國立雲林科技大學 工業工程與管理所
National Yunlin University of Science & Technology Industrial Engineering and Management

品質與可靠度工程實驗室
Quality and Reliability Engineering Lab.

因子實驗設計分析-Minitab操作

授課教授： 童超塵 老師

實驗室網址 永久: http://campusweb.yuntech.edu.tw/~qre/index.htm
目前: http://140.125.88.116/QRE
2006/1/12 第一版

產生實驗規劃表

- Stat➔DOE➔Factorial➔Create Factorial Design

產生實驗規劃表-預設產生器

- 顯示兩因子兩水準各種實驗解析度

Type of Design

- 2-level factorial (default ger
- 2-level factorial (specify ge
- Plackett-Burman design
- General full factorial desigr

Number of factors: 2

Help

Display Available Designs...

Designs...

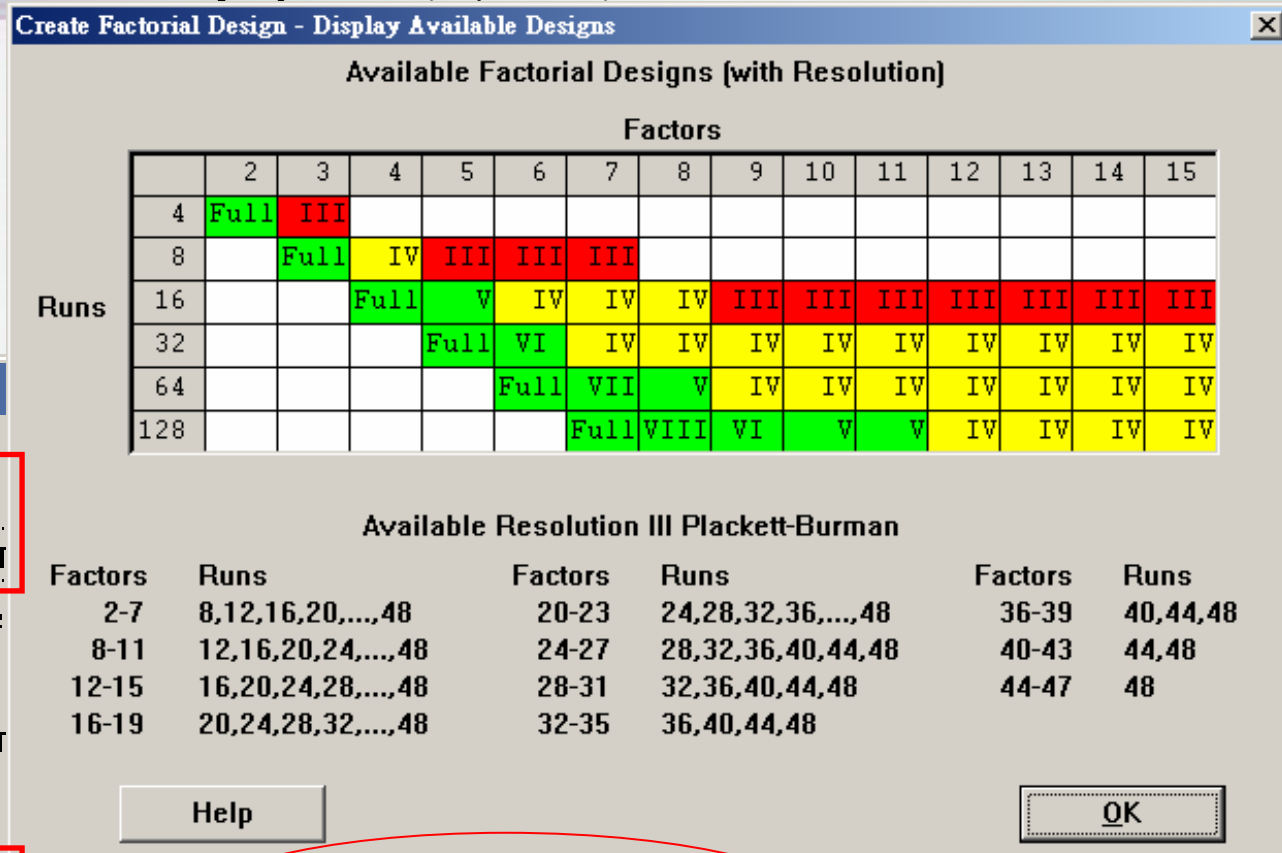
Factors...

Options...

