

Standard Terminology Relating to Design of Experiments¹

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1. Scope

1.1 This standard includes those statistical items related to the area of design of experiments for which standard definitions appear desirable.

2. Referenced Documents

2.1 *ASTM Standards*:²

E456 Terminology Relating to Quality and Statistics

3. Significance and Use

3.1 This standard is a subsidiary to Terminology E456.

3.2 It provides definitions, descriptions, discussion, and comparison of terms.

4. Terminology

aliases, n —in a fractional factorial design, two or more effects which are estimated by the same contrast and which, therefore, cannot be estimated separately.

DISCUSSION—(1) The determination of which effects in a 2^n factorial are *aliased* can be made once the *defining contrast* (in the case of a half replicate) or *defining contrasts* (for a fraction smaller than $\frac{1}{2}$) are stated. The *defining contrast* is that effect (or effects), usually thought to be of no consequence, about which all information may be sacrificed for the experiment. An identity, I , is equated to the *defining contrast* (or *defining contrasts*) and, using the conversion that $A^2 = B^2 = C^2 = I$, the multiplication of the letters on both sides of the equation shows the aliases. In the example under fractional factorial design, $I = ABCD$. So that: $A = A^2BCD = BCD$, and $AB = A^2B^2CD = CD$.

(2) With a large number of factors (and factorial treatment combinations) the size of the experiment can be reduced to $\frac{1}{4}$, $\frac{1}{8}$, or in general to $\frac{1}{2^k}$ to form a 2^{n-k} fractional factorial.

(3) There exist generalizations of the above to factorials having more than 2 levels.

balanced incomplete block design (BIB), n —an incomplete block design in which each block contains the same number

k of different versions from the t versions of a single principal factor arranged so that every pair of versions occurs together in the same number, λ , of blocks from the b blocks.

DISCUSSION—The design implies that every version of the principal factor appears the same number of times r in the experiment and that the following relations hold true: $bk = tr$ and $r(k - 1) = \lambda(t - 1)$.

For randomization, arrange the blocks and versions within each block independently at random. Since each letter in the above equations represents an integer, it is clear that only a restricted set of combinations (t, k, b, r, λ) is possible for constructing balanced incomplete block designs. For example, $t = 7, k = 4, b = 7, \lambda = 2$. Versions of the principal factor:

Block	1	2	3	6
2	2	3	4	7
3	3	4	5	1
4	4	5	6	2
5	5	6	7	3
6	6	7	1	4
7	7	1	2	5

block factor, n —a factor that indexes division of experimental units into disjoint subsets.

DISCUSSION—Blocks are sets of similar experimental units intended to make variability within blocks as small as possible, so that treatment effects will be more precisely estimated. The effect of a block factor is usually not of primary interest in the experiment. Components of variance attributable to blocks may be of interest. The origin of the term “block” is in agricultural experiments, where a block is a contiguous portion of a field divided into experimental units, “plots,” that are each subjected to a treatment.

completely randomized design, n —a design in which the treatments are assigned at random to the full set of experimental units.

DISCUSSION—No block factors are involved in a completely randomized design.

completely randomized factorial design, n —a factorial experiment (including all replications) run in a completely randomized design.

composite design, n —a design developed specifically for fitting second order response surfaces to study curvature, constructed by adding further selected treatments to those obtained from a 2^n factorial (or its fraction).

DISCUSSION—If the coded levels of each factor are -1 and $+1$ in the 2^n factorial (see notation 2 under discussion for **factorial experiment**), the $(2n + 1)$ additional combinations for a *central composite design* are

¹ This terminology is under the jurisdiction of ASTM Committee E11 on Quality and Statistics and is the direct responsibility of Subcommittee E11.10 on Sampling / Statistics.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.