton.

The output voltage of a static inverter is frequently a piece-wise constant, periodic waveform. For such cases, a method is presented for finding the steady-state current waveform.

2. "The Short Circuit modes of a Synchronous Machine".
W. Charlton.

Time domain matrix methods coupled with convenient linear transformations are used to obtain expressions for the winding currents of a synchronous machine subjected to a symmetrical three-phase short circuit.

3. "Chute profile for maximum exit velocity in gravity flow of granular materials".
W. Charlton and A.W. Roberts.

An analysis of the required profile shape of gravity flow discharge chutes to achieve maximum exit velocity is presented. The dynamic equations for a grain element in the flowing stream are developed and an expression for exit velocity is obtained.

Department of Mechanical, Civil and Mining Engineering

1. "Power Input to Reciprocating Air Compressors".
S.E. Bonamy.

2. "The Transfer of Heat Across a Gaseous Interface during the Propagation of a Shock Wave in a Tube".
S.E. Bonamy and R.T. Wheway.

3. "The impact velocity of ring type automatic compressor valves".
R.W. Upfold.

4. "Valve Flutter".
R.W. Upfold.

5. "An examination of ring type compressor inlet valves".
R.W. Upfold.

6. "Bulk Handling and Testing of Granular Materials".
A.W. Roberts.

W.H. Charlton and A.W. Roberts.

R.T. Wheway.
Department of Metallurgy

1. Part Chapter on "Kossel Technique" in a publication entitled "The Electron Probe Micro Analyser"
N. Kennon.
Published by McMaster University, Canada. (1970).

2. "The Isothermal Transformation of Austenite at Temperatures Near Ms - I Transformation Products".
Austenite containing 1.44%C transforms isothermally at temperatures near Ms to two products both having a lenticular morphology, and which were identified from habit plane measurements. One product has a habit plane near (225)γ and is identified as isothermal martensite, the other product has a habit plane near (110)γ and is identified as lower bainite. Transmission electron metallography shows that the structural inhomogeneities in the plates of the two transformation products are consistent with this identification.

3. "The Isothermal Transformation of Austenite at Temperatures Near Ms - II Transformation Diagram".
This paper describes the results of a detailed metallographic study of the isothermal transformation of austenite containing 1.44%C at temperatures between 69.5°C and 130°C. Two transformation products, lower bainite and isothermal martensite were formed at temperatures both above and below Ms (93°C), and the 1% transformation curves used to construct the isothermal transformation diagram. This is the first
determination of the transformation diagram for unequivocally identified products formed at temperatures near Ms in any alloy.

Brine solutions of various NaCl contents were frozen in a laboratory-size mould under different solidification rates. The concentrations of NaCl at various positions in the ingots were determined. The convection velocities in the liquid cores were also measured.
The results showed that the severity of segregation was proportional to the initial concentration of NaCl and the solidification rate. The latter was shown to obey the well-known square root relationship for metal ingots. The results also showed that the liquid in the centre and ahead of the solidification front was positively segregated during freezing and that this was reversed after the ingots had solidified. This phenomenon, which has also been observed in steel ingots, was explained by gravitational effects. Convection velocities were mostly in the range 1.5 to 3.0 in./sec. These values are comparable with those which have been measured in industrial steel ingots.
The relevance of this investigation to industrial ingots is indicated.

5. "Laboratory Investigation of the Effect of Coke Shape on Flooding and its Implication to Blast Furnace Hanging". N. Standish & J.B. Drinkwater.
6. "Representation of Inclusion Count Data by the Rosin-Rammler Law".
N. Standish & I.D. Simpson.
Metallurgical Transactions, 1970, 1, 331.
Inclusions counted in Al deoxidized iron and copper ingots and the results were fitted to the R-R Law. From the parameters obtained it was concluded that inclusion morphology affects the distribution of these non-metals in the ingots investigated. The practical value of a linear relationship of the R-R type is that it would enable comparisons to be made of inclusion populations and to lead to a more rational unit by which steel cleanness may be resumed.

7. "Discussion of Fluid Motion Through the Partially Solid Regions of a Casting and its Importance in Understanding A-Type Segregation".
N. Standish.
Solidification results have been presented which show that ice ingots obey the square root law and that those for ammonium chloride ingots do not. These results were used to argue that some of the conclusions of McDonald and Hunt may not be applicable to metallic ingots. It was suggested that the formation of A-segregates is also constant with the intervention of the solute flotation and the solidification pattern in steel ingots.

