A BRIEF HISTORY

OF

THE DEPARTMENT OF STATISTICS
THE UNIVERSITY OF NEW SOUTH WALES

1948 - 1983

THE EARLY YEARS IN MEWS ST., ULTIMO 1948-56

The first undergraduate courses for *The New South Wales Institute of Technology* were given in 1948, even before there was such an Institute, although legislation to establish it was foreshadowed, and fall back procedures set up should the legislation not be passed. The importance placed by the Government of NSW (in which the relevant minister and driving force was R.J. Heffron) on getting such a technologically oriented tertiary institution, the first of its type in Australia, in operation as soon as possible was the justification for starting in such an informal way. For carrying on the Institute's affairs without specific academic or administrative staff, library facilities, buildings or the like, the practicalities were dealt with by using staff and facilities of the Department of Technical Education, and locating it within the precincts of Sydney Technical College at Ultimo close to Central Railway station. Post-secondary Diploma courses of high standard had been conducted by the Department of Technical Education (as the Technical Education Branch of the Department of Education) for many years: it was intended to convert some of these to Degree courses and to establish new Degree courses in developing technological areas to provide continuing support for Australia's postwar industrial expansion. The foreshadowed President, Wallace C. Wurth, of the Institute which was in many ways modelled on The Massachussetts Institute of Technology, was also Chairman of the Public Service Board of NSW, the senior public servant in NSW whose service as Commonwealth Director of Manpower during the war undoubtedly helped form his views as to the importance of technological training, which he and others considered to have been inadequately provided in the single traditional university in each State which had been the Australian pattern. His views and position in NSW were of primary importance in getting the new institution established without the apparent necessity for large capital and recurrent expenditure.

None of the initially planned technological undergraduate courses included major studies in statistics - even though this had been described by R.A. Fisher as *the* technology of the twentieth century! - mathematics in general, though included in all courses, appeared only as a servicing subject.

However, a post-Diploma subject in statistics of 3 terms duration, with an enrolment of about 30, was being provided in 1948 by J.H. Weiler from the Mathematics Department of the Sydney Technical College, and this was augmented by a similar subject from the Mathematics Department at the Newcastle Technical College given by J.B. Douglas in 1949. These subjects could be regarded as embryonic forms of the Master of Statistics programme established later.

At this time staff were being recruited with the prospect of appointment to the *Institute* when it was established. By 1950, appropriate staff of the Department

of Technical Education were being approved to conduct courses on behalf of *The New South Wales University of Technology*: the conservative academic view within Australia that an Institute of Technology was not equivalent to a University had led to its renaming in the legislation under which its establishment was proclaimed on 1st July 1949. Then on the "Appointed Day" 1st July 1954, the University became an entirely self-governing body although it continued to have access to a great variety of Public Service facilities for many years. (And in 1955 the titles of President and Director, carried over from the Institute, became Chancellor and Vice-Chancellor.) The School of Mathematics, then located in the Faculty of Applied Science, had three staff members with special interests in statistics: J.B. Douglas, G.E. Ferris and J.H. Weiler.

Undergraduate service subjects in statistics had begun by 1952 as components of the Wool Technology, Applied Physics and Civil Engineering degree programmes - a copy of the final examination paper for the subject in the Civil Engineering programme is attached, showing an interesting mixture of spherical trigonometry, differential equations and statistics. Given the genesis of the institution, part-time versions, generally in the evening, of almost all such subjects were taught, this being a feature continued to the present time, though sometimes in the form of late afternoon classes accessible to both full and part-time students.

Consultative services in statistics had been provided informally throughout the University from very early days. In 1953, a subject of a type offered for many years and aimed at experimental research workers throughout the University first began: *The Application of Statistical Methods to the Design of Experiments*, later titled *Statistics for Research Workers*. Although it was intended as, and was, a service to staff in the various technologically oriented Schools it had other values, including the lifting of the standards of experimental work throughout the University, and the prospect of convincing academic staff of the importance of statistics to their disciplines and in their undergraduate programmes. These subjects proved very popular, with enrolments often having to be restricted to a group of specific disciplines in a particular year, and sometimes with a Part II in a second year. They were finally withdrawn, in spite of their popularity, when staffing difficulties - as described later - made it all but impossible to keep up with undergraduate course commitments.

Associated generally with consultative activities in Statistics, a circular announced: "Establishment of a Computing Laboratory within the School of Mathematics ... A computing laboratory will start ... on Monday 16th February 1953 ... Electrically operated computing machines will be available for use ... by members of staff and research workers ... Advice on computational problems will be given ... and ... the services of a machine operator [Miss Judy Murray] will be made available ..." This also reflected the importance given by statistics staff to the practical implementation of statistical procedures in research and teaching: the carrying out of an analysis and its interpretation were of equal importance to

When the Faculty of Medicine was established, its First Year included Mathematics I, and so by 1962 a Second Year service subject in statistics specifically for medical students was provided - later the Faculty abandoned the compulsory Mathematics requirement and appointed a statistician within the Faculty who became responsible for the teaching of medical statistics, though much statistical consultative work with the Faculty by Statistics staff continued. In 1965 service subjects were provided in Applied Science generally, Electrical Engineering, Surveying, Civil and Mechanical Engineering, and Industrial Engineering: each of these subjects had been formulated after detailed discussions with the relevant Schools, with topics and applications directly tied to the appropriate disciplines.

Links with Australian and overseas statistical communities were fostered by a visitors' programme - around 1965, for example, visitors included P.A.P. Moran, E.J. Williams, J.F.C. Kingman, G.N. Alexander (State Rivers and Water Supply Commission, Vic.), J.O. Irwin, Leslie Fox, J.A. Nelder, I.J. Good, T. Chapman and K. Woodger (CSIRO Division of Land Research and Regional Survey), J.S. Maritz and A.T. James. These contributed to the seminar programme which in general ran on a fortnightly basis. As well, visits by staff to other Australian statistical organizations during term-time were arranged in order to observe teaching and administrative arrangements while they were actually operating. A particularly valuable overview of overseas experience in 1960-61 was afforded by a British Council grant which enabled J.B. Douglas to visit most of the centres of statistical activity in the United Kingdom (including University College London, Imperial College, L.S.E., Rothamsted, Birmingham, Manchester, Edinburgh and Aberdeen) and a Carnegie Corporation Fellowship which did much the same for North America (e.g. Harvard, Yale, Princeton, Iowa State, Toronto, U. of Michigan, Cornell and Berkeley).

On campus social activities for staff and graduate students were supplemented by off-campus gatherings at Oatley, and, especially, tennis parties at South Hurstville, overseas visitors often adding lustre to these occasions.

During these years there was an acute shortage of statisticians (and mathematicians), so that academic appointments to cope with the increasing activities in teaching, research and consultation became extremely difficult to make. To carry on the existing teaching programmes, part-time lecturers had to be used, e.g. in 1964 from CSIRO, The Institute of Traffic and Highway Research, and the Schools of Economics, Mechanical Engineering and of Textile Technology. Following much discussion, 'cadetships' modelled on those sponsored by industry and the public service were set up by the University Council in 1960. These paid a yearly allowance of 530 pounds during the completion of an Honours Bachelor degree, and provided a subsequent appointment as a Teaching Fellow for 3 years to enable the completion of a Ph.D. Graduates from the scheme were outstanding, the first being Pam Cox (nee Wadsworth); and the next two in 1969 Lynne Billard

(now in the USA) and Jane E. Reeves (now in the UK), both being still active in statistics.

A related activity was the production in 1966 of a glossy booklet *Careers in Statistics* which described some of the joys of being a statistician and gave some technical details regarding the means to attain such a state.

