FACTORIAL DESIGN

Definition

- Factorial experiment is an experiment whose design consist of two or more factor each with different possible values or levels.
- Factorial Design technique introduced by fisher in 1926.
- Factorial design applied in optimization techniques.

- **Factor :** It is assigned Variable , i.e. independent variables influencing the response.

  E.g. Concentration, temperature.

- **Levels :** Values assigned to the factor.

  E.g. Low(-1), high(+1).

- **Response :** Is the measured property of the process

  E.g. dissolution rate, Hardness of tablet.

- **Effects :** Change in response caused by varying levels.
- **Interaction :** Overall effect of two or more variables.
- **Runs :** Experiment conducted according to the selected design.

  E.g. 22 = 4 Runs

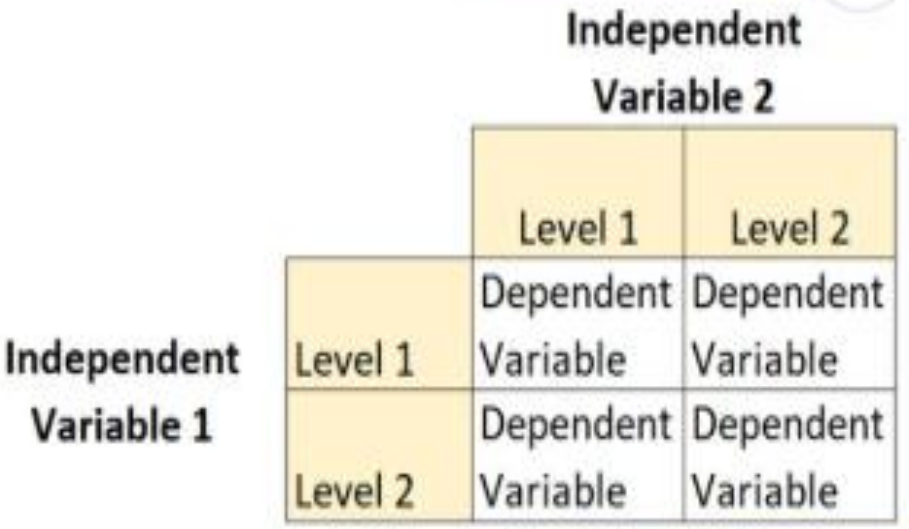
Types of Factorial Design

- There are two types of factorial designs. 1. Full Factorial Design .
  2. Fractional Factorial Design.
- Full Factorial Design:
  A design in which every setting of every factor appears with setting of every other factor is full factorial design.
- Simplest design to create ,but extremely inefficient.
- If there is k factor, each at Z level, a full FD has Zk.
- Number of runs (N) N=y x
- where , y=number of levels, x= number of factors E.g. 3 Factors, 2 levels each 23 =8

- Factors: Factors can be quantitative (numerical number) or they are qualitative .
- Factorial design depends on independent variables for development new formulation .
- Factorial design also depends on levels as well as coding.

- Factorial Design: 2^2 , 2^3 , 3^2 , 3^3
- 2^2 FD= 2 Factors, 2 Levels=4 runs.
- 2^3 FD=3Factors,2Levels=8runs.
- 3^2 FD= 2 factors, 3 Levels=9 runs .
- 3^3 FD =3 Factors, 3 Levels=27 runs

-]A **2×2 factorial design** is a type of experimental design that allows researchers to understand the effects of two independent variables (each with two levels) on a single dependent variable.



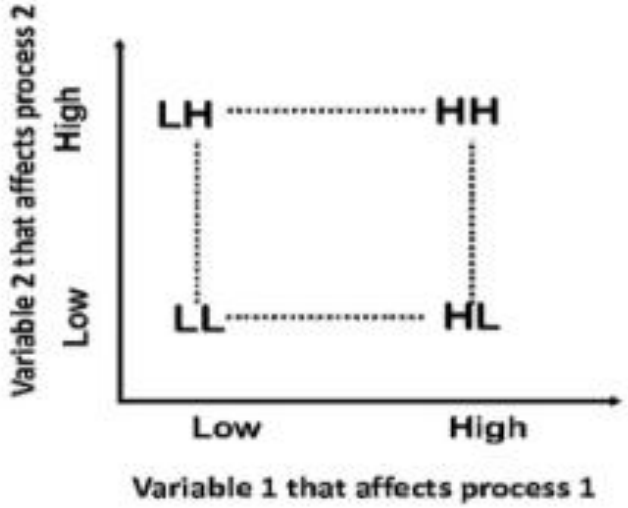
		Independent Variable 2	
		Level 1	Level 2
Independent Variable 1	Level 1	Dependent Variable	Dependent Variable
	Level 2	Dependent Variable	Dependent Variable

- For example, suppose a botanist wants to understand the effects of sunlight (low vs. high) and watering frequency (daily vs. weekly) on the growth of a certain species of plant.