8. "The Extension of Graphical Analysis of Counter-Current Iron Ore Reduction".
N. Standish.
A method based on the transfer unit concepts has been presented as a means of extending the utility of graphical representation of iron ore reduction data. The method was applied to analyse the available reduction results obtained in the Bo-Rist apparatus. It was concluded that although for some tests the resistance was almost totally within the solid, for others the gas resistance appeared to be significant. These and other conclusions were compared with results available in the literature and application of these to reduction under blast furnace conditions was also considered.

9. "Statistical Study of Inclusion Distribution in Steel Ingots".
N. Standish, B.P. Bamsley and I.D. Simpson.
A study was made of inclusions distribution in laboratory ingots of Al deoxidized iron and in a 12 ton experimental ingot of Ti killed steel. From the statistical parameters obtained and the results of segregation and EPMA investigation, it was concluded that the size-frequency distribution of both oxide and sulphur inclusions is related to their morphology and to casting conditions and ingot structure. Results of chemical analysis showed that except for oxygen there was no measurable segregation of the other elements present.

10. "Investigation of Pressure Drop in Packed Beds with Melting".
N. Standish & R. Newell
Pressure drops were measured in a column packed with glass spheres and wax particles, both in random and preferential distributions. Variables investigated included wax content, gas flow rates and temperatures.

It is shown that for random distribution of wax, pressure drop is exponentially related to wax content above the melting point of wax and the below this it increases with increasing gas rate and temperature.

For preferred distribution of wax the highest increase in pressure drop is obtained with horizontal distribution of wax and the least with vertical distribution.

Comparison with operating blast furnace data and application of results to practice are also included.


The validity and accuracy of three methods of shape strain analysis are examined by applying these methods to the experimental determination of the shape strain in a system in which this strain is precisely known - deformation twinning in B-tin. Single -, two -, and three - surface methods are used to determine the twinning (habit) plane, direction and magnitude, and the results are compared with the known values and are used to assess the relative merits of the three methods. Analytical versions of the methods are presented and the maximum information obtainable from different combinations of the input data is given; in some cases the results are over determined and statistical assessment is possible.
The experimental results of all three methods are shown to be in excellent agreement with theoretical values and the results obtained from surface measurements, are considered to be truly representative of twins forming within the bulk. The significance of the results is examined in terms of the application of these methods to martensitic transformations.

12. "A Multi-point Record From A Single Pen Recorder".  
T.W. Barnes.  
A sequentral switch has been made, using simple logic elements. With it, up to six temperature indications can be recorded in sequence, on the chart of a single pen recorder. The switch serves to successively connect the thermocouples to a recorder, one at a time; this is a multiplexing action.  
The methods employed are well known and reliable for the purpose.

M. Atkinson.  
Characteristic maximum drawing loads and fracture loads have been measured in a new press embodying a secondary clamping tool of the Engelhardt type and a sensitive load cell in the punch stem. The ratio of these loads in a single specimen, 'draw-fracture', cup drawing test is shown to be a useful parameter for assessing normal anisotropy of sheet steel.  
Test conditions (involving only one die for a wide range of sheet thickness) which give good discrimination of anisotropy are described. Comparison of three parameters now available
for assessing normal plastic anisotropy, i.e. tensile strain ratio, limiting drawing ratio and the loads ratio from the 'draw-fracture' test, revealed that experimental error does not account for the scatter in the relationships between these parameters. It is suggested that the greatest discrepancy arises from the use of an 'average strain ratio' (for several directions) to describe normal anisotropy.

The ratio of width strain to thickness strain in a tensile test is an important indication of anisotropy. Earlier work had established that variations in plastic behaviour commonly resulted in uneven width strain and hence in errors in the estimation of final width. This machine incorporates an integrating pneumatic width gauge operating over a gauge length of five inches. All width and length measurements are stored and the ratio of incremental width and thickness strains is determined by an analogue computer.

15. "A Chemical Polish-etch for Silver".
N. Salasoo
Letter to the Editor. A chemical method for simultaneous polishing and etching of silver, for metallographic examination, has been developed. The process delineates both grain boundaries and substructures within grains.

16. "The effect of Particle Shape on Flooding Rates in Packed Columns".
N. Standish and J.B. Drinkwater.
The effect of particle shape on flooding velocities in counter-current gas-liquid systems were investigated using Standish's transient beam apparatus. The results show that particle shape is a significant variable in the flooding process and that decreased sphericity leads to the lowering of flooding rates. The results also lend support to the pressure gradient theory of flooding and strongly suggest that the lowering of α-factor is due to packing geometry rather than to interfacial shear.
DIVISION OF LITERATURE AND LANGUAGE

Head of Division: P.K. Elkin,
B.A., Dip.Ed. (Syd.),
B.Litt., D.Phil.(Oxon).

