Chapter 268

Design Generator

Introduction

This program generates factorial, repeated measures, and split-plots designs with up to ten factors. The design is placed in the current database.

Crossed Factors

Two factors are *crossed* if all levels of one factor occur with each level of the second factor. No distinction needs to be made as to whether a factor is random or fixed. Factorial and randomized block designs are examples of designs that contain crossed factors.

Nested Factors

In the repeated measures and split-plot designs, at least one of the factors is nested in another factor. A factor is *nested* when all levels of this factor do not occur with each level of another factor. For example, suppose a study is being made to compare the heart rate of males and females. Five males and five females are selected. One factor in the study would be gender with two levels: male and female. Another factor would be individual with ten levels: P1, P2, …, and P10. Since five of the ten individuals are in the males group and the other five individuals are in the females group, individuals are nested within gender.

The basic structure of *repeated measures* and *split-plot* designs is identical. The difference between the two is in the way the factor levels are assigned within the individual factor. Consider an exercise study in which heart rate readings are to be made on an individual at five different points in time. If the amounts of exercise is assigned at random before each reading, the design is a split plot. If the amounts of exercise follow the same pattern for each individual, the design is a repeated measures.

Procedure Options

This section describes the options available in this procedure.

Design Tab

This panel specifies the parameters that will be used to create the design values.

Experimental Setup

Factor (1 to 12) Values

The values used to represent the rows are specified here. These values may be letters, digits, words, or numbers. The list is delimited by blanks or commas. The number of levels of a factor corresponds to the number of values that are listed here.

To specify a nested factor, use the word Nested followed by the number of levels within a group. For example, entering 'Nested 4' signifies a design in which four individuals are placed in each group. The number of groups is found by crossing the factors before the nested factor.

An easy way to replicate a design is to specify a nested factor as the last factor with the number of replicates specified as the number of levels.

Data Storage

Store Data with the Dataset

Check this box to generate the design data on the dataset. The data will be identical to the design data generated on the output window.

Store First Factor In

The first factor is stored in this column. Each additional factor that is specified is stored in the column s immediately to the right of this column. A factor is specified when values are entered into its Factor Values box.

Warning: The program fills these columns with data, so any previous data will be replaced.

Example 1 – Three-by-Four Factorial Design with Three Replicates

This section presents an example of how to degenerate a three-by-four factorial design with three replicates per treatment combination. To run this example, take the following steps. **CAUTION: since the purpose of this routine is to generate (not analyze) data, you should always begin with an empty dataset.**

You may follow along here by making the appropriate entries or load the completed template **Example 1** by clicking on Open Example Template from the File menu of the Design Generator window.

1 Open a new (empty) dataset.

- From the **File** menu of the NCSS Data window, select **New**.
- Click the **Ok** button.

2 Open the Design Generator window.

- Using the Analysis menu or the Procedure Navigator, find and select the **Design Generator** procedure.
- On the menus, select **File**, then **New Template**. This will fill the procedure with the default template.

3 Specify the design parameters.

- On the Design Generator window, select the **Design tab**.
- Enter **1 2 3** in the **Factor 1 Values (A)** box.
- Enter **1 2 3 4** in the **Factor 2 Values (B)** box.
- Enter **Nested 3** in the **Factor 3 Values (C)** box.
- Check the box **Store Data with the Dataset.**

4 Run the procedure.

- From the Run menu, select **Run Procedure**. Alternatively, just click the green Run button.

Three-by-Four Design with Three Replicates

C1	C2	C3
1	1	1
1	1	2
1	1	3
1	2	4
1	2	5
1	2	6
1	3	7
1	3	8
1	3	9
1	4	10
1	4	11
1	4	12
2	1	13
2	1	14
2	1	15
2	2	16
2	2	17
2	2	18
2	3	19
2	3	20
2	3	21
2	4	22
2	4	23
2	4	24
3	1	25
3	1	26
3	1	27
3	2	28
3	2	29
3	2	30
3	3	31
3	3	32
3	3	33
3	4	34
3	4	35
3	4	36

Notice that the simulated response is placed in variable C1, C2 contains the three values for factor 1, C2 contains the four values of factor 2, and C3 contains the value of the nested factor. When these data are analyzed, C3 will be ignored.

You would now proceed with your experiment, obtain the real response values, and analyze the data using either the Analysis of Variance, GLM, or Mixed Models procedure. The output will appear as follows.

ANOVA for 3-by-4 Factorial

Expected Mean Squares Section

Source Term	DF	Term Fixed?	Denominator Term	Expected Mean Square
A (C2)	2	Yes	S(AB)	S+bsA
B (C3)	3	Yes	S(AB)	S+asB
AB	6	Yes	S(AB)	S+sAB
S(AB)	24	No		S

Note: Expected Mean Squares are for the balanced cell-frequency case.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A (C2)	2	83609.72	41804.86	0.59	0.563864	0.113222
B (C3)	3	200053.6	66684.55	0.94	0.438592	0.181412
AB	6	832589.6	138764.9	1.95	0.113775	0.521955
S	24	1709695	71237.28			
Total (Adjusted)	35	2825948				
Total	36					

* Term significant at alpha = 0.05

Of course, your F-Ratios will be different because you are using a different set of random numbers. However, you will be able to see the number of degrees of freedom that are associated with each factor.

