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**the  
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ZEALAND  
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THE NEW ZEALAND STATISTICIAN

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Volume 2

July 1967

Number 2

THE NEW ZEALAND STATISTICAL ASSOCIATION (INCORPORATED)  
EIGHTEENTH ANNUAL CONFERENCE

in conjunction with

THE OPERATIONAL RESEARCH SOCIETY OF NEW ZEALAND

Venue : Shell Theatre, The Terrace, Wellington.

PROGRAMME

Tuesday, 4th July \_\_\_\_\_

- 9.30 a.m. "Interpretation of Biological Data by Path Analysis"  
11.00 a.m. "Statistical Methods in Medical Diagnosis,  
using Yes-No Symptoms"  
2.00 p.m. "Gross Private Domestic Capital Formation in N.Z."  
3.30 p.m. "The Simple Analysis of Time Correlated Events"

Wednesday, 5th July \_\_\_\_\_

- 9.00 a.m. "Application & Extension of Prelou's Transect Method  
for Forest Disease Assessment"  
10.30 a.m. "Use of Probability Generating Functions in  
Population Statistics"  
11.30 a.m. Annual General Meeting of the N.Z. Statistical Assn.  
2.00 p.m. "Facets of Census-Taking, with Specific Reference to  
the 1966 Census"  
3.30 p.m. "Voting Swings in the 1966 General Election"

Thursday, 6th July \_\_\_\_\_

- 9.00 a.m. "Operational Research as a Management Service"  
10.30 a.m. "Linear & Separable Programming in Beef Production"  
2.00 p.m. "Dynamic Programming Models of NZ Electricity  
Production"  
3.30 p.m. "Wellington Telephone Fault Service Review"

ACKNOWLEDGEMENT

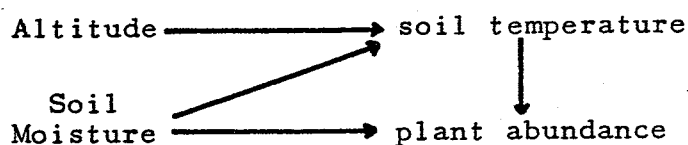
The Executive Committee wishes to record its appreciation of the generosity of Shell Oil (N.Z.) Ltd in allowing the Association the use of the Theatre for the Conference free of charge.

## INTERPRETATION of BIOLOGICAL DATA by PATH ANALYSIS

D. Scott,  
Plant Physiology Division,  
D.S.I.R. Palmerston North.

A dilemma that frequently arises in applying many of the existing methods of statistical analysis to biological data is that we have to assume that certain variables are statistically independent even though we know from biological or physical considerations that they must interact. The method of path analysis is described which has all the features and advantages of multiple regression analysis and in addition was developed for situations where there is interaction between all variables.

In any situation some variables can be designated as causes and others as effects and in this way a network of causal relationships can be built up.



In such a diagram the variables at the head of one or more arrows are interpreted as being a function of only those variables at the tails of these arrows. The mathematical theory of the method then allows the equations to be determined which enable the quantitative prediction of the values of each of the effect variables for particular values of the cause variables as well as determining the quantitative changes expected along the individual steps of the pathway.

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News of a Research Computer, see opposite page →

APPLICATION and EXTENSION of PRELOU'S TRANSECT METHOD  
for FOREST DISEASE ASSESSMENT

W.G. Warren,  
Forest Research Institute,  
Rotorua.

It is assumed that a forest area can be regarded as a mosaic of two kinds of sub-area - the one in which a disease may be present although all the trees may not at the the time be infected, and the other which is completely disease-free. Prelou has shown how to use the run lengths of healthy and diseased trees along narrow belt transects to estimate the proportion of "infected" area and the proportion of diseased trees within such area. Her methods are described and some ideas for their extension, by adding a measure of disease level, to the spatial and temporal picture, are presented.

The method is illustrated by application to some forest disease records in New Zealand, in particular to the needle cast fungi, *Dothestroma Pini*.

The computational problems of (1) solving the estimating equations, and (2) determining the theoretical distribution of run lengths of healthy trees are considered. This leads to some simple but interesting and not well known concepts in combinational analysis, specifically the compositions, partitions, and denumerants of whole numbers.