ACADEMIC STAFF

Department of English

Professor

Lecturer

Senior Tutor

Tutors
Mrs. I.S. Sharp, B.A. Dip.Ed.(Syd.)
Miss J.C. Walker, B.A.(Syd.) (appointed 16.2.70)

Department of General Studies

Lecturer
D.J. Dillon-Smith, M.A. Dip.Ed.(Syd.)
STAFF RESEARCH ACTIVITIES

Department of English

1. The English Department is following a number of lines of research, according to the individual interests of members of the Department. The major topics undertaken are: satire, with particular reference to comments on its nature and function from the eighteenth century to the present day; eighteenth and twentieth century translations of Juvenal's satires; the poetry of Thomas Hardy; the novels and plays of Samuel Beckett in English translation, and, in the field of Australian literature, the writings of Miles Franklin.

2. Miss J.C. Walker has been investigating the uses to which modern theories of literary criticism can be put in the study and teaching of medieval literature. She has just completed a thesis for the degree M.A. on "Chaucer's Troilus and Criseyde discussed in terms of modern literary critical theory".

3. Mr. P.G. Abotomey has undertaken "A critical analysis of the novels of Miles Franklin" towards the degree of Master of Arts.


Department of General Studies

Mr. D. Dillon-Smith is inquiring into aspects of the English language in the eighteenth century, with particular reference to polite and vulgar usage. He is also investigating possibilities of a language study in the Illawarra region especially in connection with migrant population.
Department of English

"Dryden's Translation of Juvenal's Sixth Satire".
P.K. Elkin.

DIVISION OF PHYSICAL SCIENCE

Head of Division: Professor A. Keane
M.Sc. (Syd.), Ph.D. (N.S.W.)

ACADEMIC STAFF

Department of Geology

Senior Lecturer
A.C. Cook, Ph.D. (Cantab.), A.M.Aus.I.M.M., F.G.S.

Lecturers
R.A. Facer, B.Sc. (Syd.)
E.R. Phillips, B.Sc., Ph.D. (Qld.)

Tutor
G.D. Gibson, B.Sc., Dip.Ed. (Syd.)

Department of Mathematics

Professor
A. Keane, M.Sc. (Syd.), Ph.D. (N.S.W.)

Senior Lecturers
A.E. Chapman, M.Sc. (Lond.)
(promoted November 1970)
P. Suryanarayana, B.Sc. (Andhra), M.A. (Madras), Ph.D. (Calif.)
(appointed October 1970)
K.P. Tognetti, B.E., M.Eng.Sci. (N.S.W.)

Lecturers
M.W. Bunder, B.Sc. (N.S.W.), M.A. (New England),
Ph.D. (Amsterdam)
T.S. Horner, B.Sc., Dip.Ed. (Syd.)

Tutor
Department of Physics

Senior Lecturers
K.J. Ausburn, B.Sc. (Syd.), M.Sc. (Lond.), Ph.D. (N.S.W.)
D.I.C., A.Inst.P.

J.N. Stephens, M.A. (Cantab.), Ph.D. (N.S.W.), Grad. A.I.P.
A.M. Inst.F.

Lecturers
J.N. Mathur, M.Sc. (Alig.), Dr. rer. nat. (Kiel).

A.I. Segal, B.Sc. (Melb.), Grad. A.I.P.

Vacancy

Tutor
J.L.K. Lising, B.Sc. (N.S.W.)

G. Moore, B.Sc. (N.S.W.)

N. Montgomery, B.Sc. (N.S.W.)
HIGHER DEGREE TOPICS

Department of Geology

Doctor of Philosophy

Statistical Studies in Sedimentation.
(K.R. Johnson - enrolled 1969)

Master of Science

The Vertical and Lateral Variations in the Petrographic Composition of the Bulli Seam of the South Bulli Syncline.
(H.W. Read - enrolled 1967)

A Petrographic Study of the Stratigraphy of Australian Coal Seams.
(M. Smyth - enrolled 1969)

Studies in Stratigraphy and Sedimentation in the Southern Coalfield.
(C. Waters - enrolled 1969)

A Study of the Post-Permian Quartzites of Southern N.S.W.
(J.H. Callender - enrolled 1970)

Department of Mathematics

Doctor of Philosophy

Development of Languages for use in Conversing with a Digital Computer via a Remote Terminal.
(N.W. Bennett - enrolled 1968)