		Watering Frequency	
		Daily	Weekly
Sunlight	Low	Plant Growth	Plant Growth
	High	Plant Growth	Plant Growth

Two Level Full FD

- 2 Factors: X1 and X1 (Independent variables) 2 levels : Low and High
  Coding : (low -1),(high +1)



Three Level Full FD

- In three level factorial design, 3 factors: X1 , X 2and X3.
  3 levels are use,

  1) low(-1)
  2) intermediate (0)
  3) high (+1)

- The simplest form of factorial design is the 2^3 factorial design.

  e.g. 2^3 Factorial design of Sustained release Metformin tablet

Ingredients	**Category**
Microcrystalline cellulose	Diluent
Ethyl cellulose	Sustained Release polymer
PVP-K30	Binder
Magnesium Stearate	Lubricant
Aerosil	Glidant

All inactive Ingredients

Among all inactive ingredients, microcrystalline cellulose, ethyl cellulose, PVP K30 were taken as the independent factors.

Sr. No.	Notation	Independent factors (mg/tab)	Levels	
			-1	+1
1.	X1	Microcrystalline cellulose	80	100
2.	X2	Ethyl cellulose	5	10
3.	X3	PVP K30	3	5

- The experimental plan for a three-factor, two-level 2^3 design is as follows;

No	X_1	X_2	X_3
1	-1	-1	-1
2	-1	1	-1
3	1	-1	-1
4	1	1	-1
5	-1	-1	1
6	-1	1	1
7	1	-1	1
8	1	1	1

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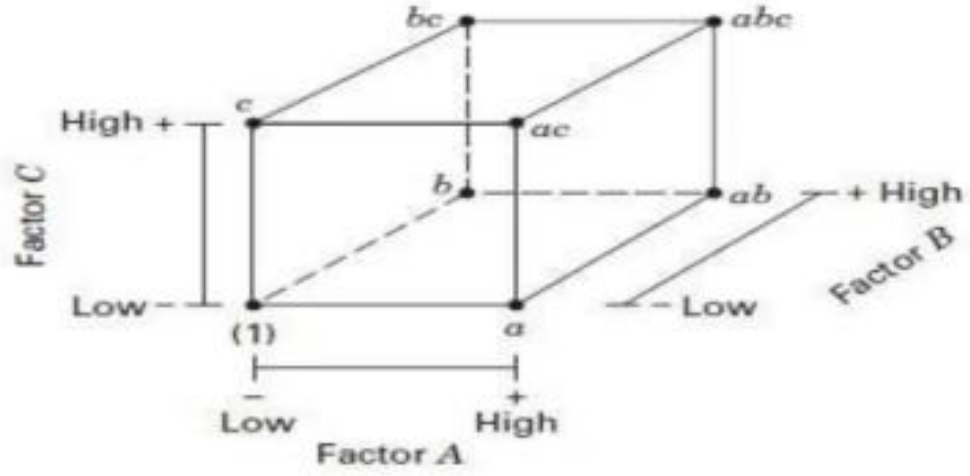

(a) Geometric view

Run	Factor A	B	C
1	–	–	–
2	+	–	–
3	–	+	–
4	+	+	–
5	–	–	+
6	+	–	+
7	–	+	+
8	+	+	+

(b) Design matrix

Fractional Factorial Design

- As the number of variables increases, experimental runs also increases, To overcome these issue in a methodical approach, Fractional Factorial Design is introduced.
- It expressed as,
  X^{n-x} ,

  where, X = No. of Levels

  n = No. of Factors

  x = Degree of Fractionation

Advantages

- Its easier to study the combined effect of two or more factors simultaneously and analyze their interrelationships.
- It has a wide range of factor combination are used.
- It saves time.
- It permits the evaluation of interaction effects.

Applications

APPLICATIONS:

- Formulation and Processing
- Clinical Chemistry
- Medicinal Chemistry
- High Performance Liquid Chromatographic Analysis
- Formulation of Culture Medium in Virological Studies.
- Study of Pharmacokinetic Parameters.

Software Used

- Design Expert 7.1.3
- SYSTAT sigma Stat 3.11
- CYTEL East 3.1
- Minitab
- Matrex
- Omega
- Compact 21-Apr-15 O

Disadvantages

- Its complex when several factors are involved simultaneously.
- Wasting of time and experimental material.
- Increase in factor size leads to increase in block size which increase the chance of error.