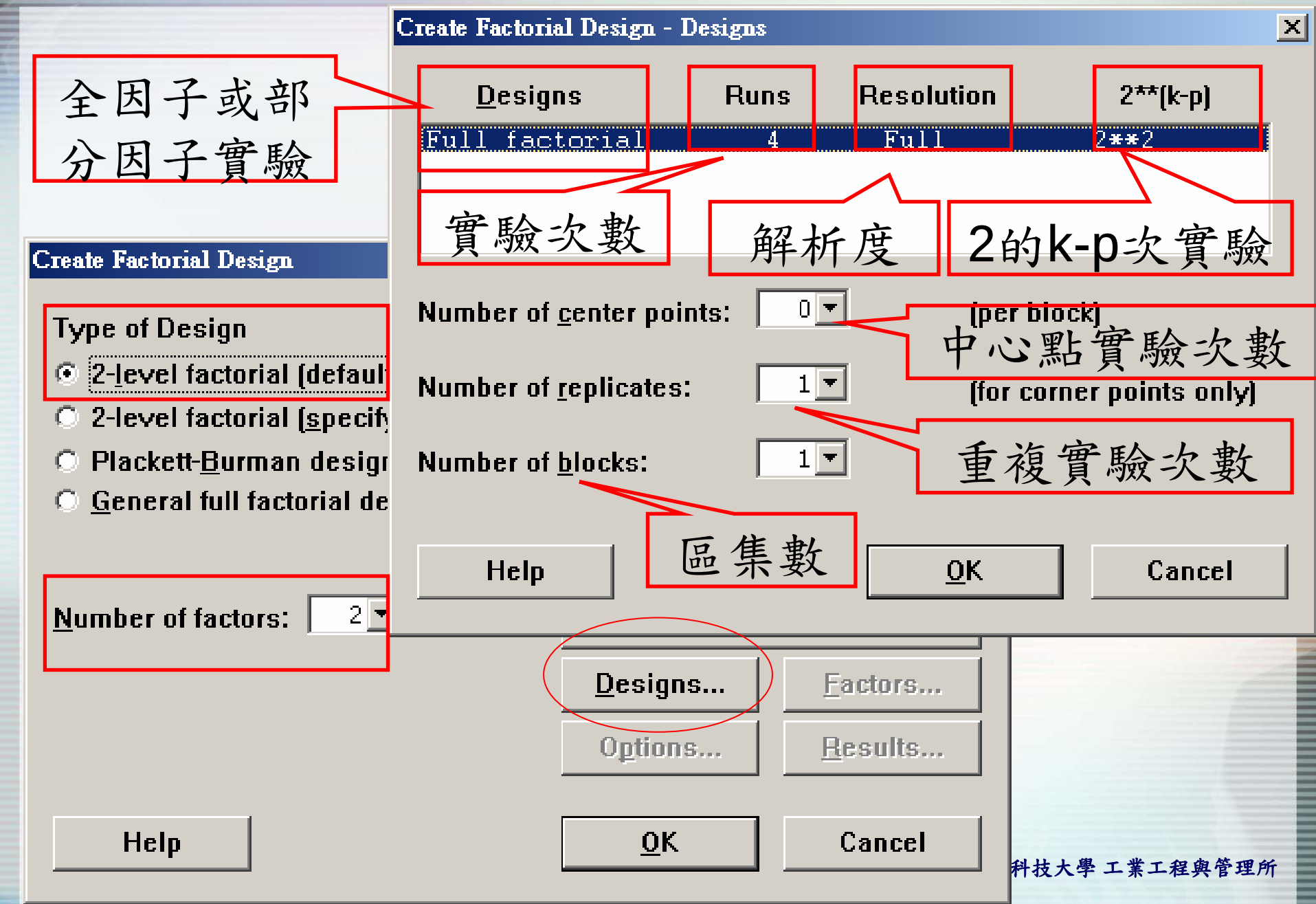
Results...