Mathematical Methods of Traffic Flow.
(P. Castle - enrolled 1969)

Methods for the Calculation of Heterogeneous Reactor Systems.
Neutron Transport in Subcritical Lattices.
(B.E. Clancy - enrolled 1967)

Oscillations within and on a Fluid contained by Arbitrary Bounds.
(D.J. Clarke - enrolled 1967) (To be awarded)

Relative Nuclear and Particle Reaction Theory.
(J.L. Cook - enrolled 1969) (Title changed 1969)

Collision Probability Methods in Reactor Lattice Calculations.
(G. Doherty - enrolled 1967)

A Correction to the Narrow Resonance Approximation for the Calculation of Resonance Absorption.
(T.S. Horner - enrolled 1966)

(K.J. Maher - enrolled 1969)

Reactor Theory
(D.J. McKeegan - enrolled 1968)

Eigenvalues of Matrices by Numerical Methods
(A.G. Morris - enrolled 1970)

Wind Generated Currents in a Basin.
(P.J. O'Halloran - enrolled 1968)

Numerical Methods Used in Neutronics Calculations.
(J.P. Pollard - enrolled 1967)

Language Translation and Optimization.
(D.J. Richardson - enrolled 1966) (To be awarded)
Master of Science

Statistical Studies of Population.
(N.M. Broers - enrolled 1969)

Nuclear Reactor Theory.
(D.J. Lear - enrolled 1970)

The Inverse Scattering Problem.
(E.J. Clayton - enrolled 1970)

Mathematical Models in Marketing.
(J.K. Doherty - enrolled 1970)

Population Distributions.
(D. Roudenko - enrolled 1969)

Validity of an Operational Solution to LAPLACE'S equation with non-linear boundary conditions.
(R.W. Wilcox - enrolled 1969)

Master of Arts

Mathematical Models for the Wollongong Urban Area.
(Miss J. Shaw - enrolled 1967)

Department of Physics

Doctor of Philosophy

(A.I.M. Ritchie - enrolled 1968) (To be awarded)

Fission Physics.
(J.W. Boldeman - enrolled 1968) (To be awarded)
Master of Science

The Limitations of Infra-red Image Detectors in Astronomy.
(H. Fraser - enrolled 1967) (Title changed from 1968)

Application of the Mossbauer Effect to the Study of Solid Solutions.
(J. Lising - enrolled 1966)

Studies of the Information Content of Photographic Emulsions.
(J.M. Robinson - enrolled 1968)

Infra-red Imaging Devices.
(C.J. Sofield - enrolled 1968)

An Atmospheric Water Vapour Meter.
(P.W. Thompson - enrolled 1968)

STAFF RESEARCH ACTIVITIES

Department of Geology

1. Coal Carbonization: A study is being made of the relation between the properties of coals and those of their cokes, with particular emphasis on petrographic aspects of both. Two aspects which have received particular attention are coking properties of low vitrinite coals and the effects of blending high rank low vitrinite coal with low rank high vitrinite coal. In part this is a collaborative project with the Australian Iron & Steel Geology and Coke Research Sections.

2. The Variation of Coal Properties in the Southern Coalfield, N.S.W.: One aspect of this study concerns the collection of data, a second the development of methods of analysing the data and a third the relation of the variation to structure
and sedimentation conditions. It has been demonstrated that a significant relationship exists between the thickness of Bulli Seam and some of the structures which affect the seam.

3. **Sedimentation in the Sydney Basin:** Particular attention is being paid to sediments in the coal measures. Methods are being developed for the analysis and description of vertical and lateral variations.

4. **Myrmekites:** Myrmekites are quartz-plagioclase intergrowths found on the rims of some plagioclase crystals. The development of myrmekite in retrograde schists from Broken Hill is being investigated to help resolve the question of their origin.

5. **Intrusive Complexes of South-Eastern Queensland:** Research is being continued on the petrography of these mainly granitic masses.

6. **The paragenesis of gneissic rocks from Broken Hill:** Preliminary petrographic studies of the mine sequence "granitic" gneisses from Broken Hill is being carried out.

7. **Magnetic Properties of Rocks:** Palaeomagnetic aspects and the relation of magnetic properties to the petrology and mineralogy of the rocks are being considered. The Illawarra region offers scope for the application of rock magnetic studies to structural geology and mining geology.