Because of the emphasis of the Department on the applicability of statistics, links with industry, commerce and the Public Service were regarded as of great importance. Hence a Statistics Advisory Panel was established in 1962, with a membership of 22 drawn from the Universities, the Survey Research Centre, ICIANZ, the Snowy Mountains Authority, Ferranti Ltd., the Australian Bureau of Statistics, BHP, the Electricity Commission, CSIRO, the Department of Main Roads, MWSDB, MLC, CSR, WD&HO Wills, AGL, the Department of Education, the Reserve Bank and APM. Not only did the existence of the Panel emphasize the importance of statistics in other than the academic world, and the members of the Panel provide advice and balance both in meetings and in personal contact, these (and other) organizations provided vacation employment for students majoring in statistics, Panel members ensuring direct access to the relevant personnel units. The 'demand' for vacation employment by students and the good relations established by the Department with employers made possible a system by which the Department was able to match students and jobs, these nominations being accepted by the employers - in a number of cases the initial employment of a student on graduation was with one of the organizations with which vacation employment had been arranged. In 1964, for example, 17 students (of 29 seeking such employment) were placed, with some 39 seeking placement in the following year. In a later reorganization the Statistics Advisory Panel was abolished, a reconstituted Visiting Committee being set up in 1970 which continued until 1976 when it was 'absorbed' by a Visiting Committee for the School of Mathematics generally, which, failing to find a mission, was also abandoned.

The University established its consultative service, UNISEARCH, in 1958, this being a new development in Australia. Statistics staff were in demand for the provision of statistical advice through it, and many minor and a number of major projects were undertaken with its supporting facilities for the preparation of professionally appearing Reports, realistic costing, and adequate insurance cover. This was of course of benefit not only to individual statisticians but also to other University consultants with whose projects they were working - and financially to the University generally.

Partly because of the Murray Committee's Report and the increasing involvement of the Commonwealth in the funding of tertiary education, there was great interest in the way Australian Universities were likely to expand. Consequently one of the earliest externally funded statistics research projects was an investigation by R.B. Davis, WD&HO Wills Research Fellow in Statistics, leading to the thirty six page publication in 1960 of "*Estimates of Australian University Enrolments 1960-74*".

In 1964, and again in 1966, for reasons which included staff establishment and recruitment problems, disagreements over appropriate computing facilities, the philosophy behind the development of undergraduate service subjects and of "Pass" graduate programmes such as a Master of Statistics, the Statistics staff unanimously sought separation from the School of Mathematics. This included the possibility of location in another Faculty and association with the teaching of statistics in Economics, Psychology and Sociology although to achieve this the backgrounds of the existing staff would have implied the necessity of substantial re-education and/or the recruitment or redeployment of other staff. Partly because the establishment of a Chair of Statistics, itself a source of disagreement, was actively under consideration during this period the University administration would not agree to such changes, and the Department - not without recurring tensions - has continued to be a Department of the School of Mathematics. (With the benefit of hindsight, it does not now seem likely that a small School of Statistics could have survived within the University structure as it has developed.) Of course this has affected in many ways the kind of Department it has evolved to, for instance the abandonment of experimental components of major subjects, of visits to field stations and the CSIRO Division of Mathematical Statistics, of arranged vacation employment, and a gradual transfer of interests to more theoretical structures.

The research activities of staff included studies of truncated distributions, recurrence intervals of river height exceedances, dynamics of exploited fish populations, freezing point depression in milk (J. Dairy Res.), and exponential regression (Biometrika), to make a brief selection. Among the projects carried out through the Computing Laboratory were factor analysis in psychosomatic depression, temperature variation with height in the atmosphere, analyses of bandicoot measurements, and the resistance of nailing to fire damage.

In 1965 the first awards by the newly established Australian Research Grants Committee were made - one of these went to S. Lipton, C.A. McGilchrist and A.D. Joffe, with R.J. Cowan as a Research Assistant, for work on Exponential Regression.

Long before 1966 the School of Mathematics and the Department of Statistics had outgrown their accommodation: less than half the staff were located in Building M, with the balance in ex-army huts dispersed over the site. The stage was therefore set for another move.

IN THE MORVEN BROWN BUILDING 1967-1973

With the transfer of almost all of the University's activities to Kensington, a 'permanent' home for the School of Mathematics was designed on the upper campus on land resumed from a Randwick Municipality nine hole golf course, in what was originally planned as a three story brick building to be shared with the Faculty of Arts. It included 84 student places in Computing Laboratories, and the vinyl tiled corridor floors displayed various experimental designs such as Graeco-Latin Squares. Originally called the Arts-Mathematics Building, it was eventually named the Morven Brown Building after the first Dean of the Faculty of Arts. And in 1969 the University's second Vice-Chancellor, R.H. (Sir Rupert) Myers was appointed, this roughly corresponding to the end of the explosive expansion of the University.

Undergraduate and research computing up to the mid nineteen sixties had been carried out on electro-mechanical calculating machines - in earlier times on purely mechanical machines such as Odhners, Multos and Curtas (though never Brunsvigas) - with brand-names such as Facit, Friden (with an automatic square root facility!), Madas, Marchant and Monroe. An unusual development was the acquisition of an Olivetti Programma 101 machine, perhaps the first personal computer though of course not called by that name: it stored programs on magnetic cards and was used extensively in research and consultative activities, although its facilities were quickly overtaken by commercially successful machines such as the ALTAIR 8800, the Apple II, the Tandy TRS-80 and the Commodore PET.

By August 1956 the University had an English Electric DEUCE electronic computer, the first large commercially available digital computer in Australia, which was given the local name of UTECOM. (It was preceded at Sydney University by the construction there of SILLIAC, the Sydney version of the Illinois ILLIAC machine.) Programming was hardly readily accessible, being in ALPHA code (machine language) or GIP code (a primitive matrix language), though later work by C. Hamblin from Philosophy made available a much friendlier GEORGE code. Of course it was card oriented batch processing which was implemented, with typical turn-around of a day or so. Perhaps the first major statistical investigation carried out on it was a series of simulations to investigate the performance of the chi-squared independence criterion for 2 by 2 contingency tables, but consultative assistance on various projects derived from other sources (e.g. The Electricity Commission of NSW - Linear Programming; CSIRO - genetic selection experiments; Chemistry - Fourier Analysis of crystal structure) was also provided.

By 1966 an IBM 360 Model 50 main-frame had been acquired by the University. This was a very important development for Statistics, for it eventually

made possible the introduction of interactive terminal-based computing for the first time. Following collaborative work using APL through W.N. Holmes of the Systems Development Institute of IBM in Canberra, the fully interpretative APL\360 system was installed in 1972 on the IBM 360/50 machine together with a laboratory equipped with 15 IBM 2741 hardcopy terminals, first for graduate and Fourth Year Honours subjects, and then to a limited extent for undergraduate classes generally. The laboratory was located in the Electrical Engineering building, and its facilities were shared, principally with Computer Science and Engineering.

From this time, the computing system APL (A Programming Language: but editing and file-handling are part of the 'Language') played an increasingly important role in the teaching, research, consultative and administrative functions of the Department of Statistics until the early nineteen-nineties. The development of the physical facilities, fundamental to the use of interactive computing, is sketched very briefly. By the time the next building, the Mathews, was occupied the student Computing Laboratories contained not electro-mechanical but electronic non-programmable calculating machines. These were replaced as finance permitted (completely by 1979) with laboratories containing hard-copy terminals connected with the main-frame computer in the first instance running APL\360. With a new mainframe CYBER 72-76 in 1974 came APLUM (University of Massachussets APL), with 2 student laboratories each containing 12 APL capable Decwriters (after an unhappy experience with Kleinschmidt terminals), the Cyber 72-76 being augmented by a CYBER 171-8 in 1977. Finally APL2 came with the IBM 3090 (which had a vector processor) in 1987, initially using the same hard-copy terminals but eventually VDUs with separate printers: it was succeeded by PC laboratories with the decommissioning of the mainframe. Although APL was the major programming language taught, use was also made of FORTRAN, and in addition to the local STATAPL there was access to SAS, SPSS and other statistical and mathematical packages.

Abandoning the chronological order within buildings for the moment to pursue a single theme, some of the computer based developments from the nineteen-seventies over the next twenty years or so are outlined.