OK

Cancel

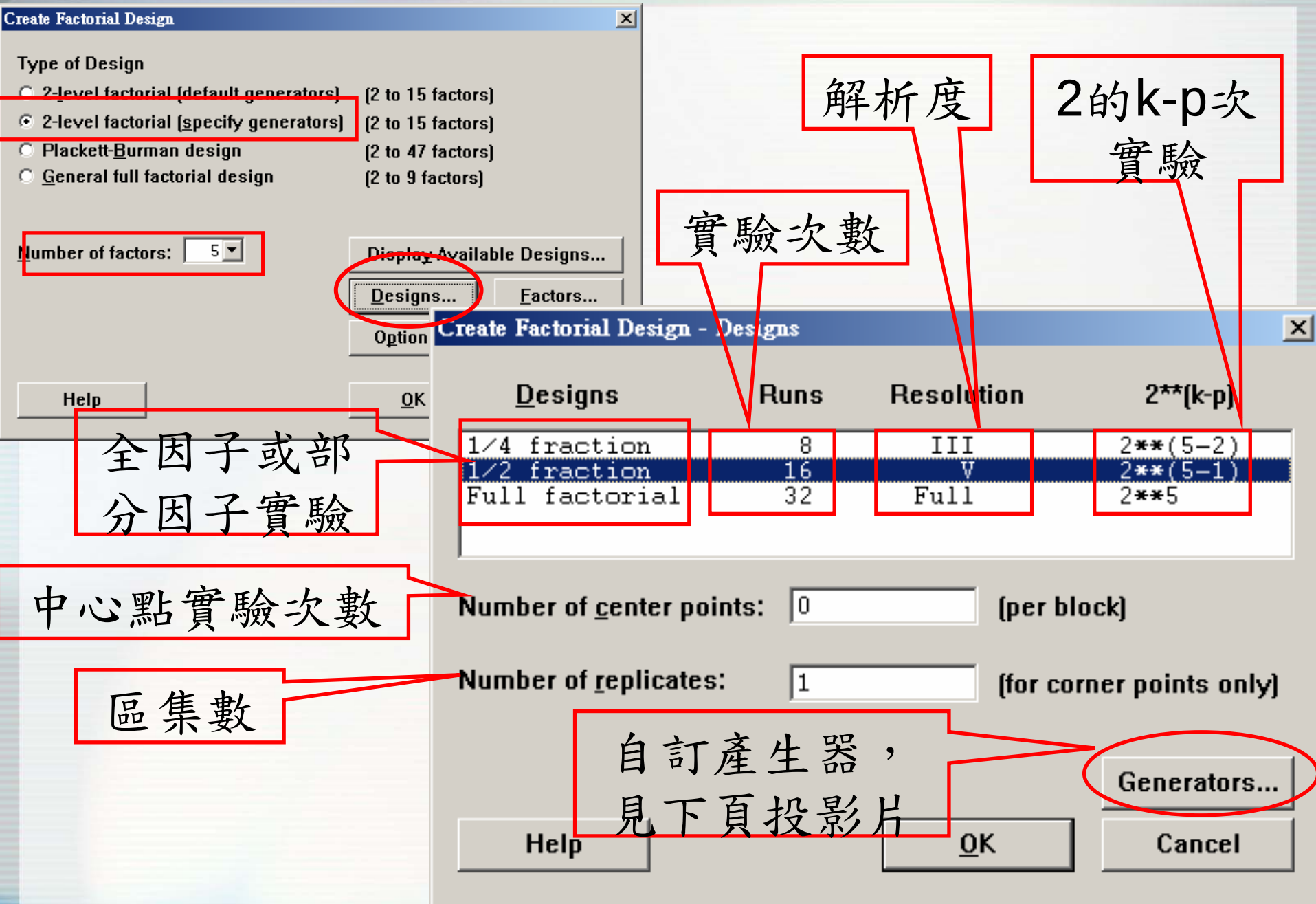


產生實驗規劃表-預設產生器

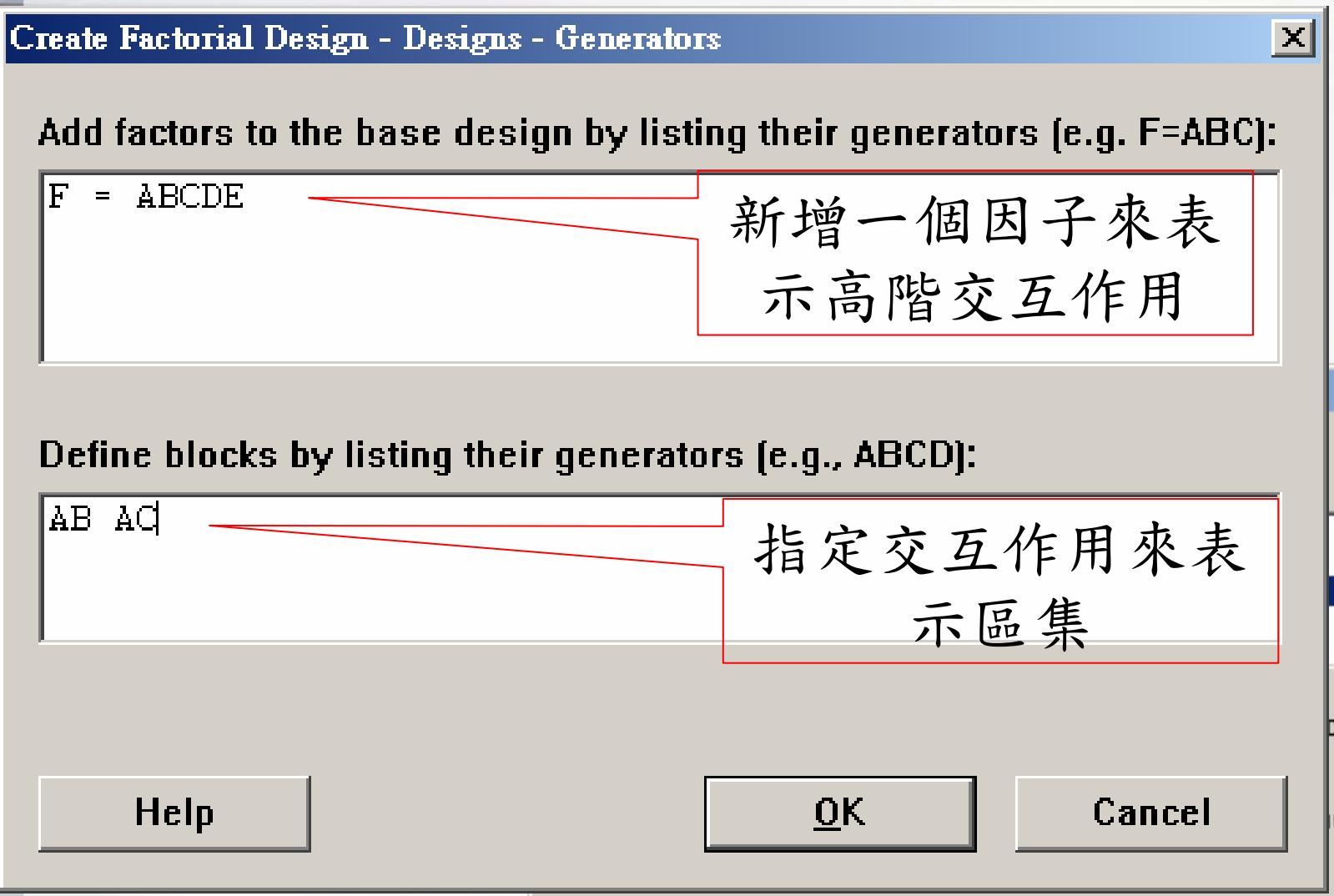


C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C1
StdOrder	RunOrder	CenterPt	Blocks	A	B										
4	1	1	1	1	1										
3	2	1	1	-1	1										
2	3	1	1	1	-1										
1	4	1	1	-1	-1										