8. **Study of Extrusive Rocks of the Illawarra Region:** With the planned commencement of an additional large-scale quarrying operation in the Illawarra Region an approach was made to the operators for permission to engage in long-term study of the physical and perhaps chemical characteristics of the igneous rock. It is intended that this study will supply information on the character of, and variation through, the rock.
9. **Geology and Photographic Recording:** Compilation of a photographic record of aspects of Geology as illustrated by features in the Illawarra Region has begun. This is important in so far as many features are processes currently in active or formative stages, and might not otherwise be adequately recorded. Other aspects are particularly well represented in the Illawarra Region.

**Department of Mathematics**

1. **Nuclear Reactor Theory:** Equivalence relations for clustered rods are being investigated. It seems that a simple approach is not possible and that considerable computing effort will be needed to obtain a useful result.

2. Papers were prepared on the basing of propositional and predicate calculus as well as various systems of set theory on combinatory logic. Research into the consistency of the combinatory system is continuing.

3. Un procurability of adequate but reasonably inexpensive recording equipment for measuring long wave spectra has hindered experimental investigations on the phenomena (i) surging of Port Kembla harbour, (ii) the occurrence of long waves over the Continental shelf, and particularly, (iii) the propagation of long waves up the South Coast. Two such instruments were ordered from the Both Company in South Australia and after two years that Company withdrew from the contract. Theoretical considerations of these and other problems is a continuing exercise. In the past year five separate aspects have been brought to a conclusion and five theoretical papers have been submitted to Journals of the marine sciences. These aspects are (i) two-dimensional seiche motions in enclosed bodies of water, (ii) the dynamic response of
enclosed bodies of water to applied wind stresses with
due account being made for friction, (iii) internal seiche
motions, (iv) the dynamic response of estuaries to forced
oscillations at the entrance, and (v) standing waves over
the Continental shelf.
Further developments of items (ii), (iv) and (v) are
currently being considered. In particular, more accurate
modelling of the friction effects is undergoing investigation
for the dynamic response of a lake to an applied wind stress,
the response of estuaries is being treated where a clapotis
forms outside the entrance, and better modelling procedures
are being developed for standing and edge waves on a
Continental shelf.
It is proposed to begin a study of the dynamic effects of
ocean currents for a long time scale over the Continental
shelf region and subsequently to provide more information
of water movement off the South Coast.

equations resulting from extension of Lotka-Volterra equations
to account for log and history effects on numbers and age
distribution. Computational techniques for modelling of
interacting population models.

5. Operations Research: The use of computer modelling for
the analysis of queueing and inventory models is continuing.
Statistical design of computer simulation experiments.
Analysis of autocorrelated interdeparture distribution of
queues to be used for series queueing systems. Dynamic
programming and branch and bound techniques are being used
to investigate problems in search and detection.
The problem of the selection of a computer with a realistic
set of buyer constraints is being modelled as a programming
problem.
Department of Physics

Investigation of infra-red image detectors for astronomical applications are continuing. An 18-inch Newtonian infra-red stellar telescope is nearing completion and is being brought into operation initially with infra-red photographic plates as the detectors.

Mossbauer spectroscopic investigations of some magnetic minerals are continuing.

PUBLICATIONS

Department of Geology

1. "Early Joint Formation in Sediments".
   A.C. Cook and K.R. Johnson.

   Jointing in some 'ironstone' intraclasts in a sandstone from the Sydney Basin, New South Wales shows that the joints were developed prior to contemporaneous erosion. A number of other features observed in the Sydney Basin sequence support this conclusion and suggest that an anisotropic horizontal stress field developed in the sediments very soon after their deposition.

2. "Note on Coals containing Marcasite Plant Pertrifactions, Yarrunga Creek, Sydney Basin, New South Wales".
   H.W. Read and A.C. Cook.

   Coals of low bituminous rank, resembling in type a coal from the Clyde River Coal Measures, contain numerous plant petrifications of marcasite with minor pyrite. The iron sulphides were emplaced early in the history of the coal and are associated with vitrinite-rich layers. They have
replaced plant tissue rather than filled up voids in the peat. Massive marcasite is thought to represent complete replacement, whereas the material with relict plant structure may represent an intermediate stage.


Preliminary results of palaeomagnetic studies of 540 specimens from the Pre-Cambrian Giles Complex indicate the presence of a stable TRM in rocks from the Complex. These results indicate that the position of the Earth's South magnetic pole 1100 m.y. ago (relative to Australia) was Latitude 68°S, Longitude 163°E. Using Irving's convention, this indicates a normal palaeogeomagnetic field at this time.


