Statistical Design of Experiments

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Tutorial Problems

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Example 1: Fractional Factorial Design

8.11. An article in *Industrial and Engineering Chemistry* ("More on Planning Experiments to Increase Research Efficiency," 1970, pp. 60–65) uses a 2^{5-2} design to investigate the effect of A = condensation temperature, B = amount of material 1, C = solvent volume, D = condensation time, and E = amount of material 2 on yield. The results obtained are as follows:

$$e = 23.2 \quad ad = 16.9$$
$$ab = 15.5 \quad bc = 16.2$$
$$cd = 23.8 \quad bde = 16.8$$
$$ace = 23.4 \quad abcde = 18.1$$

(a) Verify that the design generators used were $I = ACE$ and $I = BDE$.

(b) Write down the complete defining relation and the aliases for this design.

(c) Estimate the main effects.

(d) Prepare an analysis of variance table. Verify that the AB and AD interactions are available to use as error.

Example 2: Robust Design

1) The factor table is given below

Control Factors	Levels		
	1	2	3
A. Temperature (C)	T_0 - 25	T_0*	T_0+ 25
B. Pressure (mtorr)	P_0 - 200	P_0*	P_0 + 200
C. Settling time (min)	t_0*	t_0+ 8	t_0 + 16
D. Cleaning method	None*	CM2	CM3

3) Calculate the level averages for each factor an fill in the table below

Factor	Levels		
	1	2	3
A. Temperature			
B. Pressure			
C. Setting Time			
D. Cleaning Method			

4) Plot factor effects graph using the table above

5) Compute ANOVA and rank order the factor effects.

Expt No	Temperature A	Pressure B	Settling Time C	Cleaning Method D	Observations η
1	1	1	1	1	η_1=-20
2	1	2	2	2	η_2=-10
3	1	3	3	3	η_3=--30
4	2	1	2	3	η_4=--25
5	2	2	3	1	η_5=-45
6	2	3	1	2	η_6=-65
7	3	1	3	2	η_7=-45
8	3	2	1	3	η_8=--65
9	3	3	2	1	η_9=-70