N.Z. Forest Products Ltd at Tokoroa has recently installed an I.B.M. 1130 computer, primarily for work on research problems. They also have an I.B.M. 360 for commercial work. They believe themselves to be the first industry in New Zealand to install a computer solely for research purposes. In this they may well be envied, more by certain Government departments than by other companies.

VOTING SWINGS in the 1966 GENERAL ELECTION

J.W. Rowe,  
N.Z. Institute of Economic Research,  
Wellington.

Multiple regression techniques are applied to data for the last two general elections in an effort to measure voting swings. All 76 electorates in which there were candidates of the three main parties in both elections are considered.

The first part of the study endeavours to account for the 1966 roll shares obtained by National, Labour, and Social Credit separately and the second part attempts a joint estimation.

A number of interesting statistical problems are involved and preliminary results of the computer runs are presented.

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USE of PROBABILITY GENERATING FUNCTIONS  
in POPULATION STATISTICS

V.J. Thomas,  
Building Research Bureau of NZ,  
Wellington.

The use and manipulation of probability generating functions of the type :

$$G(z) = P_0 + P_1 z + P_2 z^2 + \dots$$

and their multivariate analogs. In particular, if the random variable  $r$  represents a population whose size is zero with probability  $P_0$  and one with probability  $P_1$ , and so forth, the above expression is used to derive distributions, or moments where this is not possible, for derived distributions arising from various birth and death processes.

FACETS of CENSUS-TAKING, WITH SPECIFIC REFERENCE TO  
THE 1966 CENSUS

A.A. Teague,  
Department of Statistics,  
Wellington.

Without doubt the largest statistical project undertaken in New Zealand is the periodic Census of Population, or more correctly the twin censuses of population and dwellings.

While many people have a vague appreciation of this, very few indeed realise the full extent of the range of skills used, the numbers of personnel involved, and the organisational problems and controls which a census of this magnitude entails.

Inevitably in the planning, organisation and processing, and publication associated with an operation which impinges on the lives of nearly  $2\frac{3}{4}$  million people and their associated  $\frac{3}{4}$  million dwellings, problems will arise. These must be solved. They cannot be ignored, soft-pedalled or allowed to sink into the haven of relative obscurity which is possible with smaller scale investigations should initial assessment prove faulty.

In a variety of ways, some major, others of less importance, the 1966 Census has distinct characteristics not encountered in earlier censuses. Most of these developments stem either directly or indirectly from the transition to electronic data processing. It can almost be described as a landmark in census-taking in New Zealand.

These facets of planning, organising, problems and advances will be traversed by the speaker.

GROSS PRIVATE DOMESTIC CAPITAL FORMATION  
in NEW ZEALAND

T.K. McDonald,  
NZ Institute of Economic Research,  
Wellington.

Gross Private Domestic Capital Formation during the year ended March 1963 was estimated by the "product flow" method at £243 million, comprising the following components :

Building	£ 101 million
Construction	7
Farm Development	25
Motor Vehicles	30
Manufacturers' "own construction"	1
Plant, Machinery, & Equipment	<u>79</u>
	<u>£ 243 million</u>

This exceeded the Official Estimate for that year of £195 million by £48 million. As the £101 million building component of the Official Estimate was common to both this meant a divergence of 51 per cent over the remainder, identified in the Official Estimate as "Other", with no breakdown or information on its content or estimating method. No worthwhile information is available on the composition of Official Estimates of private capital formation in New Zealand, nor was the Department of Statistics able to release any, apart from the building component, to allow a reconciliation between the two estimates. The estimates must therefore be judged on their respective merits which should be seen rather than implied.

My Estimate followed as far as was practical, the recommendations of the U.N. Statistical Office on capital formation estimates, contained in "Concepts and Definitions

of Capital Formation", although data limitations resulted in some omissions. From the industrial production and import statistics capital goods were extracted. After subtracting Government capital imports, capital exports and allowing for changes in domestic manufacturers' stocks of capital goods, the value of capital goods entering the domestic market was obtained. This value was processed through the estimated capital goods distribution system to arrive at the purchase cost of capital goods to each class of final user - Private Sector Enterprises (commercial users), Households, Government and Local Authorities. Allowance was made for the cost of installing these goods, the installed cost of capital goods purchased by Private Sector Enterprises comprising the "Plant, Machinery and Equipment" component of the Estimate. The distribution pattern of capital goods, the gross margins incurred during distribution and the costs of installing capital goods were obtained by a survey of capital goods manufacturers, retailers, wholesalers and purchasers in New Zealand. The Construction Component was obtained from the 1964 Census of Building and Construction, Farm Development from a survey conducted by the Department of Statistics, and Motor Vehicles from Post Office registration figures, confidential sources and a survey of new car distributors to determine the proportion of new car sales going to Private Sector Enterprises. Manufacturers' own construction of capital goods was obtained from the Industrial Production Statistics.