The results of detailed palaeomagnetic and rock magnetic studies of 540 specimens from the Giles Complex have indicated the presence of a stable TRM in 47 per cent of the samples. Greater precision was achieved using specimens as units rather than samples in the Fisher analysis, although both populations are statistically non-random at the 95 per cent confidence level. Anisotropy of magnetic susceptibility has apparently not affected the direction of magnetization in the undeformed Giles Complex rocks. There is some evidence of correlation between the magnetic properties and the petrology and/or iron-titanium oxide mineralogy of the rocks. Assuming acquisition in a dipole geomagnetic field, the TRM corresponds
to a North palaeo-pole (relative to Australia) at Latitude 68° N, Longitude 343° E (semi-axes of the ellipse of 95 per cent confidence: 23°, 29°).

5. "'Continental Drift: Implications of Palaeomagnetic Studies, Meteorology, Physical Oceanography and Climatology' by A.A. Meyerhoff: A Discussion". 
R.A. Facer. 
Meyerhoff's review of aspects of evidence used to "test" the Continental Drift hypothesis included comments on palaeomagnetic evidence. Additional points made in this discussion include reference to (possible) non-dipole magnetic field effects, together with the possible importance of correlation between magnetic properties and petrology/mineralogy of the rocks studied. The review by Meyerhoff, and this discussion, emphasize the need for scientific caution in the consideration of evidence used in assessment of the concept of Continental Drift.

Microprobe and optical data indicate that in contrast to igneous rocks such as adamellites and granodiorites, the non-myrmekitic plagioclase and myrmekitic plagioclase are very similar in composition. The very fine myrmekite in contrast to coarser intergrowths found in the gneisses is associated with muscovite and the origin of such an association may be related to replacement of potash feldspar during retrograde metamorphism.
1. "An Approximation for Self Shielding"
M.W. Bunder and A. Keane,
AAEC/TM539, April 1970.
Self-shielding data for $^{233}$U were fitted to a three-parameter formula for inclusion in the GYMEA library. With dilution and temperature variations included it is not possible to reproduce the results exactly but the work has aimed at reproducing the correct effective resonance integral while making the contribution to each group as correct as possible.

2. "A Paradox in Illative Combinatory Logic".
M.W. Bunder.

3. "A Two-Stage Population Model".
Keith P. Tognetti and A. Mazanov.
If an organism may exist for a constant period as an egg before it becomes an adult and if the birth rate per individual and the death rate of an egg and adult are constants, the number of adults can be represented by the differential delay equation
$$\dot{N}(t) = \gamma N(t-1) - \beta N(t).$$
It is shown that this equation behaves like the Malthusian equation with large $t$ where $\gamma$ corresponds to the Malthusian birth rate and $\beta$ corresponds to the Malthusian death rate.

With the other parameters held constant the population will inevitably die out if the egg stage is increased beyond a critical value.
An expression for the age density function is developed that is shown to asymptotically approach a negative exponential independent of time.
Wollongong University College Bulletin No. 24, December 1970.
The mathematical techniques associated with the Lotka-Volterra competition model are reviewed. It is shown that the structure of such deterministic population models can be readily investigated with computer techniques that can now be mastered easily by biologist. Some new structure relating to the phase diagram of the competition model is described.
DIVISION OF SOCIAL SCIENCE

Head of Division: Ross Duncan
MA. (Adel.)

ACADEMIC STAFF

Department of Education

Senior Lecturer


Lecturer

P.R. de Lacey, M.A. (Auckland) B.Sc.(N.S.W.) Ph.D. (N.E.)

Department of Geography

Senior Lecturer

F. Beavington, B.A. (Lond.) M.Sc.(Soil Sci.)(Aberd.)
Cert.Ed.(Cantab.)

Lecturers

E. Dayal, M.A., Ph.D. (Delhi)
Ph.D.(British Columbia)

Department of History

Professor

R. Duncan, MA. (Adel.)

Senior Lecturers

A.M. Healy, B.A.(Syd.) Ph.D. (A.N.U.)
C.P. Kiernan, M.A.(Cantab. and Melb.) Ph.D.(N.S.W.)
(promoted December 1970)

Lecturer

H.N. Ingle, B.A., M.A., (Johns Hopkins)
(commenced 26th August 1970)

Tutor

Miss J.A. Jeffrey, B.A. (Syd.)
Department of History and Philosophy of Science

Lecturer

R.D. Francis, M.A. (N.Z. and Melb.) A.B.P.s.S.

Department of Psychology

Senior Lecturer

Ph.D. (Calif.) (promoted December 1970)

Lecturer

N.L. Adams, B.Sc. (N.S.W.)

