UNIVERSITY OF QUEENSLAND
COMPUTER CENTRE

COMPUTER

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BULLETIN

EDITORIAL COMMENT

This Bulletin marks the beginning of Volume 3 and the commencement of a
New Year. The staff of the Computer Centre cordially extend to our readers
and clients our sincere wishes for a rewarding and prosperous New Year.

It has been very pleasing to see the rapidly-increasing number of applications
to receive the Bulletin that have swamped the Editor's desk in the last few
months. We hope that the Bulletin will continue to be of interest and
assistance to readers throughout 1970. The Editor especially invites articles
of computing interest from University Departments and external organizations,
as the publication of several of these last year, generated considerable interest.
This month, a biometrician describes briefly some of the applications of the
computer to biometry in animal production research. Other items include
operational information and a list of recent library accessions.

STAFF NEWS

INTRODUCING A SENIOR DEMONSTRATOR .....

The Department of Computer Science welcomes into its ranks *Michael (Mike) McLean*
who has been appointed to the position of Senior Demonstrator.

Mike hails from England, having graduated with Honours in Civil Engineering in
1968 after a four year "sandwich" course of six monthly alternations of study and
industrial training at the City University, London. Undaunted, Mike then
proceeded to the Institute of Computer Science at the University of London where
he gained his Master of Science degree with Distinction in Computer Science.
His project involved the implementation of memory protection facilities under the
control of the monitor in the PDP 9.

We hope that Mike will enjoy life in Australia, and recommend that he disregard
FORTRAN for the infinitely-richer language, STRINE.

..... AND A COMPUTER OPERATOR

Another new member of staff, *Angela Vidanovic,* is no stranger to the Computer
Centre. Angela was formerly employed as a Data Preparation Assistant, but after
an absence of several months, has returned to her old haunt to become a
Machine Operator.

PROGRAMMER'S PRAYER

To begin the year in a suitable spirit, the following "prayer" is included for
every aspiring programmer.

> Our Computer, which art in Centre,
> Hallowed by thy BATCH,
> Thy output come.
> Thy source statements be done
> In MACRO as they are in FORTRAN.
> Give us this day our daily compilations.
> And forgive us our Syntax Errors
> As we forgive them that give us the wrong input data
> And lead us into fatal diagnostics;
> But deliver us from Parity errors,
> For thine is the Computation,
> The Software and the Hardware,
> For ever and ever,
> Exit.

CARD FORTRAN INFORMATION

Users are reminded that during CARD FORTRAN execution, setting switch 16 will
cause the examination of all I, F, E output fields to determine whether
sufficient field length has been allowed. If the field width is insufficient,
the field will be expanded and a diagnostic message output on the console
typewriter. It is important to note that even though an explicit sign may not
be output, allowance must be made for it when calculating a field width. (If
the quantity is positive, the + sign will be replaced by a blank.) This means,
incidentally, that an I1 field cannot be used in this mode. A problem may
arise in a compile and run job if switch 16 was set *during compilation* to
suppress the punching of a binary object deck, since there may be no
opportunity to reset switch 16 before proceeding to the run phase of the job.

For further operational details, users are referred to Chapter 10 of the
Technical Manual No. 2, CARD FORTRAN (MNT-2), copies of which may be obtained
from the Computer Centre.

LIBRARY ACCESSIONS

This month's list outlines the books and periodicals on computer science that the Libraries of the University of Queensland acquired in August 1969.

Artandi, Susan S. *An Introduction to Computers in Information Science.* 1968. (029.7 ART, Main Lib.)

Rogers, Andrei. *Network Analysis.* 1966. (Q311.23 ROG, Engin.Lib.)

Salzman, Lawrence. *Computerized Economic Analysis.* 1968. (330.018 SAL, Engin.Lib.)

Symposium on Cost Benefit Analysis, Melbourne. October 24, 1967. *An Introduction to Cost-Benefit Analysis.* 1967. (338.522 SYM, Main Lib.)

Treyz, George I. *Computer Problem Kit for Economics.* 1969. (330.0184 TRE, Economics Lib.)

Kucera, Henry. *Computational Analysis of Present-Day American English.* 1967. (Q427.973 KUC, Main Lib.)

Mann, Henry B. ed. *Error Correcting Codes.* 1968. (519.7 MAN, Elect.Engin.Lib.)

Computer-Aided Integrated Circuit Design. 1968. (621.38173 COM, Elect.Engin.Lib.)