The Estimate is open to suspicion, especially in view of its divergence from the Official Estimate. It does however provide a detailed breakdown of the product composition of capital formation, its origins and its component costs in, I hope, sufficient detail to allow the drawing of conclusions as to its validity.



## PRESIDENT'S REPORT

### Membership

There were 109 members on 31 March, 1967, but 9 of these memberships lapsed at this time because the subscriptions had not been paid since 1965.

Eight organisations have joined the Association as corporate members.

### Committee

The Committee met four times during the year ended 31st March, and has met several times since then.

### Activities

Once again this year Shell Oil (N.Z.) Ltd have kindly allowed us to use their Theatre for our Conference. Members will have appreciated the comfort and convenience of the surroundings. Last year's Conference was most successful and one paper at least had some coverage from the N.Z.B.C.

The cocktail party almost broke even. I should like to thank John Revfiem and the ladies from the Biometrics Section of the Department of Agriculture for its organisation.

The subject mix of the papers presented was generally agreed to be about right and the same mixture is attempted again this year. The Operational Research Society is once again contributing the papers for the third day.

The Secretary met representatives of other scientific societies under the auspices of the Royal Society of New Zealand to discuss co-operation between societies. As a result of this meeting notices of activities are being circulated amongst secretaries.

### The New Zealand Statistician

Dr Warren has again produced two issues of the journal, the second being this Conference issue. I should like to take this opportunity for thanking him and Mr Poole for the work they have done.

### Technicians Course in Statistics

Mr Offenburger, head of the Mathematics Department, Wellington Polytechnic, has approached the Association for assistance in setting up some sort of course for statistical assistants or technicians. Members will have read the views of the members of the Association on Mr Offenburger's suggestion in the previous issue of the New Zealand Statistician.

G.A. Vignaux

### FINANCIAL REPORT

The overall financial position of the Association and the cash balances have both increased by about £30. Ordinary subscriptions were doubled at the beginning of this year, bringing in an extra £20, and corporate membership provided a further £32. About £8 were saved in hall rent. Against these must be set the cost of just over £40 in producing two issues of the New Zealand Statistician.

By transferring the cost of providing free tickets to speakers to Conference Expenses, the cocktail party can actually be said to have made a profit - for the first time in the Association's history.

The Association's financial position has improved to the extent intended, and its income should be adequate to cover the increase in activities that was envisaged at the time when subscription rates were increased two years ago.

G.C. Arnold

## FINANCIAL

## STATEMENTS

RECEIPTS & PAYMENTS ACCOUNT  
for year ending 31st March 1967

<u>Receipts (£)</u>	<u>1967</u>	<u>1966</u>	<u>Payments (£)</u>	<u>1967</u>	<u>1966</u>
Bank Balance (from last year)	38	45	Donation to Wellington Polytech. Library	3	nil
<u>Subscriptions</u>	73	21	NZ Statistician V1/1	20	3
Ordinary 41			<u>Conference</u>	25	
Corporate 32			Shell Social Club	4	nil
<u>Cocktail Party</u>	16		Hall Hire	nil	12
Tickets 11		12	Catering	5	11
Surplus sold 5		3	Statistician	16	nil
<u>Conference</u>	12		V1/2		
Tea Money 7		7	<u>Cocktail Party</u>	17	
Surplus sold -		4	Hall Hire	nil	2
O.R. Society 5		5	Liquor	15	15
Interest	-	1	Food	2	
Sale of Glasses	nil	2	Stamps & Stationery	6	6
			Petty Cash	2	1
			Badges	nil	5
			Glasses	nil	7
			Bank Balance (end of year)	66	38
	<u>£ 139</u>	<u>100</u>		<u>£ 139</u>	<u>100</u>

