An Example.

The following example is taken from Searle (1971, pp. 287,375). An experiment was conducted to compare the effects of three different types of fertilizer and four varieties of grain on the weight of grain (WEIGHT). The milligrams of seed planted (MSEED) for each plot were also recorded and used as the covariate. The SPSS commands and data for model 3 are presented in Figure 1.18a, and the analysis of variance tables in Figure 1.18b.

Figure 1.18a

```
RUN NAME        EMPTY CELLS EXAMPLE FROM SEARLE(1971).
COMMENT         DATA ARE TAKEN FROM P. 287 AND P. 375.
VARIABLE LIST   TREATMNT, VARIETY, WEIGHT, MSEED
N OF CASES      18
INPUT FORMAT    FREEFIELD
INPUT MEDIUM    CARD
MANOVA          WEIGHT MSEED BY TREATMNT(1,3), VARIETY(1,4)/
                ANALYSIS=WEIGHT/
                DESIGN = MSEED WITHIN VARIETY BY TREATMNT ,
                  VARIETY, TREATMNT, VARIETY BY TREATMNT/
                DESIGN = TREATMNT, VARIETY, VARIETY BY TREATMNT,
                  MSEED WITHIN VARIETY BY TREATMNT/
READ INPUT DATA
1 1 8  2
1 1 13 4
1 1 9  3
1 3 12 7
1 4 7  3
1 4 11 5
2 1 6  5
2 1 12 3
2 2 12 6
2 2 14 4
3 2 9  6
3 2 7  2
3 3 14 6
3 3 16 8
3 4 10 4
3 4 14 6
3 4 11 5
3 4 13 7
FINISH
```

Figure 1.18b

TESTS OF SIGNIFICANCE FOR WEIGHT USING SEQUENTIAL SUMS OF SQUARES

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIG. OF F
WITHIN+RESIDUAL	4.30000	3	1.43333		
CONSTANT	2178.00000	1	2178.00000	1519.53488	.000
MSEED WITHIN VARIETY BY TREATMNT	92.11472	8	11.51434	8.03326	.057
VARIETY	5.31810	3	1.77270	1.23677	.433
TREATMNT	36.16611	2	18.08306	12.61609	.035
VARIETY BY TREATMNT	.10107	1	.10107	.07051	.808

TESTS OF SIGNIFICANCE FOR WEIGHT USING SEQUENTIAL SUMS OF SQUARES

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIG. OF F
WITHIN+RESIDUAL	4.30000	3	1.43333		
CONSTANT	2178.00000	1	2178.00000	1519.53488	.000
TREATMNT	10.50000	2	5.25000	3.66279	.157
VARIETY	36.78571	3	12.26190	8.55482	.056
VARIETY BY TREATMNT	34.71429	2	17.35714	12.10963	.037
MSEED WITHIN VARIETY BY TREATMNT	51.70000	7	7.38571	5.15282	.103

1.19 Randomized Block Designs

In this design the experimental unit is divided into groups (blocks). The main object of this is to keep the experimental errors within each group as small as possible. The accuracy of the experiment is increased by making comparisons within the resulting relatively homogeneous experimental units. The model for this design is

$$Y_{ij} = \mu + \beta_i + \tau_j + \epsilon_{ij}$$

where β_i is the block effect and τ_j is the treatment effect.