Computer Communications Symposium, University of California at Los Angeles, 1967. *Computers and Communications.* 1968. (621.38 COM, Main Lib.)

Computerized Process Control. 1968. (658.5 COM, Engin.Lib.)

Corlett, Peter N. *Practical Programming.* 1968. (651.8 COR, Education Methods Lib.)

IFIP Working Conference of Simulation Programming Languages, Oslo, 1967. *Simulation Programming Languages.* 1968. (651.8 IFI, Engin.Lib.)

Meier, Robert C. *Simulation in Business and Economics.* 1969. (658 MEI, Main Lib.)

Sanders, Donald H. *Computers in Business.* 1968. (658.5 SAN, Accountancy Seminar Room)

International Computers Limited. *Computer International.* Current year only retained. (651.269 INT, Engin.Lib.)

West Virginia University Conference on Computer Applications in Music, Morgantown, 1966. Papers. 1967. (780.1 WES, Music Lib.)

APPLICATION OF COMPUTERS TO BIOMETRY IN ANIMAL PRODUCTION

P.M. Pepper

The author of this article, Miss Patricia Pepper, holds a Bachelor of Science degree and a postgraduate Diploma in Automatic Computing from the University of Queensland.

Miss Pepper works as a Biometrician in the Animal Industry Division at the Department of Primary Industries.

Biometry is an important tool in animal production research. It is used in the design of experiments so that the maximum amount of useful information can be obtained from an experiment and is statistically analysed to evaluate the significance of the results. As many trials are of similar design and frequently a large number of variates are measured in one experimental design, the method of analysis is largely routine. Thus, the use of a computer is very valuable. In addition, computations can be lengthy, especially with an unbalanced design.

Programs have been written for experimental designs most frequently used in the Animal Industry Division at the Department of Primary Industries, and these are discussed. A linear model with normally distributed variates is assumed. However, there is provision for various transformations on the raw data if these assumptions do not hold (Bartlett, 1947).

The most common design employed is the *balanced factorial* where there is the same number of observations in all cells. The effects can be fixed or random. If the levels of an effect are a random sample **from** a normally distributed population of levels, the effect is said to be *random*. An effect can be nested within another effect. This is sometimes called an *hierarchal classification*.

In the first example of an analysis of variance of a balanced factorial, the design was a 3 x 3 x 2 factorial with fixed effects. These factors were types of grain, levels of roughage, and levels of salt respectively. Four steers were allocated at random to each treatment combination. As there were three missing values, there is a loss of three error degrees of freedom. The *analysis of covariance technique* in which a pseudo variate is introduced for each missing value is employed in the program (Nair, 1940). Only a sample of the tables of means is given in Example 1.

In the second example, the model was a mixed model of fixed and random effects. Factor A represents treatments which are fixed. Groups (B) were also fixed, whilst animals within groups (C.B.) were random. The appropriate errors against which the

effects have been tested, are printed out in a preliminary outline of the analysis.

Covariance is quite a useful tool for eliminating from the estimates of treatment effects, some effect which can be measured but not controlled (Cochran & Cox, 1966). Thus, gain in body weight could be adjusted for feed intake by using feed intake as a covariate. Balanced factorials can include *split plots* when the whole plot (which may be a plot of grain or a pen of animals) is subdivided into subplots to which levels of another factor are allocated at random.

The third example illustrates the use of covariance. The analysis of the number of days animals took to attain a fixed slaughter weight, with and without adjustment for initial body weight by covariance, is given. The design in this example was a 4 x 2 x 2 x 2 x 2 balanced factorial with fixed effects.

Another type of balanced design often used is the *latin square*, the rows and columns of which should represent the major sources of variation in the experimental material.

In feeding trials with dairy cattle, the measurement criterion (e.g. milk yield) changes with time, and the rate of change may vary markedly from cow to cow. The design which gives the most sensitive treatment comparisons is the *switchback* or *reversal* design. Brandt (1938) showed that the difference between two treatments was confounded with the (n - 1)th component of the interaction (period x treatment sequence) when there were n test periods. Lucas (1956) extended the design to more than two treatments. This is the method used in the program for analysing switchback designs.

In the fourth example, the design was:

Treatment sequence

	A B C	A B C
Period	B C A	C A B
	A B C	A B C

with two cows per treatment sequence.