With the recognition that cooperative work by students on assignments was increasing sharply, a Library called ASSIGN of computer based assignments unique in execution to each student (and for each attempt a student might make) was constructed over some years, consisting eventually of about 80 separate assignments, with appropriate answers being provided - sometimes in coded form - for the benefit of students and tutors. They included computational and theoretical problems, some concerned primarily with teaching (e.g., demonstrating the Central Limit Theorem in practice), some with assessment, and most with a mixture of these two aspects - in every case, however, the student was required to interact with the computer and not merely observe

passively what was produced on the terminal. The Library covered many of the areas of statistics taught: probability theory, estimation (both theory and practice), experimental design, least squares, simulation, hypothesis testing, regression, transformation of random variables, data analysis and many other topics. When set up for use in a subject, an assignment identified the user, made it available between two declared dates (which led to the almost complete disappearance of late assignments) and provided a statement to be signed by the student that it was his or her work which was being handed in. There was also a third type of assignment for laboratory work in Theory of Statistics subjects - these were substantially longer and typically open ended. In the event, it turned out that most assignments had additional advantages, including their accessibility at any time when the Laboratories were not time-tabled for specific classes, thus relieving the pressure on terminals which was inevitable with the large numbers in servicing classes. Moreover, because of their teaching components, while they did not constitute formal CAI they were a useful adjunct to the tutorials which were progressively becoming less adequately staffed because of budgetary difficulties, and required students actually to carry out applications of the theory and procedures to which they had been exposed in lectures.

Many of these assignments made use of the user friendly open statistical Library STATAPL in their execution, especially for simulation and to provide numerical answers for the individually produced assignments. This general purpose Library (originally called STATUTIL), with all its documentation on-line, contained some hundreds of functions dealing with Analyses of Variance, Confidence Intervals, Data Analysis, Estimation for Continuous and Discrete Distributions, Fitting Continuous and Discrete Distributions, Graphing, Hypothesis Testing, Likelihood Calculations, Mathematical Functions, Continuous and Discrete Probability Functions, Regression, and Simulation of Continuous and Discrete Random Variables. The Library, much of whose implementation and maintenance was carried out by Rhonda Gock (from March 1976 to December 1988), was intended for stand-alone use by students and research workers, many of the wholly interactive functions if invoked by an inexperienced user seeking explicitly the specification of any parameters required (or supplying automatically the 'usual' values) while an experienced user could specify these as part of the invocation. (A brief account of its status in 1980 is given in I. Francis, *Statistical Software, A Comparative Review* (1981), Elsevier North Holland.) An expert system extension to STATAPL is described separately in the next Chapter.

Record keeping and mark processing were automated with functions which assisted with the entry of student names and register numbers (there was no computerized central student record system then) and their scores for assignments, tests and examinations. Scores could be processed to produce marks with specified characteristics, such as a given mean and standard

deviation, or with specified (or standard University) proportions in the grades of High Distinction, Distinction, Credit, ...: when these adjustments were carried out as a subject was being taught not only were students well informed about their progress but minimal adjustments at its end were required. After the finalization of the results for any task an automatic printout for Notice Board display could be produced - including the 'result' for a particular student of "SEE ME".

With the growth of enrolments in Statistics majors in Science and Arts courses, with the proliferation of pre- and co-requisites and other course requirements, and with the increasing complexity of timetables, the task of staff at the beginning of a year or session in advising students of practicable alternatives became more and more difficult. All statistics subjects and their attributes, such as those mentioned above, were therefore entered (using APL) to form a data base which could be invoked by staff, using software principally implemented by R.D. Williams, to construct individual student programmes - unfortunately central computing power was not then sufficient to allow students to explore such possibilities for themselves. Since most staff are only concerned with programme details for short periods, this led to more informed advice being given.

Throughout the University academic and administrative use of the 360/50 machine had been increasing sharply, so that the response time for an interactive user was often to be measured in seconds or even minutes, while for a large batch job the turn-around time might be not merely over-night but over nights. With a decision looming to restrict interpretative 360/50 access essentially to the administration, a meeting of major users chaired by Pro-Vice-Chancellor R.E. Vowels decided that this should be so - with the exception of users of APL. Because the teaching programmes of Statistics by this time depended so critically on its use, had such a decision not been taken it is difficult to imagine how the teaching responsibilities of Statistics could have been carried out in the following year. (The problem disappeared with the arrival of the first CYBER machine.)

Another Library originally on cards, but transferred to a computer base (though not in APL), is of Multiple Choice Questions, with answers designed to be marked and analysed by the University's central system. The Questions are organized under topic headings, and records of the results of their use in the various subjects were kept on the relevant cards, so that the person in charge of a subject who wished to construct a test could anticipate probable responses and hence produce quickly and easily a balanced test paper at an appropriate level. Because they were maintained over time and across lecturers, the questions were refined in successive years in many ways - the difficulties, well known to professional test constructors but consistently under-estimated by most teachers, in constructing unambiguous, reasonable and searching questions

were highlighted and dealt with when several lecturers were using the same Library.

Research activity continued to be very varied, with many staff involved with projects originating from - though not necessarily limited by - problems brought to the Department for statistical advice. Some of these were: plant competition experiments (Biometrika); methaemoglobin formation (J. Pharm & Pharmocol.); sequential analysis (J. Amer. Statist. Assoc.); two-sample tests (Biometrika); chemical kinetics (J. Chem. Phy. & J. Theor. Biol.); non-linear programming; tests for correlation matrices; analyses of wind gusts; optimal experimental design; dams and storage; and statistical theories of materials fracture. No comprehensive records were kept of such research activities (other than publication details), and it is not now possible to assemble anything approaching a complete account of these contributions. The Computing Laboratory also maintained its consulting assistance, three typical projects being moments of hypergeometric distributions, platelets in normal and abnormal blood, and Mornington Island aboriginal test data analyses.

Other activities concerned secondary school teaching. The highly traditional Euclidean geometry oriented syllabuses were changing, for example with the introduction of calculus and more formal algebra. But there was also pressure for the introduction of more 'applicable' mathematics and in particular statistics and non-combinatorial probability, and over many years there was substantial input through the Secondary Schools Board of Studies Mathematics Syllabus Committee in the writing of syllabus details. Similarly, for a number of years after the introduction of the TER the Board's Consultative and Executive Committee which determined the results in individual subjects of the HSC had a member of the Department on it.

University Libraries were unable to keep up with the creation of new Departments and new Journals (even then!), and at the request of the Council of the Australian Mathematical Society a review of the holdings of all mathematical and statistical journals was organized through appropriate Departments at each University. The consolidated - and massive - list, which took a number of years to prepare, intended primarily to help with a rational ordering policy and to encourage cooperation between Universities, was eventually published as *Mathematical Periodicals in Australian University Libraries* in 1971 by the Australian Mathematical Society, with the financial assistance of the Commonwealth Trading Bank of Australia, the Sidney Myer Charity Trust and the Commercial Banking Company of Sydney.

Another bibliographic activity was connected with the first (major) Citation Index for Statistics. J.W. Tukey recognized the importance of such Indices and that computing facilities were now able to be used to produce them effectively. He organized an international group of statisticians to cover geographical areas,

with the coverage of Australian journals coming from the Department at the University of New South Wales. The results were published in a number of volumes - e.g. *Index to Statistics and Probability: Citation Index* (R & D Press, 1973) - and at the time were a landmark achievement.

In 1967 the International Statistical Institute held its 36th Session in Sydney, with an active organizational role being played by members of the Department. This would have been the major statistical meeting held in Australia up to that time - that the Prime Minister (Mr Harold Holt) was its titular head may indicate its significance.

Over the Department's existence there were many secretarial staff whose contributions to its smooth running were of great importance. But Mrs Helen Langley occupied a unique position, partly because of the long period she held sway in the Departmental office (from November 1965 to May 1985) and partly because of the interest in and concern she had for both staff and students. If a member of staff made a commitment to a student in her presence, the student did not need to follow it up; examination papers and marks were almost surely on time; and all this was achieved while maintaining a happy atmosphere. When she retired she was awarded the degree of Mother of Statistics with an authentic full colour testamur at an elaborate ceremony conducted by the Department - though the Registrar's Division may not have been aware of it.

Course work post-graduate degrees based on a Pass degree in the appropriate disciplines had long been a feature of the University's offerings in the technological sciences, and a Master of Statistics programme based on a Pass major in statistics was introduced in 1969, though not without protracted discussion within the School (and the Faculty) concerning its appropriateness both regarding its substance and its name. It has turned out to be very acceptable to practising statisticians and very useful in providing a vehicle for staff to systematize material related to their special interests.

A major and long awaited staffing development which determined much of the future of the Department was the appointment on 16th October 1969 of A.M. Hasofer as Professor of Statistics in the School of Mathematics. (N.C. Kakwani was appointed as Professor of Economic Statistics in the School of Economics in the Faculty of Commerce on 1st December 1970.) At that stage, the academic staff consisted of A.M. Hasofer (Professor); J.B. Douglas (Associate Professor); A.G.L. Elliott, C.A. McGilchrist, P.J. Staff, M.K. Vagholkar (Senior Lecturers); R.B. Davis (Lecturer); C.A.J. Flory (Senior Tutor); and L.J. Hills (Tutor).