INCOME & EXPENDITURE ACCOUNT  
for year ending 31st March 1967

<u>Expenditure (£)</u>	<u>1967</u>	<u>1966</u>	<u>Income (£)</u>	<u>1967</u>	<u>1966</u>
NZ Statistician 1/1	20	3			
Administration	6	7	Subscriptions	73	21
Polytech Library	3	nil	Interest	-	1
Cocktail Party loss	1	2			
Conference loss	13	7			
Conference Badges	2	nil			
Depreciation, Glasses	1	1			
Income Surplus	27	2			
	<u>£ 73</u>	<u>22</u>		<u>£ 73</u>	<u>22</u>

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BALANCE SHEET  
as at 31st March 1967

<u>Liabilities and Association Funds</u>	<u>£</u>	<u>£</u>	<u>Assets</u>	<u>£</u>	<u>£</u>
	<u>1967</u>	<u>1966</u>		<u>1967</u>	<u>1966</u>
Accumulated Funds (from last year)	47	45	Drinking Glasses	4	5
add			Depreciation	<u>1</u>	<u>1</u>
Surplus of Income over Expenditure	27	2	Badges	3	4
			Petty Cash	2	nil
			Bank Balance	66	38
				<u>3</u>	<u>4</u>
				<u>74</u>	<u>47</u>
	<u>£ 74</u>	<u>£ 47</u>		<u>£ 74</u>	<u>£ 47</u>

Audited and found correct.  
A.W. Graham B.Com F.R.A.N.Z.  
(Honorary Auditor)

G.C. Arnold  
(Honorary Secretary-  
Treasurer)

CORPORATE MEMBERSHIP

The Association thanks the following organisations for being sufficiently interested in our activities to become Corporate Members.

Unilever (N.Z.) Ltd  
Shell Oil (N.Z.) Ltd  
I.B.M. World Trade Corporation  
A. & N.Z. Bank Ltd  
B.A.L.M. Paints (N.Z.) Ltd  
Bank of New South Wales  
Survey Research Co. Ltd  
D.H. Brown & Son Ltd

STATISTICAL METHODS in MEDICAL DIAGNOSIS  
USING YES-NO SYMPTOMS

H.R. Thompson,  
Applied Mathematics Division,  
D.S.I.R., Wellington.

The problem to be discussed concerns the allocation of patients to one of two groups (toxic and non-toxic forms of a thyroid disease) on the basis of yes-no symptoms. Extensive laboratory tests can be performed to distinguish between the two, but it was hoped that a clinical diagnosis would obviate the need for them.

Three methods of analysis are compared :

- (1) simple discrimination on the basis of the number of symptoms present ;
- (2) classical discriminant analysis assuming the variables are continuous, enabling a score to be worked out for each patient ;
- (3) estimation of the probability that a patient belongs to one group on the basis of the symptoms present, using Bayes' theorem.

Results from the three methods were very similar, the percentage of patients misclassified being about 8%.

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THE SIMPLE ANALYSIS of TIME CORRELATED EVENTS

Prof. G.H. Jowett,  
University of Otago,  
Dunedin.

It is a very convenient simplifying assumption in statistical theory to assume that the outcomes of events are independent of each other. However, in practice this is rarely justified. In this paper the special case is dealt with where the outcome of an event is affected by the outcomes of the events preceding it. No great mathematical or statistical knowledge will be assumed, it being intended to survey the methods available rather than give a technical discussion of the theory behind them.

OPERATIONAL RESEARCH as a MANAGEMENT SERVICE

R.C. Wheeler &  
J.P.M. Cornwall,  
State Services Commission,  
Wellington.

A discussion of the establishment of an Operational Research Group in the State Services Commission, and of its relationship with other management services, of the assignments undertaken by the Group and of their successes and failures. A presentation of the points of view of management on the one hand and the operational research practitioner on the other.

LINEAR & SEPARABLE PROGRAMMING  
in BEEF PRODUCTION

G.A. Vignaux,  
Applied Mathematics Division,  
D.S.I.R., Wellington.

The problem of the optimum growth and feeding schedule for stall-raised beef cattle is used to introduce the technique of separable programming. In this method a slightly modified simplex method is used to optimise under constraints which may be non-linear in certain of the variables.