產生實驗規劃表-自定產生器



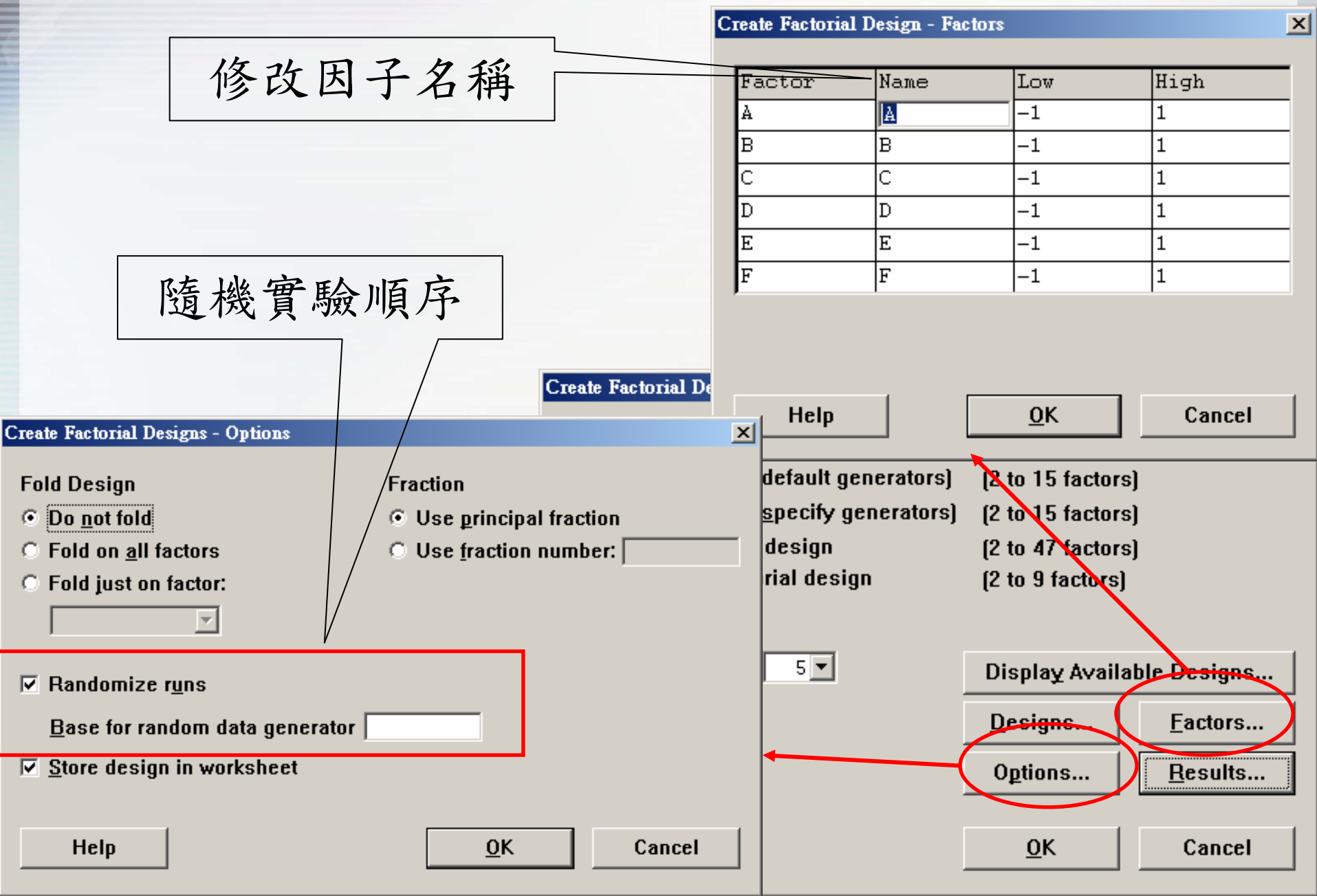
產生實驗規劃表-自定產生器

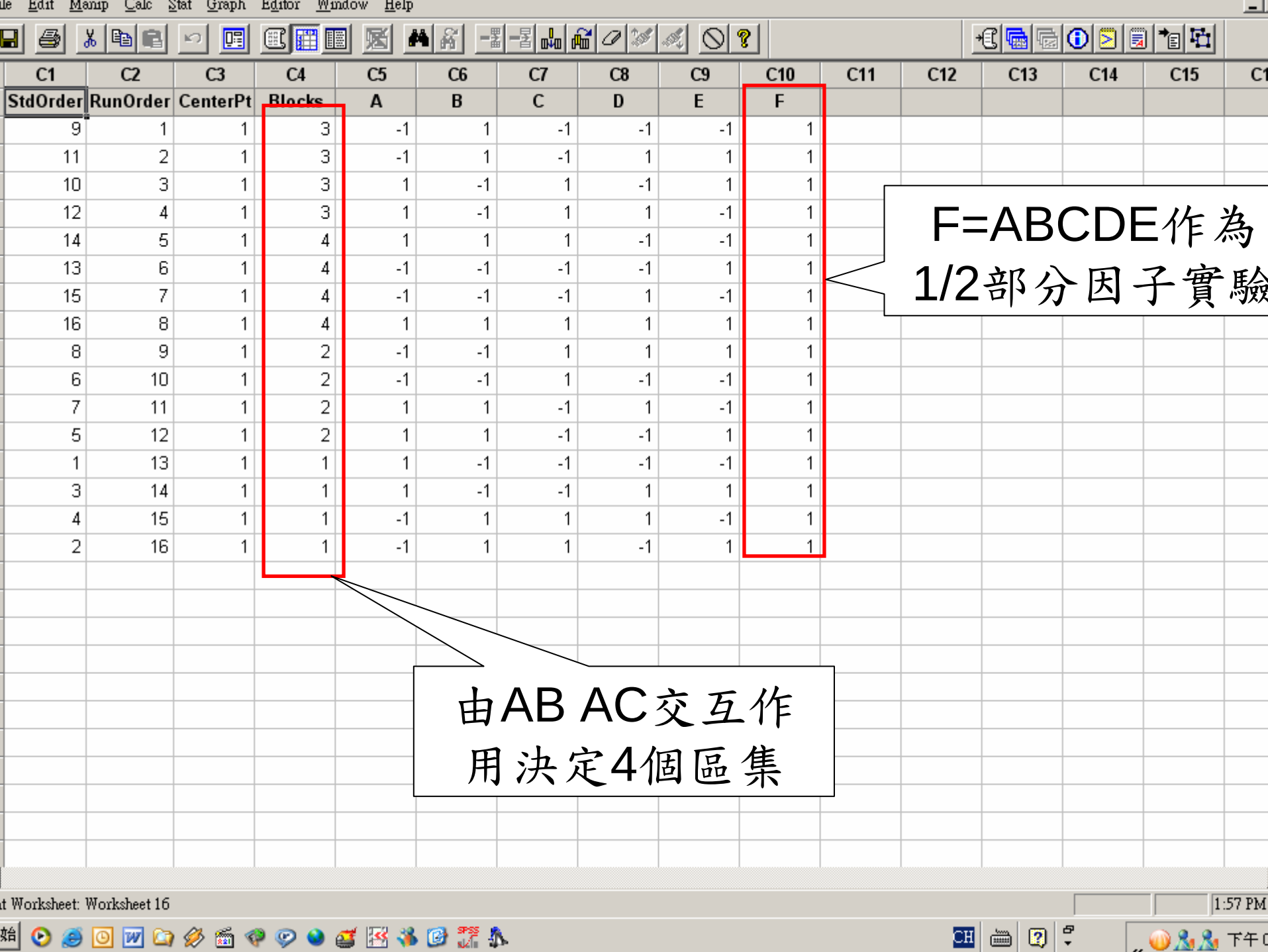


產生實驗規劃表-自定產生器

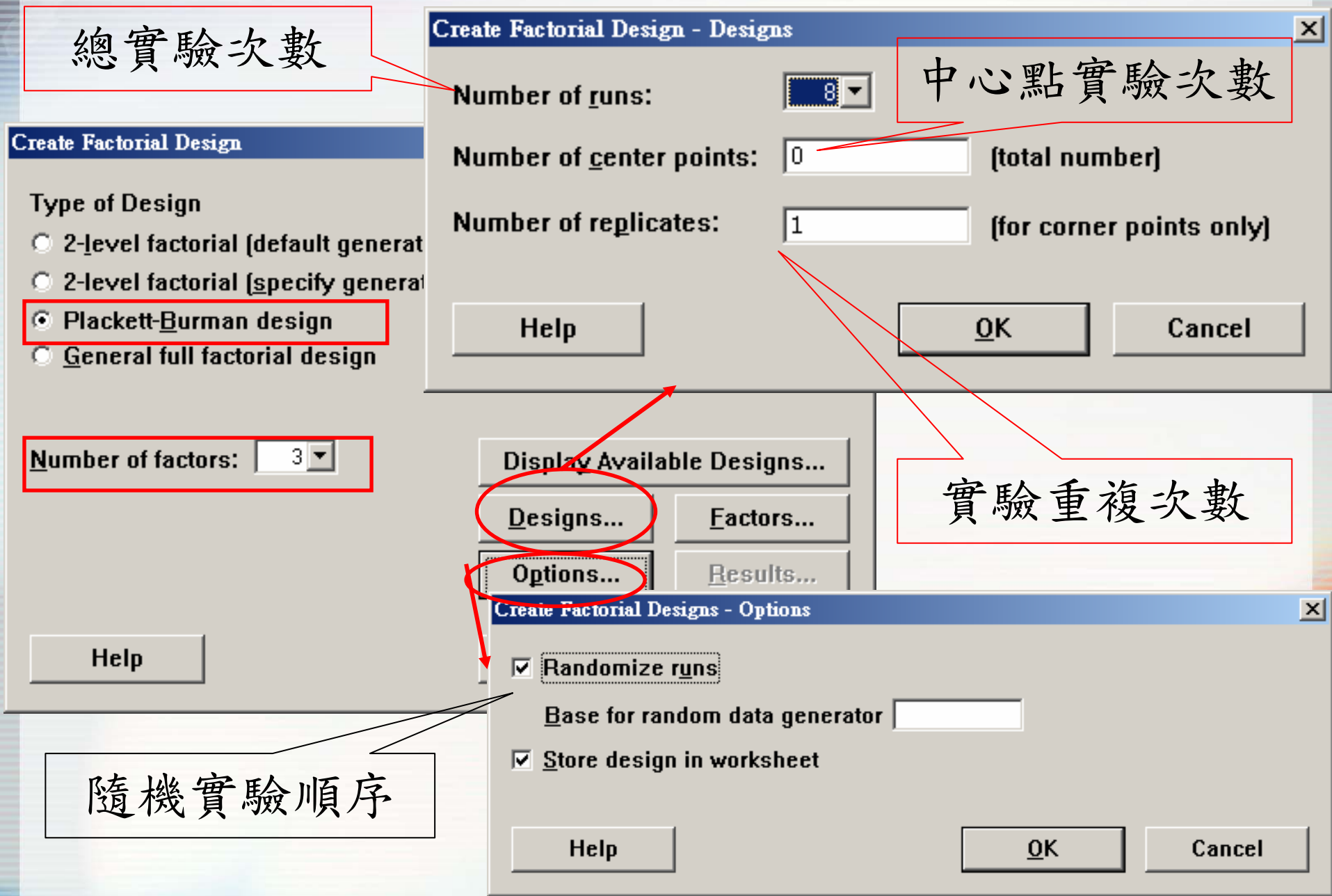
修改因子名稱

隨機實驗順序




Edit Manip Calc Stat Graph Editor Window Help
C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C11 C12 C13 C14 C15
StdOrder RunOrder CenterPt Blocks A B C D E F
9 1 1 3 -1 1 -1 -1 -1 1
11 2 1 3 -1 1 -1 1 1 1
10 3 1 3 1 -1 1 -1 1 1
12 4 1 3 1 -1 1 1 -1 1
14 5 1 4 1 1 1 -1 -1 1
13 6 1 4 -1 -1 -1 -1 1 1
15 7 1 4 -1 -1 -1 1 -1 1
16 8 1 4 1 1 1 1 1 1
8 9 1 2 -1 -1 1 1 1 1
6 10 1 2 -1 -1 1 -1 -1 1
7 11 1 2 1 1 -1 1 -1 1
5 12 1 2 1 1 -1 -1 1 1
1 13 1 1 1 -1 -1 -1 -1 1
3 14 1 1 1 -1 -1 1 1 1
4 15 1 1 -1 1 1 1 -1 1
2 16 1 1 -1 1 1 -1 1 1
F=ABCDE作為
1/2部分因子實驗
由AB AC交互作
用決定4個區集
t Worksheet: Worksheet 16
1:57 PM