But once again the Department (and the School of Mathematics) had outgrown the physical facilities of the Morven Brown building and hence planning for a new Science Building with associated lecturing, tutorial and laboratory accommodation was undertaken.

IN THE MATHEWS BUILDING 1973-83

The sixteen story off-form concrete Mathews Building (initially known as the Sciences Building), named after F.M. Mathews, Deputy Chancellor 1976-81, the longest serving member of the University Council who had indeed even been a member of the Developmental Council which planned the original Institute, and chief engineer of AIS, housed Statistics largely on the twelfth floor, initially with three student computing laboratories. It was an economy building in its finish as in every other respect, but at least again unified staff and tutorial and laboratory facilities. During the occupancy of this building the University's third Vice-Chancellor, L.M. Birt, was appointed in 1981; and its fourth, J.R. Niland - one of its own graduates - by 1992.

At this stage, the staff Computing Laboratory occupied by a Professional Officer and usually several Research Assistants also contained a small library of statistical and mathematical tables, and a selection of books on numerical methods. Its computing equipment consisted of terminals connected to the current main-frame plus a small selection of electronic calculating machines.

With the advent of interactive main-frame computing with negligible delay in response time, and the increasing use of statistical procedures in disciplines in which research workers (and even more, students) had little knowledge of and less interest in the mathematical foundations of statistics, the development of what would now be called an 'expert system' was embarked upon, financed by what would be currently called 'quality money' with the support of Pro-Vice-Chancellor J.B. Thornton. Apart from its direct use in the social sciences in particular, it was hoped that it would also be of value to scientific workers more generally, including those whose exposure to statistics may have been well in the past and who now would welcome guidance in the choice of appropriate statistical analyses. It was not intended to *teach* statistics in a direct sense: being wholly data based it was intended to be used in conjunction with courses in statistics or statistical methods or on a once off basis by an individual analysing experimental results, without the need to master data entry techniques or a command structure.

This system, with B.W. Stephens its principal implementer, was based on the already described Library of statistical functions STATAPL and was itself called STATAPL, an ambiguity which was intended to help the transition which some would make from the hand holding of the interrogative 'expert' system to a more economical and versatile direct use of the Library. When invoked, it displayed a flow chart of its facilities, and then proceeded interrogatively, asking (e.g.) whether the data were already in the computer or yet to be entered, whether they were to be treated as count (discrete) or measurement (continuous) data, whether there was one variable, or two or more than two variables, involved, and so on. In response to any question the user could answer directly, or seek

to the investigations, and a good deal also reflects activity by higher degree students working under supervision.

Distinguished graduates from the statistics programmes are to be found across academia and in scientific, industrial and commercial organizations throughout Australia and elsewhere. For example, professorial positions at the Australian National University, Florida State University, Macquarie University, the University of Georgia (U.S.A.), the Technion (Israel) and Wollongong University, and the positions of Pro-Vice Chancellor (University of the N.T.) and Dean (University of Western Sydney), are occupied by our graduates, and the chief of the Division of Corporate Services of the N.S.W. Department of Agriculture and a CSIRO Divisional Chief hold our Ph.D's. Associate Professors and Readers are also widely distributed - for example at Macquarie University, the University of Adelaide, the University of Sydney and the University of Western Sydney; a former C.E.O. of the NRMA, and a senior executive of QANTAS, are also statistics graduates.

In 1983 the academic staff consisted of A.M. Hasofer (Professor); J.B. Douglas (retiring in 1983) and C.A. McGilchrist (Associate Professors); P.J. Cooke, J.A. Eccleston, A.G.L. Elliott, M.K. Vagholkar (Senior Lecturers); R.B. Davis and P. Petocz (Lecturers); and G.K. Eagleson (Honorary Associate). To round the staffing story off to the mid nineteen-nineties, A.M. Hasofer retired in 1993, with W.M. Dunsmuir being appointed in September 1993 to his position while C.A. McGilchrist was promoted to a full professorial position a year or so before his retirement from the University of N.S.W., the only full time staff remaining from 1983 being P.J. Cooke, though J.B. Douglas and M.K. Vagholkar still were Honorary Associates. But the detailed story of later years must be told by another chronicler.

APPENDIX I

STAFF LIST, 1950 - 1996

DEPARTMENT OF STATISTICS

Name	Last Position held in Department
Abel, Julian	Research Assistant
Adamson, Wal.	Laboratory Assistant
Adler, Robert	Lecturer
Aitkin, Murray	Senior Lecturer
Bennett, Don	Tutor
Berman, Mark	Tutor
Billard, Lynne	Teaching fellow
Bofinger, Eve	Lecturer
Bofinger, Vic	Lecturer
Boskovitch, Ann	Laboratory Assistant
Bracks, Michelle	Secretary
Breitung, Karl	Visiting Lecturer
Burgess, Leonie	Research Assistant
Byron, David	Lecturer
Chan, Grace	Lecturer
Chan, Jennifer	Research Assistant
Chatterji, S.D.	Lecturer
Chelliah, Nessan	Tutor
Cochrane, Jenny	Laboratory Assistant
Cooke, Peter	Senior Lecturer
Cox, Pam	Tutor
Cowan, Richard J.	Research Assistant
Cowling, Ann	Tutor
Dalziel, ~~A~~ E.R.	Lecturer
Davis, Ron	Lecturer
Defries, Margaret	Secretary
Douglas, Jim	Associate Professor
Dunne, Renee	Secretary

Staff list, 1950 - Contd.

Eccleston, John	Senior Lecturer
Elliott, Tony	Senior Lecturer
Fang, Frances	Professional Officer
Ferris, George	Lecturer
Firman, David	Professional Officer
Flory, Chris	Senior Tutor
Gebski, Val	Tutor
Ghahreman, Shahaboddin	Tutor
Glynn, Beryl	Secretary
Gock, Rhonda	Professional Officer
Goldys, Beniamin	Lecturer
Griffiths, David A.	Senior Lecturer
Hannan, Peter	Senior Tutor
Hansen, Morgan	Senior Lecturer
Hasofer, Michael	Professor
Herbert, Harry	Tutor
Hills, Les	Senior Tutor
Hoffman, Ian	Lecturer
Hui, Yer Van	Lecturer
Joffe, Alan	Senior Tutor
Jones, Mary	Secretary
Kantor, Mark	Senior Lecturer
Keevers, Janette	Tutor
Kirsch, Rose	Professional Officer
Khmaladze, Estate	Senior Lecturer
Kohn, Robert	Research Associate
Koronacki, Jacek	Visiting Lecturer
Kuk, Anthony	Senior Lecturer
Langley, Helen	Secretary
Li, Billy	Research Assistant
Li, Shan	Research Assistant
Lind, Bronwyn	Senior Tutor
Lipton, Steve	Associate Professor
Lipton, Yvonne	Secretary
MacFarlane, John	Lecturer

Staff list, 1950 - Contd.

