Chapter 883

Balanced Incomplete Block Designs

Introduction

This module generates balanced incomplete block designs. Designs for up to ten treatments are available.

In order to make precise measurements of treatment means, uniform experimental conditions should be maintained when comparing a number of treatments. This insures that differences among the treatment means result from the application of the treatment and not from some extraneous factor. To achieve this, experimental trials are often grouped together into blocks. In such designs, conditions are kept constant within the blocks and allowed to vary between the blocks. The best known design of this type is the *randomized block* design. In this design, all treatments are present in each block.

Occasionally, the size of convenient blocks will not accommodate all the treatments of interest. For example, suppose you wanted to test four types of automobile tires for wear. An obvious choice for a block would be an automobile. You might select ten automobiles for the study. Assuming that the tires were rotated among the four positions, this experiment would control for differences in tire wear due to the type of automobile and the terrain that each traveled. However, blocking difficulties arise if you want to test six types of tires. You could redesign the automobile, or you could adopt a *balanced incomplete block* design.

In a balanced incomplete block design, the treatments are assigned to the blocks so that every pair of treatments occurs together in a block the same number of times. This achieves the *balance* that is described in the title of the procedure. The balance means that all differences between treatments are measured with equal precision.

Following is an example of how four treatments are assigned to blocks with a natural size of three experimental units. Four blocks are required for this balanced incomplete block design.

Block	Treatment
1	A B C
2	A B D
3	A C D
4	B C D

Note that each treatment occurs three times in this experimental layout. Also note that each pair of treatments occurs twice. These are the basic properties of the balanced incomplete designs.

Box, Hunter, and Hunter (1978) point out the following rules when using such designs.

1. Randomly assign the numbers to the blocks.

2. Randomly assign the letters to the treatments.

3. Randomly assign the treatments within the blocks.

4. Randomly group blocks as replicates. A replicate is a complete set of all treatments.

If you take these steps, this design can be used effectively in those situations in which the block size and the number of treatments do not match.

An introduction to experimental design is presented in Chapter 881 on Two-Level Factorial Designs and will not be repeated here.

Design Limits

The designs used in this procedure were taken from Cochran and Cox (1992). We have included designs with up to ten treatments. The following table shows what block sizes are available for each number of treatments.

Number of Treatments	Block Sizes Available
4	2, 3
5	2, 3, 4
6	2, 3, 4, 5
7	2, 3, 4, 6
8	2, 4, 7
9	2, 4, 5, 6, 8
10	2, 3, 4, 5, 6, 9

Note that some block sizes are not available for certain numbers of treatments.

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

Block Size

This option contains the size of the blocks. That is, this is the number of experimental units that are contained in each block.

Treatment Values

The values used to represent the treatments are specified here. These values may be letters, digits, words, or numbers. The list is delimited by blanks or commas. The number of treatments is implied by the number of items in this list.

Data Storage to Spreadsheet

Store Data on Spreadsheet

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

Store First Factor In

The block identification numbers of each row of the design are stored in this variable. The treatment identification numbers (or letters) are stored in the variable immediately to the right.

Warning: The program fills these variables with data, so any previous data will be lost.

Example 1 – Balanced Incomplete Block Design

This section presents an example of how to generate a balanced incomplete block design using this program. **CAUTION: since the purpose of this routine is to generate data, you should always begin with an empty output spreadsheet.**

In this example, we will show you how to generate a design with four treatments in blocks of two experimental units each.

Setup

This section presents the values of each of the parameters needed to run this example. First, from the PASS Home window, load the **Balanced Incomplete Block Designs** procedure window by expanding **Design of Experiments**, then clicking on **Experimental Design**, and then clicking on **Balanced Incomplete Block Designs**. You may then make the appropriate entries as listed below, or open **Example 1** by going to the **File** menu and choosing **Open Example Template**.

1 **Specify the design parameters.**
- Set **Block Size** to **2**.
- Set **Treatment Values** to **1 2 3 4**.
- Check the **Store Data on Spreadsheet** box.
- Enter **1** in the **Store First Factor In** box.

2 **Run the procedure.**
- From the Run menu, select **Start Calculation**. Alternatively, just click the Calculate button.

BIBD with Four Treatments in Blocks of Two

Experimental Design

Row	Block	Treatment
1	1	1
2	1	2
3	2	3
4	2	4
5	3	1
6	3	3
7	4	2
8	4	4
9	5	1
10	5	4
11	6	2
12	6	3

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