D. Diespecker, B.A., Ph.D., (N'csie.) M.A.P.s.S.
(commenced 2nd February 1970)

Tutor

C.G. Cupit, B.A. (Syd.)
HIGHER DEGREE TOPICS

Department of History

Master of Arts

Public, Professional and Political Attitudes to Education in New South Wales circa 1880-1900.
(Miss J.A. Jeffrey - transferred from Sydney Uni.)

Department of Psychology

Doctor of Philosophy

Scholastic Achievement, Anxiety and Family Value - Discrepancy in Senior School Pupils.
(N.L. Adams - transferred from Kensington, 1968)

STAFF RESEARCH ACTIVITIES

Department of Education

Research activities have been severely limited by lack of research moneys and resources, and by pressures imposed by a large part-time staffing pattern. It was possible to carry out significant research only because of an unusually low number of Diploma in Education students as a result of the Wyndham Scheme. The research projects have been as follows:

1. Research into the philosophical dimensions of moral education, with publication of a study of the role of Australian churches in education imminent.

2. A programme of auditing and contributing to a postgraduate seminar on Ethics in Education, conducted throughout the year by the University of Sydney.

3. Extension of doctoral study of the development of logical thinking among Australian children, involving
high-contact full-blooded Aboriginal children in Alice Springs and Darwin (with a grant from the Australian Institute of Aboriginal Studies).


5. Participation in the first stage of a long-term assessment of the effects at primary school of the experimental enrichment preschool kindergarten at Bourke.

6. In association with the Tertiary Education Research Centre (University of N.S.W.), a survey of firstyear students at Wollongong University College.

7. In association with members of the Psychology Department, Australian National University, a study of the cognitive development of Aboriginal children adopted by white foster parents in Adelaide (funded by the Aboriginal Council).

Department of Geography

1. A land potential assessment of the partially reclaimed lands of the lower Shoalhaven Valley. A sum of $8,000 from Federal, State and local sources has been made available for this work.

2. Trace element and other element contamination of soil of urban parkland, farmland and industrial land within Greater Wollongong.

3. A project on 'The pressure of cattle population in India' is on hand. Some maps and write-up have been completed. The project has been supported by the Social Science Research Council of Australia by way of a travel grant for the
collection of additional data.

4. Another project in hand is on 'The Regional Aspects of Technological change in Australian Agriculture'. This is in the initial stage of data collection and documentation.

5. 'Residential Patterns, Structure and Post War Growth in the Illawarra Corridor'.

The research is being financed by the Illawarra Regional Development Committee and by a grant of $100 from the State Planning Authority. Two research assistants and one cartographer are being used in the project. At the end of 1970 the patterns of residence for 1949, 1956 and 1966 had been established and rates of growth etc. computed. Further research into the development of a predictive model (Phase III) will begin in early 1971.

Two further areas of research within the broad framework of residential development are also under way:

(a) analysis of population density gradients in the Illawarra and

(b) a factorial ecology of the urban area, based on 1966 census data.

6. 'Explorations into Port Structure: Comparative Analysis of Intra-Port Shipping Linkages'.

The research is in initial stages of data collection and assembly. It is an attempt, using factor analytic techniques, of delineating the basic patterns of shipping movement within ports. The results should clarify the functional links within a port area and enable ready identification of congestion points. The research is being carried out with the co-operation of the Maritime Services Board in Sydney.
7. 'Lake Illawarra - An Urban Resource'.

This project is being carried out jointly with the Professor of Economics and at the request of the Illawarra Regional Development Committee. Initially the research involves the co-ordination and presentation of data assembled in response to questionnaires sent to Government Departments, Councils, etc. This should enable the identification of particular problem areas for further research.

Department of History

1. Research is being made into the influence and importance of science in the thought of the French Enlightenment. A comparative study of eighteenth century French and English thought on science and religion is also being undertaken.

2. In Australian history research continued during the year on the motivation, nature and social status of Londoners who migrated to New South Wales during the last quarter of the nineteenth century.

Other fields of study were trade unions, education during the late nineteenth century and the history of the labour movement.

3. In modern colonial history further progress is reported on research into intercultural problems in colonial areas, and in particular, the history of native administration and industrial development in Papua-New Guinea. Political problems in Melanesia were also investigated and research was continued into colonial education policies in Southeast Asia.