Data collected in the field on breeding trials is often *non-orthogonal*. For example, the data may be classified by age of dam and sex of offspring, which

results in disproportionate numbers of observations in each cell, and sometimes in data completely missing for some cells. The program to analyse this type of data when interactions can be assumed negligible, uses the method of fitting constants (Rao, 1955).

Although the most common use of the analysis of variance is to obtain tests of significance of treatment effects, it can also be used to estimate components of variance assignable to *random* variables. This has applications in selecting sampling designs and estimating repeatabilities and heritabilities.

In the program for estimating components of variance and covariance in a non-orthogonal experiment, the sums of squares and products are computed by the method of fitting constants, and these are equated to their expectations (Henderson, 1953; Gates and Shiue, 1962). In the fifth example which illustrates this program, the sources of variation were animals and periods.

It is frequently required to fit regression equations to data in order to predict some variable from one or more independent variables. The form of these regressions can be linear, curvilinear, multiple, a combination of multiple and curvilinear (e.g. $y = a + b_1x_1 + b_2x_1^2 + b_3x_2$) or asymptotic ($y = a + br^x$ where $0 < r < 1$). The method used in the program to fit asymptotic regression equations involves the iterative least squares estimation of the parameters (Stevens, 1951).

In the sixth example, an asymptotic regression representing body weight of one of the animals on a restricted diet as a function of time, is given.

> a is the asymptotic value of body weight (y).
>
> b is the change in body weight when time (x) passes from 0 to + infinity.
>
> r is the factor by which the deviation of y from its asymptotic value, is reduced by unit increase in x.

REFERENCES

Bartlett, M.S., 1947.   *The Use of Transformations.* Biometrics 3, 39-52.

Brandt, A.E., 1938.   *Tests of Significance in Reversal or Switchback Trials.* Iowa Agr. Sta. Res. Bull. 234.

Cochran, W.G. and Cox, Gertrude M., 1966. *Experimental Designs*

Gates, Charles E. and Shiue Cherng-jiann, 1962. *The Analysis of Variance of the S-stage Hierarchal Classifications.* Biometrics 18, 529-536.

Henderson, C.R., 1953.   *Estimation of Variance and Covariance Components.*
        Biometrics 9, 226-252.

Henderson, C.R., 1959.   *Design and Analysis of Animal Husbandry Experiments.*
        Techniques and Procedures in Animal Production
        Research.

Lucas, H.L., 1956.   *Switch-back Trials for More Than Two Treatments.*
        Jour. Dairy Sci. 39, 146-154.

Nair, K.R., 1940.   *The Application of the Technique of Analysis of
Covariance to Field Experiments with Several Missing
or Mixed Up Plots.* Sankhya 4, 581-588.

Rao, C.R., 1955.   *Analysis of Dispersion for Multiple Classified Data
with Unequal Numbers in Cells.* Sankhya 15, 253-280.