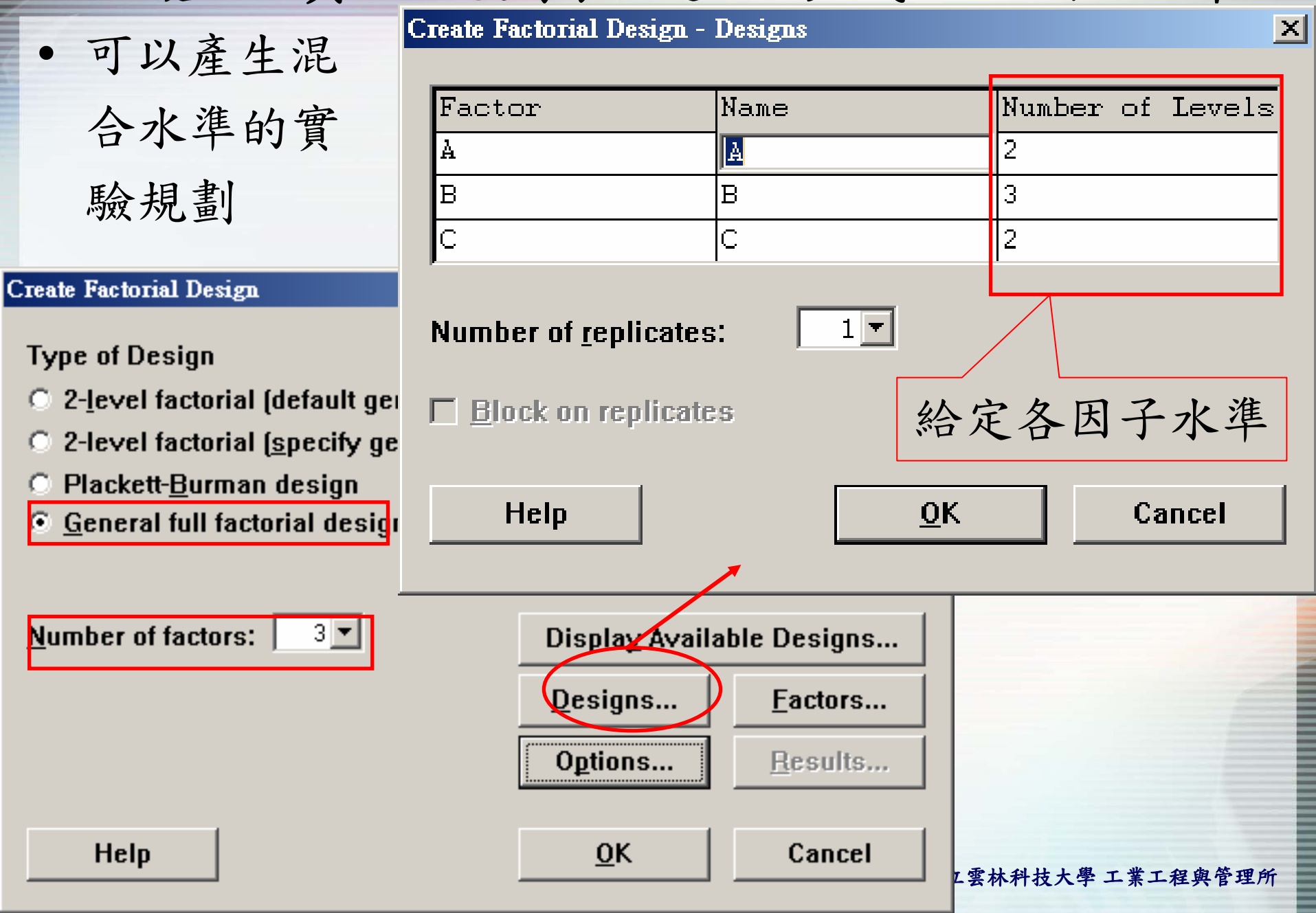
產生實驗規劃表-Plackett Burman



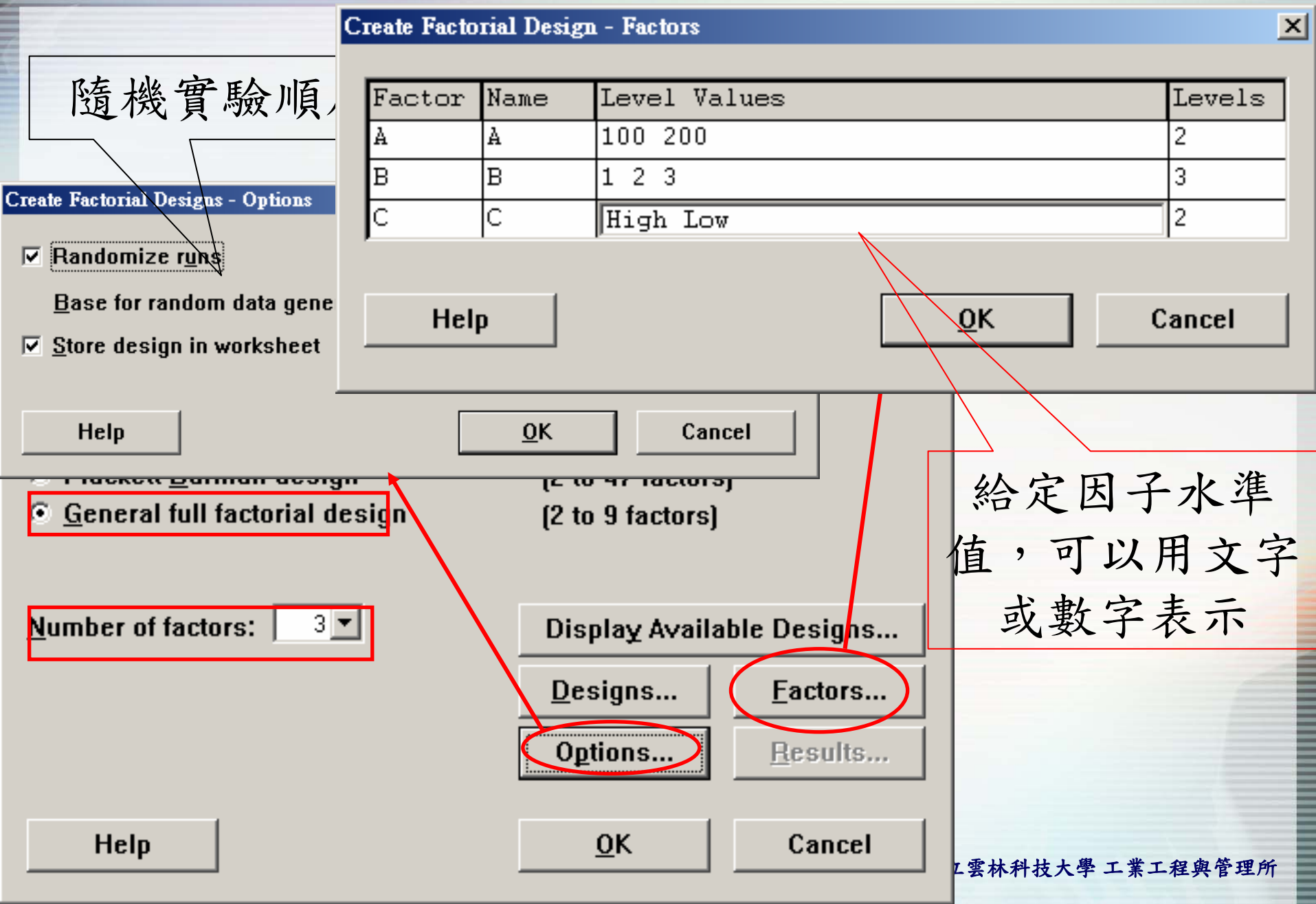
C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C1
StdOrder	RunOrder	CenterPt	Blocks	A	B	C									
2	1	1	1	1	1	-1									
4	2	1	1	-1	1	1									
5	3	1	1	1	-1	1									
1	4	1	1	1	-1	-1									
6	5	1	1	-1	1	-1									
8	6	1	1	-1	-1	-1									
3	7	1	1	1	1	1									
7	8	1	1	-1	-1	1									