A simple description of the technique is given with demonstrations of the advantages and disadvantages of the method.

"...they reject the comparison between air and road accident figures because there is a big difference between paying for a ticket and being transported safely from one place to another and driving one's own car where the risks depend on one's own skill. They say that commercial aviation should only be compared with commercial surface transport, and on a passenger-mile basis it works out six to eight times more dangerous to fly than to go by train or bus. (continued over →)

DYNAMIC PROGRAMMING MODELS  
of NEW ZEALAND ELECTRICITY PRODUCTION

M.P. Griffin,  
Applied Mathematics Division,  
D.S.I.R , Wellington.

The New Zealand system of electricity generation contains both hydro-electric and thermal stations. If the dams become empty we are unable to generate enough power. If the dams overflow we waste the potential power of the water. What is the best way to use thermal power in order to minimise the chances of these two events? This is a progress report on work being done to solve this problem using dynamic programming on a system with three dams and one source of thermal generation.

WELLINGTON TELEPHONE FAULT SERVICE REVIEW

A. Milkop,  
State Services Commission,  
Wellington.

The concluding phase of a review of the Wellington Telephone Fault Service using a computer simulation of the system is to be discussed. This follows on a presentation of the earlier phases at last year's meeting. The system consists of several queues : one for answering complaints, a second for testing them, and a third for fixing faults. The effect of changing the various queue parameters has been analysed.

from P.13

But there is something unreal, as well as repugnant, about treating air disasters on a mere statistical basis. Unreal, because, as the Swedish air-safety expert, Mr Bo Lundberg, has pointed out, it is simply the growing size and frequency of air disasters which shocks people, and this is quite unrelated to the number of miles travelled and similar considerations. Repugnant, because of the human tragedy involved in every disaster, and everybody knows that with more care and greater investment of money many lives that are now lost in air crashes could be saved!"  
Observer, 4 Sept, '66

A LISTING of NEW ZEALAND STATISTICIANS

(continued)

SEBER, George Arthur Frederick.

George Seber is Senior Lecturer in Mathematics at Auckland University. He obtained his B.Sc. at Auckland in 1959, and his M.Sc. the following year. He graduated Ph.D. in Statistics from Manchester in 1963, and has taught at Auckland in 1960 and since 1965; from 1963 to 1965 he taught at the London School of Economics. His interests include linear model analysis, population dynamics (biological), and probit analysis.

JURY, Kenneth Eric.

Ken Jury is Biometrician at the Ruakura Agriculture Research Centre, Hamilton; he joined the staff there at the end of 1958. He obtained his B.Sc. from Canterbury University in 1957 and his M.Sc. in mathematics the following year. This was followed with a B.A. from Cambridge in 1960. His interests are the application of statistical design and analysis to agricultural research, especially with animals, and the mathematical specification of growth.

WRIGHT, Graham Marshall.

Graham Wright is presently Cereal Breeder, Crop Research Division, D.S.I.R., Lincoln. He obtained an M.Sc. in mathematics from Canterbury University College in 1946. In 1947 he was Research Assistant in Animal Genetics at Massey College. He joined the Applied Mathematics Laboratory in Wellington in 1948, and went to Lincoln in 1952. He has been a part-time lecturer in Biometry at Lincoln from 1953 to 1962, and in Biometrical Genetics in 1961 and 1963. He is the author of 31 papers. His interests lie in Plant Breeding (Genetics and Phytopathology and Agronomy, Quantitative Inheritance & Evolution, Statistics) Design of experiments, and simpler aspects of Data Analysis.



Officers

of the New Zealand Statistical Association (Inc.)

President	G.A. Vignaux
Secretary-Treasurer (Hon.)	G.C. Arnold
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Dr W.G. Warren,  
c/- Forest Research Institute,  
Private Bag,  
Rotorua.

Subscription Rates : Individual, 10/- (\$1); Corporate, £4 (\$8)

The town council of this small town (Belisto, Sicily) - population 5,800 - has decided to play the football pools in hopes of clearing its chronic debts. The council said the community's income did not cover even half routine expenses and unanimously resolved to play the pools each week according to a mathematical system devised by the town clerk.

(Evening Post, 21 October, 1966)