Stevens, W.L., 1951.   *Asymptotic Regression.* Biometrics 7, 247-267.
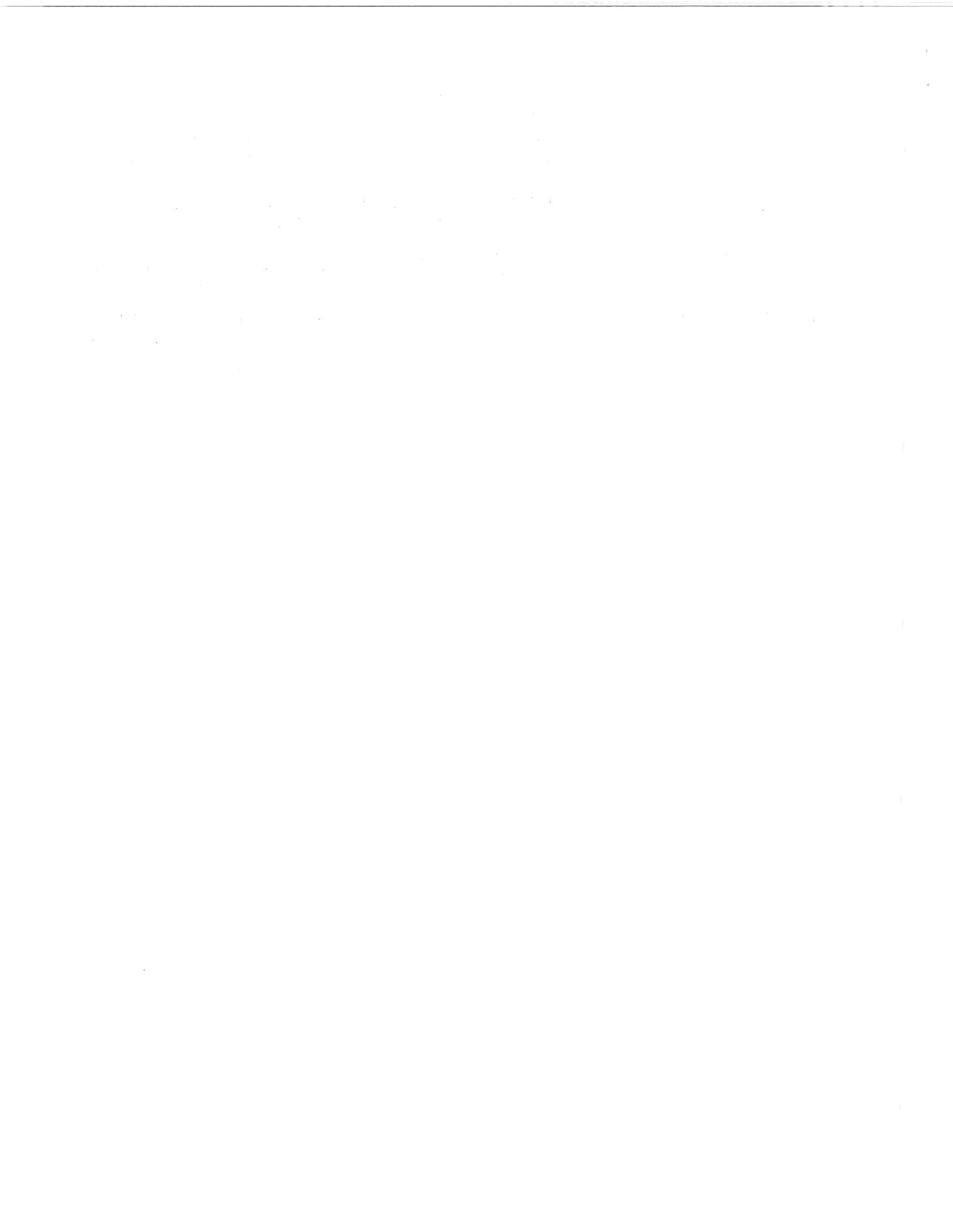
DEPT. PRIMARY INDUSTRIES 103/02   BALANCED FACTORIAL
INTENSIVE FINISHING OF CATTLE 1966
A B C D.ABC
A = GRAIN TYPES
A0 = WHEAT
A1 = BARLEY
A2 = SORGHUM
B = ROUGHAGE LEVEL
B0 = 2 KG
B1 = 1 KG
B2 = NIL
C = SALT LEVEL
C0 = NIL
C1 = SALT

BLOOD INORGANIC PHOSPHORUS (MG/100MC)

T02D01000A03M02P02
        6.73188+00

                    ANALYSIS OF VARIANCE

SOURCE	DF	MSQ	F	PROB.	SU
A.	2	2.5604055+00	4.929	* 0.011	
B.	2	2.9042056-01	0.559		
AB.	4	1.1274238+00	2.171		
C.	1	3.8026423-02	0.073		
AC.	2	1.8345934-01	0.353		
BC.	2	4.7786445-02	0.092		
ABC.	4	3.1636781-01	0.609		
.ABCD	51	5.1942808-01			7.2071359-01

A MEANS

            A   A   A
            0   1   2
              6.63   7.12   6.46

       SIG DIFFS
       1   0 *   1   2**

    AVE SE=   0.15   LSD   0.43 (5 PC)   0.57 (1 PC)

    BC MEANS

C   B   B   B
            0   1   2
0   6.85   6.70   6.59
1   6.81   6.84   6.63

    NO SIG DIFFS

    AVE SE=   0.21   LSD   0.61 (5 PC)   0.81 (1 PC)

            EXAMPLE 1.   ANALYSIS OF VARIANCE

```
                            ANALYSIS OF VARIANCE
A.              ABC
B.              BC
AB.             ABC
C.B             ABC
.ABC
                3.08705+01


                            ANALYSIS OF VARIANCE

SOURCE              DF          MSQ              F         PROB.        SD
A.                  4       3.3707235+02     5.019  **
B.                  1       8.3229129+02     3.204
AB.                 4       1.5645298+02     2.330
C.B                 6       2.5977066+02     3.868  **
.ABC                24      6.7153478+01                           8.1947226+00


            EXAMPLE 2.    ANALYSIS OF VARIANCE
```

9.