McGilchrist, Charles	Professor
Merrick, Nerida	Laboratory Assistant
Middleton, Sue	Associate Lecturer
Moody, Narelle	Laboratory Assistant
Murphy, Brian	Senior Tutor
Murray, Judy	Laboratory Assistant
Musiela, Marek	Senior Lecturer
Narouz, Nefertity	Secretary
Newell, Sharon	Secretary
Oxenburgh, Marion	Laboratory Assistant
Penev, Spiridon	Lecturer
Perry, Lyn	Senior Tutor
Petocz, Peter	Lecturer
Prvan, Tania	Lecturer
Pulley, Sandra	Laboratory Assistant
Reeve, Sandra	Secretary
Reeves, Jane	Teaching Fellow
Riad, Amira	Secretary
Richardson, Pat	Secretary
Rose, Pat	Secretary
Russell, Ken	Lecturer
Smith, Elaine	Professional Officer
Staff, Phil	Senior Lecturer
Stein, Gillian (Heller)	Lecturer
Stephens, Bruce	Professional Officer
Street, Debbie	Senior Lecturer
Tsang, Nelson,	Tutor
Vagholkar, Manoo	Senior Lecturer
Wand, Handan	Research Assistant
Weiler, Hans	Lecturer
Williams, Bob	Professional Officer
Wright, Peter	Professional Officer
Wu, Yuan	Research Assistant
Yau, Kelvin	Research Assistant
Xia, Aihua	Lecturer

APPENDIX II
RESEARCH DEGREES

1956 -	Weiler, Hans **M.Sc.**	JBD	*Some new types of quality control charts designed to reduce the amount of inspection and the sensitivity to non-normality of the parent distribution.*
1962 -	Lambert, John A. **M.Sc.**	SL	*The three parameter log-normal distribution.*
1963 -	Davis, Ronald B. **M.Sc.**	JBD	*A methodological investigation of the lung cancer - cigarette smoking problem.*
	Tallis, G. Michael **M.Sc.**	JBD	*A statistical investigation of certain genetic parameter estimators and predictors of genetic gains.*
	McGilchrist, Clyde A. **M.Sc.**	SL	*Asymptotic and oscillatory regression.*
1964 -	Hansen, Morgan A. **Ph.D.**	JBD	*Some aspects of mathematical programming.*
1965 -	Tallis, G. Michael **Ph.D.**	JBD	*Truncation, grouping and the construction of distributions with special reference to normal distributions.*
	Bennett, George **Ph.D.**	JBD	*The application of probability theory to the allocation of engineering tolerances.*
1966 -	McGilchrist, Clyde A. **Ph.D.**	SL/JBD	*Plant competition experiments.*
1967 -	Staff, Phillip J. **M.Sc.**	JBD	*The displaced Poisson distribution.*

* Supervisors etc. - initials refer to the Staff List in Appendix I

IN THE MATHEWS BUILDING 1973-83

The sixteen story off-form concrete Mathews Building (initially known as the Sciences Building), named after F.M. Mathews, Deputy Chancellor 1976-81, the longest serving member of the University Council who had indeed even been a member of the Developmental Council which planned the original Institute, and chief engineer of AIS, housed Statistics largely on the twelfth floor, initially with three student computing laboratories. It was an economy building in its finish as in every other respect, but at least again unified staff and tutorial and laboratory facilities. During the occupancy of this building the University's third Vice-Chancellor, L.M. Birt, was appointed in 1981; and its fourth, J.R. Niland - one of its own graduates - by 1992.

At this stage, the staff Computing Laboratory occupied by a Professional Officer and usually several Research Assistants also contained a small library of statistical and mathematical tables, and a selection of books on numerical methods. Its computing equipment consisted of terminals connected to the current main-frame plus a small selection of electronic calculating machines.

With the advent of interactive main-frame computing with negligible delay in response time, and the increasing use of statistical procedures in disciplines in which research workers (and even more, students) had little knowledge of and less interest in the mathematical foundations of statistics, the development of what would now be called an 'expert system' was embarked upon, financed by what would be currently called 'quality money' with the support of Pro-Vice-Chancellor J.B. Thornton. Apart from its direct use in the social sciences in particular, it was hoped that it would also be of value to scientific workers more generally, including those whose exposure to statistics may have been well in the past and who now would welcome guidance in the choice of appropriate statistical analyses. It was not intended to *teach* statistics in a direct sense: being wholly data based it was intended to be used in conjunction with courses in statistics or statistical methods or on a once off basis by an individual analysing experimental results, without the need to master data entry techniques or a command structure.

This system, with B.W. Stephens its principal implementer, was based on the already described Library of statistical functions STATAPL and was itself called STATAPL, an ambiguity which was intended to help the transition which some would make from the hand holding of the interrogative 'expert' system to a more economical and versatile direct use of the Library. When invoked, it displayed a flow chart of its facilities, and then proceeded interrogatively, asking (e.g.) whether the data were already in the computer or yet to be entered, whether they were to be treated as count (discrete) or measurement (continuous) data, whether there was one variable, or two or more than two variables, involved, and so on. In response to any question the user could answer directly, or seek

additional information, defer, abandon, or invoke additional procedures. It also asked frequent questions regarding the appropriateness of the statistical procedures invoked, and while it could not prevent the user from giving wrong answers (e.g. asserting that the individuals' responses in matched samples are independent), it made explicit what was being assumed and hopefully encouraged further thought about the data.

The system was used in a variety of applications, including Open Day displays at which visitors were encouraged to bring along data to be analysed: several of these led to subsequent projects which were pursued in some depth by staff members. It was, however, never used extensively by the social scientists to whom it was partly directed, and being based on typewriter-like hard copy output (from the only kind of terminal then available) was slow for investigative work on other than relatively small data sets and had relatively limited graphical displays. Consequently, unlike the Library STATAPL, it was not maintained once the conversion to VDUs and more sophisticated printers was complete.

When APL2 was introduced on the IBM 3090 main-frame in 1987, the library STATAPL was converted more or less directly from CYBER APLUM to the new environment. A further conversion and extension of some STATAPL and ASSIGN workspaces, running under the name of SALAD, was implemented by D.M. Byron, these especially exploiting the printing and graphical facilities associated with the use of VDUs and more versatile colour printers.

A not atypical story, except for scale, of the development of a service subject is that for Surveying (now called Geomatic Engineering). As a result of the mid nineteen seventies mining boom in Australia, enrolments in the subject suddenly exploded to 150. This created a major problem for the mechanics of teaching such an applied subject, and focussed attention on precisely what topics should be in it. As the result of detailed consultation with the School of Surveying the syllabus was determined to be primarily Least Squares Adjustment of Surveying Data with a probabilistic background and a matrix formulation of the problems studied. The mathematical structure of APL was particularly well suited to this, and a comprehensive set of computer based Least Squares assignments was built up over several years in an exclusively surveying context. As with other fields, the change in interest level of students is very pronounced when their statistics subject uses substantially the language of and applications to the discipline of primary interest, in this case surveying: the motivational value of meaningful data is difficult to over-emphasize. In general, the provision of service subjects for specific disciplines (rather than an omnibus subject or subjects) was, and is, justified not only for the above reason but also because of the differing mathematical preparation of groups of students, and the timetable requirements of other - especially engineering - programmes.

Another example with rather more general application was the construction of a syllabus for (most) second year Applied Science students. Here it was thought that the design and analysis of experiments was of primary importance and a treatment of the General Linear Hypothesis suitable for a service course was devised together with matching numerical exercises. Printed Notes were issued to students (and tutors) since no appropriate text books existed. The practice of preparing printed Notes on various topics extended across other subjects, perhaps especially at the graduate level.

With the increasing tendency of main course students to have less exposure to 'real' data because the programmes they undertake tend to include little experimental science, it became more difficult to incorporate data analyses where the interpretations are meaningful because the data are meaningful (to the *students*) and where the results are as might be anticipated - or, more interestingly - unexpected and to be accounted for; and for students to recognize that the effort of data acquisition justifies corresponding effort in model building and analysis. This was historically the major justification for the inclusion of experimental work in main courses; the problem remains.

In general, the usage of high-speed digital computing facilities by Statistics students increased steadily. Over a six month period in 1982, for example, there were over 8000 accesses of the graphical workspace in STATAPL by students in main and service courses, most of these occurring in dealing with assignments.

Reflecting its extensive use in the Department, a Radio Course 'An Introduction to APL' was prepared for the University's Continuing Education programme. This consisted of ten lectures, on ten cassettes, together with a set of printed Notes, and those enrolled who were located close enough to the campus were able to attend tutorials conducted in conjunction with it. At that time (1984) APL was only a main-frame facility, and the opportunity for its home use on PCs was yet to arrive.

Once again, only a selective account of research activity is given. Topics actively investigated included: multivariate open Markov processes (Trab. Estadist. Invest. Oper.); insoluble phosphorus use by eucalypts (Plant & Soil); experimental design (Ann. Statist., Biometrika, Comm. in Statist., J.R.Statist.S.(B), Aust.J. Statist.); reliability studies (J. Struct. Mech.); discrete distributions (Aust. J. Statist., Sankhya, J.R.Statist.S.(B)); cusums (Technometrics); coronary heart disease (J. Chron. Dis.); random fields (Ann. Prob.); recursive estimation (Biometrie-Praximetrie); cholesterol studies (Ann. Hum. Gen.); stochastic models in carcinogenesis; restricted parameter estimation; tests of power 1; linear models with infinite variance; interactive computing & statistical teaching; and life tables. As would be expected, many of these studies were carried out in conjunction with scientists and engineers whose practically based problems stimulated and at least initially gave direction

to the investigations, and a good deal also reflects activity by higher degree students working under supervision.