Example 2 – Randomized Block Design

This section presents an example of how to degenerate a randomized block design with three blocks and four treatments. To run this example, take the following steps. **CAUTION: since the purpose of this routine is to generate (not analyze) data, you should always begin with an empty dataset.**

You may follow along here by making the appropriate entries or load the completed template **Example 2** by clicking on Open Example Template from the File menu of the Design Generator window.

1 Open a new (empty) dataset.

- From the **File** menu of the NCSS Data window, select **New**.
- Click the **Ok** button.

2 Open the Design Generator window.

- On the menus, select **Analysis**, then **Design of Experiments**, then **Design Generator**. The Design Generator procedure will be displayed.
- On the menus, select **File**, then **New Template**. This will fill the procedure with the default template.

3 Specify the design parameters.

- On the Design Generator window, select the **Design tab**.
- Enter **1 2 3** in the **Factor 1 Values (A)** box.
- Enter **A B C D** in the **Factor 2 Values (B)** box.
- Make sure that the **Factor 3 Values (C)** box is blank.
- Check the box **Store Data with the Dataset.**

4 Run the procedure.

- From the Run menu, select **Run Procedure**. Alternatively, just click the Run button (the left-most button on the button bar at the top).

Randomized Block Design

C1	C2
1	A
1	B
1	C
1	D
2	A
2	B
2	C
2	D
3	A
3	B
3	C
3	D

Notice that C1 contains the three values for the blocks, and C2 contains the value of the treatment.

It is important to remember that when you use this design, you must randomly assign treatments to the four letters and randomly assign the physical blocks to the three block numbers.

You would now proceed with your experiment, obtain the response values, and analyze the data using the GLM procedure. You would specify blocks (C1) as random and treatment (C2) as fixed. You would set the Which Model Terms option of the Model tab to Up to 1-Way. After running the analysis, the format of the output appears as follows.

ANOVA for Randomized Block Design

Expected Mean Squares Section

Source Term	DF	Term Fixed?	Denominator Term	Expected Mean Square
A (C2)	2	No	S(AB)	S+bsA
B (C3)	3	Yes	S(AB)	S+asB
S(AB)	6	No		S

Note: Expected Mean Squares are for the balanced cell-frequency case.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A (C2)	2	140324.7	70162.34	0.79	0.495026	
B (C3)	3	431012.9	143671	1.62	0.280672	0.211531
S	6	531277.3	88546.22			
Total (Adjusted)	11	1102615				
Total	12					

* Term significant at alpha = 0.05

Example 3 – Repeated Measures Design

This section presents an example of how to degenerate a repeated measures design with three groups, two individuals per group, and two treatments which we will label 'Pre' and 'Post.' To run this example, take the following steps. **CAUTION: since the purpose of this routine is to generate (not analyze) data, you should always begin with an empty dataset.**

You may follow along here by making the appropriate entries or load the completed template **Example 3** by clicking on Open Example Template from the File menu of the Design Generator window.

1 Open a new (empty) dataset.

- From the **File** menu of the NCSS Data window, select **New**.
- Click the **Ok** button.

2 Open the Design Generator window.

- On the menus, select **Analysis**, then **Design of Experiments**, then **Design Generator**. The Design Generator procedure will be displayed.
- On the menus, select **File**, then **New Template**. This will fill the procedure with the default template.

3 Specify the design parameters.

- On the Design Generator window, select the **Design tab**.
- Enter **1 2 3** in the **Factor 1 Values (A)** box.
- Enter **Nested 2** in the **Factor 2 Values (B)** box.
- Enter **Pre Post** in the **Factor 3 Values (C)** box.
- Check the box **Store Data with the Dataset.**

4 Run the procedure.

- From the Run menu, select **Run Procedure**. Alternatively, just click the Run button (the left-most button on the button bar at the top).

Repeated Measures Design

C1	C2	C3
1	1	Pre
1	1	Post
1	2	Pre
1	2	Post
2	3	Pre
2	3	Post
2	4	Pre
2	4	Post
3	5	Pre
3	5	Post
3	6	Pre
3	6	Post

Column C1 contains the three group values which are sometimes referred to as the *Between* factor. Column C2 contains the identification numbers of the six individuals required for this design. Notice that each individual is placed in only one group (C1). Column C3 contains the pre-post labels. The design is ready for analysis by the GLM procedure.

You would now proceed with your experiment, obtain the response values, and analyze the data using the GLM procedure. You would specify variable (C1) as fixed, variable (C2), as nested, and variable C3 as fixed. After running the analysis, the output appears as follows.

ANOVA for Repeated Measures Design

Expected Mean Squares Section

Source Term	DF	Term Fixed?	Denominator Term	Expected Mean Square
A (C2)	2	Yes	B(A)	S+csB+bcsA
B(A)	3	No	S(ABC)	S+csB
C (C4)	1	Yes	BC(A)	S+sBC+absC
AC	2	Yes	BC(A)	S+sBC+bsAC
BC(A)	3	No	S(ABC)	S+sBC
S(ABC)	0	No		S
	S			

Note: Expected Mean Squares are for the balanced cell-frequency case.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A (C2)	2	246267.2	123133.6	5.26	0.104519	0.227807
B(A)	3	70225.5	23408.5			
C (C4)	1	37632	37632	0.31	0.617203	0.057865
AC	2	98376.5	49188.25	0.40	0.699505	0.063179
BC(A)	3	365667.5	121889.2			
S	0	0				
Total (Adjusted)	11	818168.7				
Total	12					

* Term significant at alpha = 0.05