4. Research is being carried out into the development of the Russian State, and Russian politics and international relations in the eighteenth and nineteenth centuries.
5. Further progress was made in the collection of archival material and the department has acquired temporary storage space at the Big W at Warrawong, equipped with about 1,000 running feet of shelving. This shelving is now completely filled and the material which remains to be catalogued and shelved would fill an additional estimated 370 running feet. All these records are potentially of great use, not only to historians, but to economists and geographers as well.

Department of History and Philosophy of Science

The sole staff member was on study leave during 1970. Research was commenced on Australian migration and crime.

Department of Psychology

Two lines of research were concluded during 1970:

(a) the vocational interests of personnel employed in the data processing industry, and
(b) learning via vibratory stimulation of the skin.

A major research programme has been planned for 1971. This investigation concerns the perception of critical levels in industrial instrumentation and control systems using two sensory modes for signal input. This research is contingent on the success of application for funds made to the A.R.G.C.

PUBLICATIONS

Department of Education

1. "Classificatory performance among Aboriginal and white Australian children".
   P.R. de Looey.
   Report to the Australian Institute of Aboriginal Studies, Canberra. Cyclostyled.
2. "The Development of classificatory ability in Australian children".
P.R. de Lacey.

3. "Environment and logical thinking among Aboriginal children".
P.R. de Lacey.
Paper presented to the Annual Conference of the Australian Institute of Aboriginal Studies, Canberra, Cyclostyled.

4. "An index of contact for Aboriginal Communities".
P.R. de Lacey.

5. "A cross-cultural study of classificatory ability in Australia".
P.R. de Lacey.

6. "Custodial function and preschools. In care of preschool children and some other factors relating to the employment of women in the Illawarra region".
J.S. Hagan and P.R. de Lacey.
Report to the Illawarra Regional Development Committee. Economics Department, Wollongong University College. Cyclostyled.

7. "Social Class and Compensatory Education".
J.S. Hagan and P.R. de Lacey.
Outlook, v (1970).
8. "Religious Instruction in State Schools".
   B.V. Hill.

9. "Different but Equal: an Examination of the Rationale for a Binary System of Tertiary Education".
   B.V. Hill.
   *Vestes, xiii,* (July 1970).

10. "Religious and Moral Issues in Australian Schools".
    B.V. Hill.

11. "Education to Meet the Challenge of our Times".
    B.V. Hill.

12. "Western Education at the Crossroads".
    B.V. Hill.

**Department of Geography**

1. "The Hinterland-Foreland Continuum: Concept and Methodology".
   R. Robinson.
   *Prof. Geogr.,* xxii (1970), 28-34.

2. "Systems Analysis and the Allocation of Port Investments; Recent Developments in Methodology and Application to Developing Countries".
   R. Robinson.
   Paper read to Section 21, 42nd ANZAAS Congress, Port Moresby, 1970.
1. "Vibrotactile code learning by young adolescent girls".
   D.D. Diespecker.

2. "Short Duration Signals and Learning of Simple Vibrotactile Code".
   D.D. Diespecker.
HIGHER DEGREES AWARDED

Doctor of Philosophy

P. Van der Werf (Mechanical Engineering, 1966)
P.C. Arnold (Mechanical Engineering, 1968)
R.T. Wheway (Mechanical Engineering, 1968)
N.F. Keenon (Metallurgy, 1968)
C.P. Kiernan (History, 1969)
R.W. Upfold (Mechanical Engineering, 1969)
B. Chauncy (Chemistry, 1970)
G.J. Hamilton (Chemistry, 1970)
F.M. Hall (Chemistry, 1970)
G.L. Jackson (Chemistry, 1970)
I.H. Reece (Chemistry, 1970)
Z. Herceg (Electrical Engineering, 1970)
K.J. McLean (Electrical Engineering, 1970)
C. Chirella (Mathematics, 1970)

Master of Science

R. Rudzats, (Chemistry, 1963)
M.W. Dyos (Mathematics, 1966)
T.W. Barnes (Metallurgy, 1966)
J.P. Pollard (Mathematics, 1967)
D.J. McKeegan (Mathematics, 1967)
P.J. O'Halloran (Mathematics, 1968)
K.J. Maher (Mathematics, 1968)
J.R. Snedden (Chemistry, 1968)
A.J. Gilks (Mathematics, 1969)
A.R. DeL. Musgrove (Mathematics, 1969)
D.G. Thompson (Mathematics, 1969)
Master of Engineering

P. Van der Werf (Mechanical Engineering, 1964)
M.J. Lowrey (Civil Engineering, 1968)

Master of Engineering Science

S.R. Webb (Mechanical Engineering, 1968)
D. Roach (Mechanical Engineering, 1970)