Distinguished graduates from the statistics programmes are to be found across academia and in scientific, industrial and commercial organizations throughout Australia and elsewhere. For example, professorial positions at the Australian National University, Florida State University, Macquarie University, the University of Georgia (U.S.A.), the Technion (Israel) and Wollongong University, and the positions of Pro-Vice Chancellor (University of the N.T.) and Dean (University of Western Sydney), are occupied by our graduates, and the chief of the Division of Corporate Services of the N.S.W. Department of Agriculture and a CSIRO Divisional Chief hold our Ph.D's. Associate Professors and Readers are also widely distributed - for example at Macquarie University, the University of Adelaide, the University of Sydney and the University of Western Sydney; a former C.E.O. of the NRMA, and a senior executive of QANTAS, are also statistics graduates.

In 1983 the academic staff consisted of A.M. Hasofer (Professor); J.B. Douglas (retiring in 1983) and C.A. McGilchrist (Associate Professors); P.J. Cooke, J.A. Eccleston, A.G.L. Elliott, M.K. Vagholkar (Senior Lecturers); R.B. Davis and P. Petocz (Lecturers); and G.K. Eagleson (Honorary Associate). To round the staffing story off to the mid nineteen-nineties, A.M. Hasofer retired in 1993, with W.M. Dunsmuir being appointed in September 1993 to his position while C.A. McGilchrist was promoted to a full professorial position a year or so before his retirement from the University of N.S.W., the only full time staff remaining from 1983 being P.J. Cooke, though J.B. Douglas and M.K. Vagholkar still were Honorary Associates. But the detailed story of later years must be told by another chronicler.

APPENDIX I

STAFF LIST, 1950 - 1996

DEPARTMENT OF STATISTICS

Name	Last Position held in Department
Abel, Julian	Research Assistant
Adamson, Wal.	Laboratory Assistant
Adler, Robert	Lecturer
Aitkin, Murray	Senior Lecturer
Bennett, Don	Tutor
Berman, Mark	Tutor
Billard, Lynne	Teaching fellow
Bofinger, Eve	Lecturer
Bofinger, Vic	Lecturer
Boskovitch, Ann	Laboratory Assistant
Bracks, Michelle	Secretary
Breitung, Karl	Visiting Lecturer
Burgess, Leonie	Research Assistant
Byron, David	Lecturer
Chan, Grace	Lecturer
Chan, Jennifer	Research Assistant
Chatterji, S.D.	Lecturer
Chelliah, Nessan	Tutor
Cochrane, Jenny	Laboratory Assistant
Cooke, Peter	Senior Lecturer
Cox, Pam	Tutor
Cowan, Richard J.	Research Assistant
Cowling, Ann	Tutor
Dalziel, ~~A~~ E.R.	Lecturer
Davis, Ron	Lecturer
Defries, Margaret	Secretary
Douglas, Jim	Associate Professor
Dunne, Renee	Secretary

Staff list, 1950 - Contd.

Eccleston, John	Senior Lecturer
Elliott, Tony	Senior Lecturer
Fang, Frances	Professional Officer
Ferris, George	Lecturer
Firman, David	Professional Officer
Flory, Chris	Senior Tutor
Gebski, Val	Tutor
Ghahreman, Shahaboddin	Tutor
Glynn, Beryl	Secretary
Gock, Rhonda	Professional Officer
Goldys, Beniamin	Lecturer
Griffiths, David A.	Senior Lecturer
Hannan, Peter	Senior Tutor
Hansen, Morgan	Senior Lecturer
Hasofer, Michael	Professor
Herbert, Harry	Tutor
Hills, Les	Senior Tutor
Hoffman, Ian	Lecturer
Hui, Yer Van	Lecturer
Joffe, Alan	Senior Tutor
Jones, Mary	Secretary
Kantor, Mark	Senior Lecturer
Keevers, Janette	Tutor
Kirsch, Rose	Professional Officer
Khmaladze, Estate	Senior Lecturer
Kohn, Robert	Research Associate
Koronacki, Jacek	Visiting Lecturer
Kuk, Anthony	Senior Lecturer
Langley, Helen	Secretary
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Prvan, Tania	Lecturer
Pulley, Sandra	Laboratory Assistant
Reeve, Sandra	Secretary
Reeves, Jane	Teaching Fellow
Riad, Amira	Secretary
Richardson, Pat	Secretary
Rose, Pat	Secretary
Russell, Ken	Lecturer
Smith, Elaine	Professional Officer
Staff, Phil	Senior Lecturer
Stein, Gillian (Heller)	Lecturer
Stephens, Bruce	Professional Officer
Street, Debbie	Senior Lecturer
Tsang, Nelson,	Tutor
Vagholkar, Manoo	Senior Lecturer
Wand, Handan	Research Assistant
Weiler, Hans	Lecturer
Williams, Bob	Professional Officer
Wright, Peter	Professional Officer
Wu, Yuan	Research Assistant
Yau, Kelvin	Research Assistant
Xia, Aihua	Lecturer

APPENDIX II
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1966 -	McGilchrist, Clyde A. **Ph.D.**	SL/JBD	*Plant competition experiments.*
1967 -	Staff, Phillip J. **M.Sc.**	JBD	*The displaced Poisson distribution.*

* Supervisors etc. - initials refer to the Staff List in Appendix I

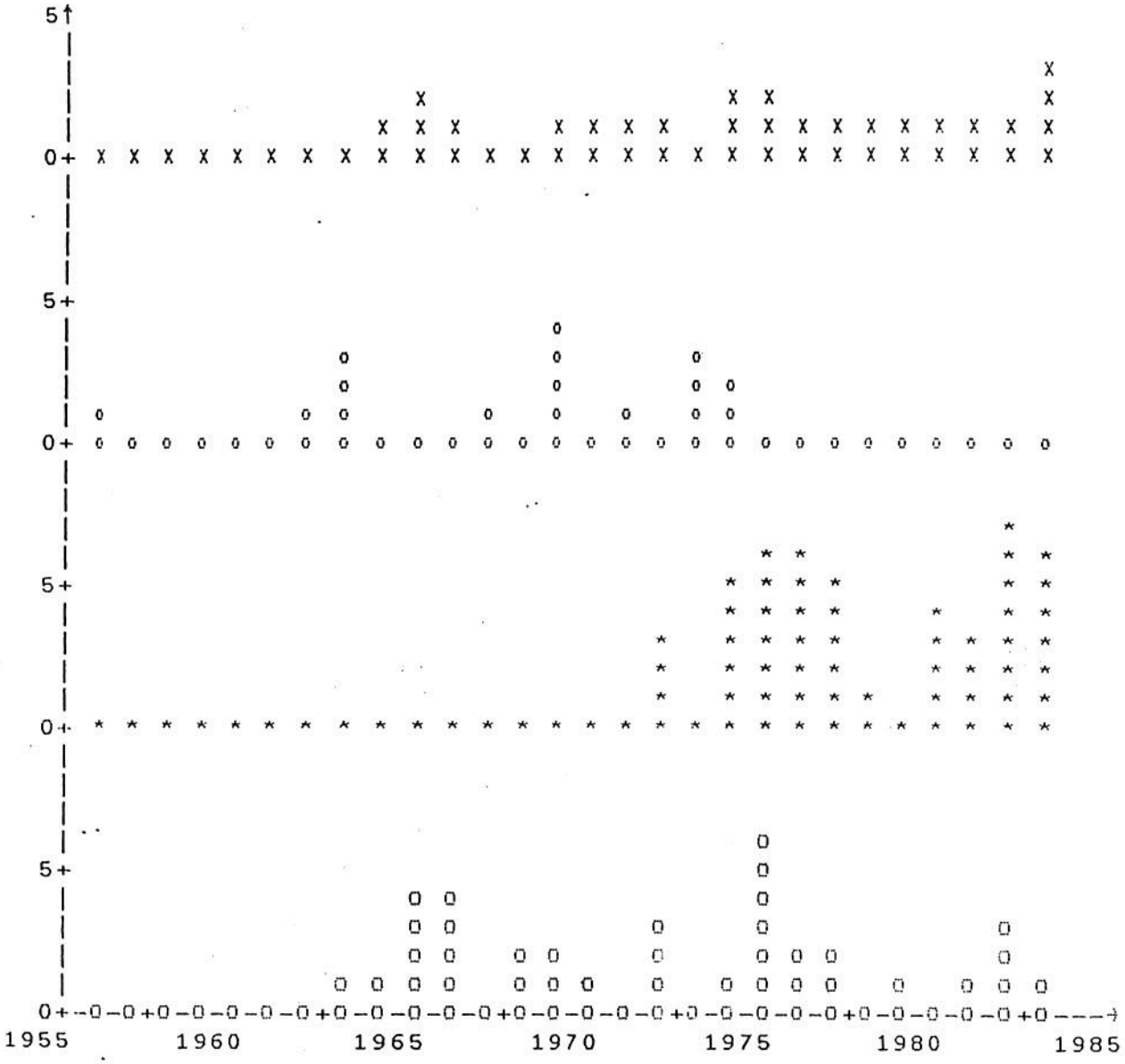
1969 -	Billard, Lynne **Ph.D.**	MKV	*Sequential tests for two-sided alternative hypotheses.*
	Herbert, Harold G. **M.Sc.**	AJM/ CAM	*A queueing system in which the arriving of customers is scheduled.*
	Malanos, Con **M.Sc.**	JBD	*Non linear programming.*
	Mian, M. Hanif **M.A.**	KB/ RMD	*Multistage cluster sampling.*
	Stark, Alan E. **M.A.**	AGE/ JBD	*Estimating restricted parameters with particular reference to the Poisson distribution.*
1970 -	Reeves, Jane E. **Ph.D.**	MKV/ CAM	*Bayesian estimation in the first order auto-regressive model.*
1971 -	Mathenius, Julie M. **M.Sc.**	CAM	*Estimation procedures using relationships between probabilities.*
	Staff,, Phillip J. **Ph.D.**	JBD	*Stochastic models in chemistry.*
1972 -	Huxham, Samuel H. **Ph.D.**	CAM	*Probability models and extreme value theory.*
1973 -	Bennett, Don J. **M.Sc.**	CAM	*Paired comparisons with more than two response categories.*
	Gipps, Peter G. **M.Sc.**	AGE	*Response surfaces under transformations of the independent variables.*
	McKay, Ronald J. **Ph.D.**	MA	*Simultaneous procedures in discriminant and regression analysis.*
1974 -	Kirkwood, Geoffrey P. **Ph.D.**	AMH/ CMA	*discrete round robin queueing model.*
	Jones, Peter N. **M.Sc.**	CAM	*Analysis of hydrological recession curves.*
	Lind, Peter **M.Sc.**	JBD	*Properties of and estimation in*