MK3F01F01D02
AU4F02F08D02
AU4F09F02D01

DAYS ON EXPERIMENT
INITIAL SHRUNK WEIGHT AS COVARIATE

ANALYSIS OF VARIANCE

SOURCE	DF	MSQ	F	PROB.	SD
A.	3	2.5767465+02	1.031		
B.	1	1.0975449+01	0.044		
AB.	3	2.8463278+02	1.138		
C.	1	5.4842200+01	0.219		
AC.	3	1.3756598+02	0.550		
BC.	1	2.7081963+02	1.083		
D.	1	2.8627460+02	1.144		
AD.	3	5.3821479+02	2.152		
BD.	1	3.6532431+02	1.460		
CD.	1	3.1790775+02	1.271		
E.	1	6.1285877+02	2.450		
AE.	3	8.9401932+01	0.357		
BE.	1	1.1891480+00	0.005		
CE.	1	2.3615311+01	0.094		
DE.	1	3.5382698+02	1.415		
.ABCDE	37	2.5013802+02			1.5815752+01

B =8.6069883=01 ** SE 1.4437146=01

DAYS ON EXPERIMENT

ADHF00F01D01.

1.32707+02

ANALYSIS OF VARIANCE

SOURCE	DF	MSQ	F	PROB.	SD
A.	3		0.687		
B.	1		0.050		
AB.	3		0.706		
C.	1		0.002		
AC.	3		0.250		
BC.	1		0.002		
D.	1		0.077	0.050	
AD.	3		1.010		
BD.	1		0.125		
CD.	1		0.007		
E.	1		1.429		
AE.	3		0.247		
BE.	1		0.433		
CE.	1		0.334		
DE.	1		0.114		
.ABCDE	38				2.168+01

EXAMPLE 3.   USE OF COVARIANCE

10.

AVERAGE MILKING RATE (LB./MIN.)

	D.F.	M.S.	F	PROB.
TREATMENTS	2.	0.27621	5.280	0.0301
ERROR	9.	0.05231		

TREATMENT MEANS		GREATER THAN 5P.C.		GREATER THAN 1P.C.
1	2.8019			
2	2.9698	3		
3	2.5987			
S.E.OF TREAT.DIFF.		0.11436		
COEFF.OF VAR.		8.19740		

EXAMPLE 4.   ANALYSIS OF SWITCHBACK DESIGN

SALIVA ANALYSES SHEEP   SODIUM

ANALYSIS OF DISPERSION

	Y 1 Y 1
A	10269.1079
B	2324.6823
AB	3797.7141
RESIDUAL	1436.3131

COEFFICIENTS OF COMPONENTS

	A	B	AB	RESIDUAL
A	43.000000	0.000000	11.761904	5.000000
B		37.904762	6.666666	3.000000
AB			31.238096	14.000000
RESIDUAL				29.000000

VARIANCE AND COVARIANCE COMPONENTS

	Y 1 Y 1
A	206.33988
B	39.93141
AB	99.37615
RESIDUAL	49.52804

EXAMPLE 5.   ANALYSIS OF VARIANCE

BODY WEIGHT OF COW 252 ON A RESTRICTED DIET FOR 23 WEEKS

REGN MS	DF	RESIDUAL MS	F	PERCENT VAR	SEE
6025.465	21	31.74420	189.82	94.76	5.63420
A		B	R		
323.72425		103.30078	0.46091		
1.30710		5.60100	0.04049		

REGN MS	DF	RESIDUAL MS	F	PERCENT VAR	SEE
6032.059	21	31.13528	193.74	94.86	5.57990
A		B	R		
323.62464		104.10325	0.64667		
1.28790		5.56406	0.04095		

REGN MS	DF	RESIDUAL MS	F	PERCENT VAR	SEE
6032.201	21	31.12168	193.83	94.86	5.57868
A		B	R		
323.63200		104.15576	0.44549		
1.28709		5.56419	0.04101		

ESTIMATES

427.79	370.03	344.30	332.84	327.76	325.46	324.45	324.00	323.79	323.70
323.66	323.65	323.64	323.64	323.63	323.63	323.63	323.63	323.63	323.63
323.63	323.63	323.63	323.63						

EXAMPLE 6.   ASYMPTOTIC REGRESSION

12.