			the Thomas distribution.
	Searle, Gregory C.L. **Ph.D.**	MKV	*A sequential test with power one and its application to cusum charts.*
1975 -	Adler, Robert J. **Ph.D.**	AMH	*Excursions above fixed levels by random fields.*
	Gipps, Peter G. **Ph.D.**	AJM/ AMH	*Development and manipulation of mathematical models of traffic flow.*
1976 -	Russell, Kenneth G. **Ph.D.**	JAE	*On the theory of row-column designs.*
1977 -	Tallis, G. Michael **D.Sc.**		*Statistical modelling in biology with reference to the sheep and wool industries and medicine.*
	Leelar, Thaepin B. **Ph.D.**	CAM	*The role of body weight and the effect of weight reduction in hyperlipidaemia with particular reference to men with coronary heart disease.*
1978 -	Stark, Alan E. **Ph.D.**	CAM	*Models of correlation between mates and relatives and some applications.*
1979 -	Gleeson, Alan C. **Ph.D.**	CAM	*Analysis of plant competition experiments.*
1980 -	Sandland, Ronald L. **Ph.D.**	CAM	*Stochastic growth processes.*
1981 -	Simpson, Judith M. **Ph.D.**	CAM	*Inference for genetic models in epidemiology.*
1982 -	Petocz, Peter **Ph.D.**	AMH	*Upcrossings by oscillatory processes and their envelopes.*
1983 -	Hills, Les J. **Ph.D.**	CAM	*Time series in medical research.*
	Drastik, Vic C. **Ph.D.**	PJC	*Minimum mean square error estimation*

	Wilson, Richard **Ph.D.**	RJA	*A study of model random fields.*
1984 -	Collins, Mark **Ph.D.**	MKV	*Distribution free tests of subhypotheses.*
1986 -	Lianto, Susanti **Ph.D.**	CAM	*Recursive estimation in the general linear model.*
	Ghahreman, Shahab **Ph.D.**	AMH	*Extrema of gaussian process by simulation*
1987 -	Cullis, Brian **Ph.D.**	CAM	*Analysis of repeated measures data from designed experiments.*
1990 -	Byron, David M. **Ph.D.**	MKV	*G exchangeability and the construction of distribution free statistics.*
	Rutledge, Robert D. **Ph.D.**	AMH	*The use of geometric transformations in geostatistical estimation.*
1991-	Jiao, Zhaorong **Ph.D.**	CAM	*Generalised mixed models*
	Zijun, Wang **Ph.D.**	CAM	*Estimating high quantiles of a distribution*
1992-	Harapan, Tobing **Ph.D.**	CAM	*Multivariate repeated measurement analysis*
1993-	Shu, Hui Liaw **Ph.D.**	PJC/ CAM	*Statistical analysis and statistical modelling of wool fibres*
	Yuan, Wu	CAM	*Repeated measures analysis*

1991 -	Sylvie Moawad, Khanh Nguyen
1992-	Leonie Burgess
1993-	Mylan Diep, Jeneen Kelly, Sonia Minns, Minh Nguyen

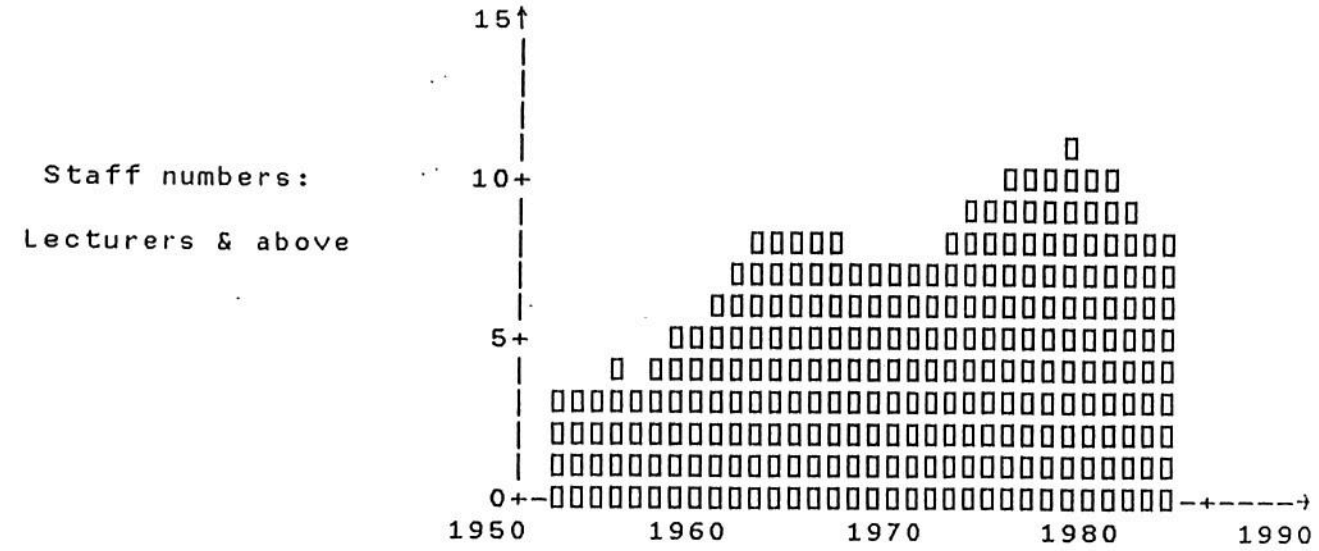
Appendix V



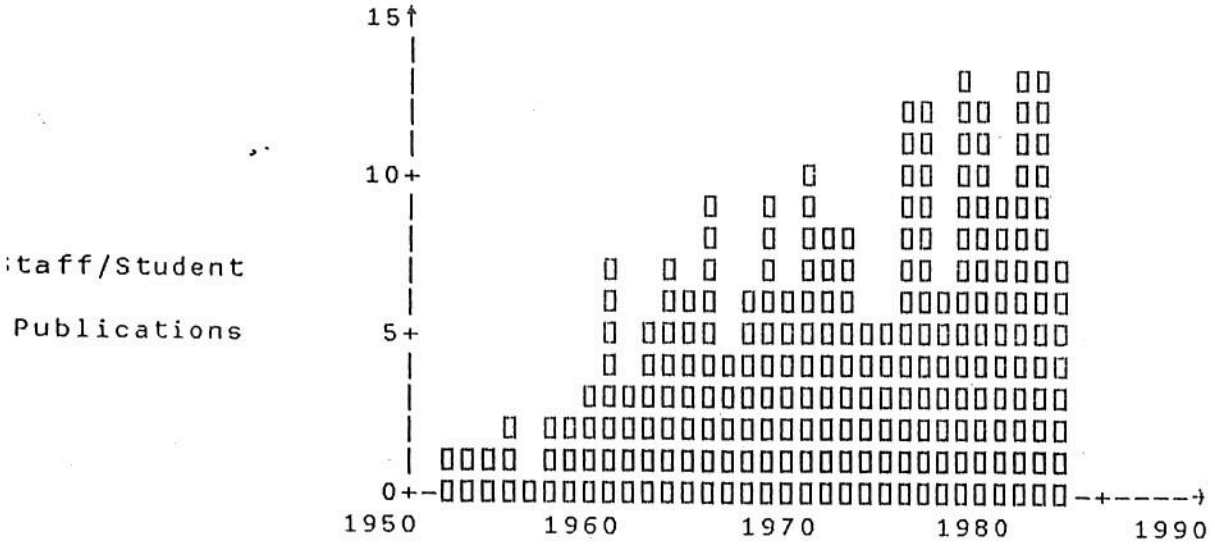
Numbers of degrees awarded in the relevant years:

Doctorates of Philosophy
Masters of Arts or Science
Masters of Statistics
Honours Bachelors of Arts or Science

Appendix VI



Numbers of staff of the rank of Lecturer and above as listed in the University Calendars of the relevant years. There were also usually 1,2 or 3 Teaching Fellows, Tutors or Senior Tutors, and Computing Assistants/Professional Officers in addition.



umbers of Publications by staff members and graduate students of the Department as listed in the University Research and Publications Reports for the relevant years.

UNIVERSITY OF TECHNOLOGY.

ANNUAL EXAMINATION, 1952.

No. 10.43.

9TH SEPTEMBER.

CIVIL ENGINEERING COURSE.

Mathematics.

YEAR III.

Time allowed—Three hours.

Any number of questions may be attempted; it is expected that full marks may be given to a candidate completing satisfactorily less than the total number of questions on the paper.

The questions are not of equal value partly because of length and partly because of difficulty differences; more credit will be given for complete solutions than for an equivalent quantity of fragments.

Text books, lecture notes, books of tables and slide rules may be used.

Marks.

20 1. Define the Heaviside unit function

$$H(x - a),\ a \text{ a constant},$$

and quote its Laplace transform.

Considering the delta function—

$$\delta(x) = \lim_{a \to 0} \frac{H(x) - H(x - a)}{a},$$

and using the above property of $H(x - a)$, show that it might be hoped that the Laplace transform of $\delta(x)$ would be unity, pointing out at what stage the argument fails to *prove* this result.

By use of a generalised delta function $\delta(x - a)$, obtain the usual approximate equation of the centre line of a light beam built in at the origin of co-ordinates, simply supported at the other end, of flexural rigidity EI and length $2l$, with an isolated load W placed at the middle of the beam.

Marks.

20 2. The spherical triangle ABC has—

$$a = 65° 18',\ b = 46° 20' \text{ and } \beta = 40° 12'.$$

Use the sine rule to find α, and hence complete the solution with the half angle formulae (or otherwise).

Check—

(i) that both sets of solutions conform to the laws of quadrants;

(ii) that the values found satisfy the sine rule.

12 3. A normally distributed variate has a mean μ and standard deviation σ. Explain briefly how the standard tables are used in order to determine probabilities associated with this distribution.

The lengths of studs turned out by a certain automatic machine are normally distributed with a mean of 3·220 cm. and a standard deviation of 0·003 cm. On Go, Not Go gauges the settings are 3·226 and 3·212 cm.; determine to one decimal place the percentage rejected as under and over size respectively.

In a random sample of 100 studs from a day's production about how many would you expect to be rejected, on the basis of the above result? (No additional numerical work is expected.)

20 4. The outputs of a day and a night shift are under discussion—it is believed that the productions of the two may differ, but it is not clear which may be smaller if in fact they differ.

(*a*) Over a period of several weeks the productions, when recorded in shifts, gave the following :—

	Day Shift.	*Night Shift.*
Mean	5·14	4·57
Variance	0·810	0·296
Number of shifts ...	7	7

Investigate whether in fact these data suggest that the productivities of the shifts do differ, it being reasonable to take the outputs as normally distributed.

Marks.

(*b*) After the above analysis had been proposed, it was suggested that on certain days productivity might have been low for both shifts (e.g., because of wet weather), and as a result the last seven shifts were examined as set out :—

	Day Shift.	*Night Shift.*	*Difference.*
Day 1 ...	6	5	1
2 ...	6	5	1
3 ...	4	4	0
4 ...	5	5	0
5 ...	6	5	1
6 ...	4	4	0
7 ...	5	4	1

Treating these as paired data, with a mean difference of 0·57 and variance of the differences 0·286, do these suggest any real difference exists ?

Reconcile the two conclusions above if they are not in agreement, and indicate on which you place more reliance.

15 5. A manufacturing process is modified in a manner intended to reduce the variability of the product. Long experience with the earlier process has established that the variance of the product associated with it is 28 (arbitrary units): when 25 of the products of the new process are examined, their variance is found to be 14. Can it be reasonably claimed (the usual normal distribution being postulated) that the new process has reduced the variability ?

If, however, a new product could be manufactured by two processes equivalent except that they might differ in the variability of the product, and a test showed that 17 cases with the first and 30 cases with the second gave sample variances of 28 and 14 respectively, would there be good grounds for asserting on the basis of these data that the second process was to be preferred ?

Marks.

25 6. Expressing $S_n(x)$ in terms of Heaviside unit functions, where—

$$\begin{aligned} S_n(x) &= 0,\ x < 0, \\ &= 1,\ 0 < x < 1, \\ &= 2,\ 1 < x < 2, \\ &\cdots\cdots \\ &= n-1,\ n-2 < x < n-1, \\ &= n,\ n-1 < x, \end{aligned}$$

obtain the Laplace Transform of $S_n(x)$.

A light beam is built in at the origin of co-ordinates, not support at the other end, and loaded so that the load on a portion distant x from the origin is $S_n(x)$. Subject to the usual approximations, determine the equation of the centre line of the beam and hence its maximum deflection. (Take the flexural rigidity to be EI.)

25 7. An inspector wishes to carry out tests on concrete poured on contract. He takes 10 samples (of one each) from successive pourings, and then chooses 2 of these at random for testing (because of the complicated nature of the tests he is using). His procedure is to test these two, and—

(i) if these two are satisfactory, pass the job;

(ii) if one or more are unsatisfactory, refuse to pass the job.

(*a*) Show that if there are in fact μ unsatisfactory members of the lot of 10 the probability that he will pass the job is—

$$\left(1 - \frac{\mu}{10}\right)\ \left(1 - \frac{\mu}{9}\right).$$

(*b*) Plot the performance characteristic of the above rule of inductive behaviour for $\mu = 0, 1, \ldots 10$. How large may μ be and yet have the probability of passing the job at least $\frac{1}{2}$?

(*c*) Comment briefly on the rule proposed.

12 8. If P is the probability of an observed value of a continuous variate, then it can be shown that $-2 \log_e P$ is distributed as χ^2 with 2 degrees of freedom.

In four different experiments, the probabilities associated with a particular event were—

Experiment	1	2	3	4
P	0·177	0·286	0·150	0·092.

Determine, using the additive property of χ^2, whether the overall results appear to be significant.