產生實驗規劃表-通用形式全因子設計

- 可以產生混合水準的實驗規劃



產生實驗規劃表-通用形式全因子設計



Edit Manip Calc Stat Graph Editor Window Help

C1	C2	C3	C4	C5	C6-T	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
StdOrder	RunOrder	Blocks	A	B	C										
8	1	1	200	1	Low										
2	2	1	100	1	Low										
7	3	1	200	1	High										
4	4	1	100	2	Low										
11	5	1	200	3	High										
12	6	1	200	3	Low										
6	7	1	100	3	Low										
10	8	1	200	2	Low										
5	9	1	100	3	High										
9	10	1	200	2	High										
1	11	1	100	1	High										
3	12	1	100	2	High										

以文字表示兩個水準

3個水準

以數字表示兩個水準

Worksheet: Worksheet 19

2:16 PM

CH

下午 02

自定實驗規劃表

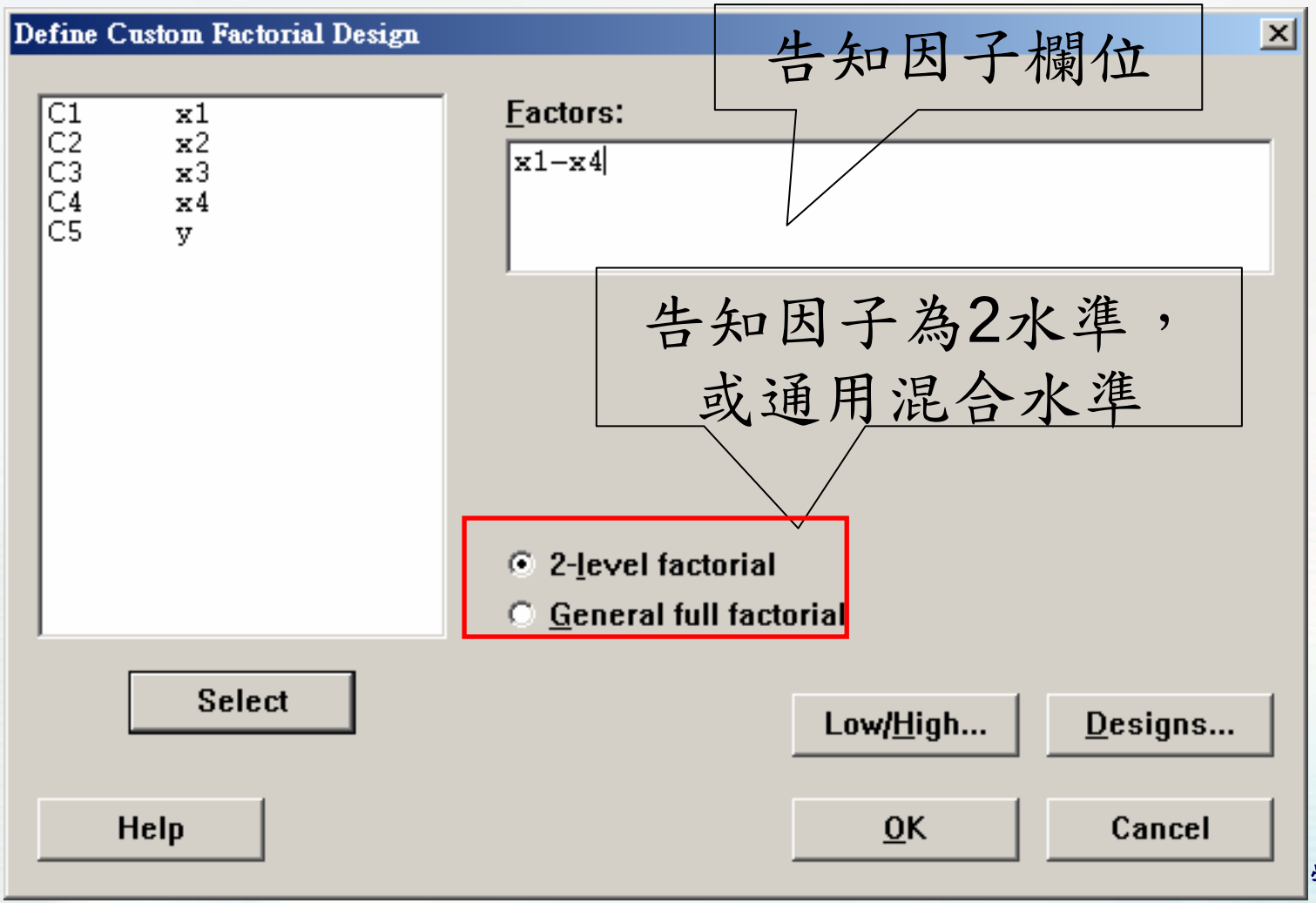
- 輸入一個實驗規劃表與實驗（望大品質特性）結果如右表

x1	x2	x3	x4	y
-1	-1	-1	-1	45
1	-1	-1	-1	71
-1	1	-1	-1	48
1	1	-1	-1	65
-1	-1	1	-1	68
1	-1	1	-1	60
-1	1	1	-1	80
1	1	1	-1	65
-1	-1	-1	1	43
1	-1	-1	1	100
-1	1	-1	1	45
1	1	-1	1	104
-1	-1	1	1	75
1	-1	1	1	86
-1	1	1	1	70
1	1	1	1	96

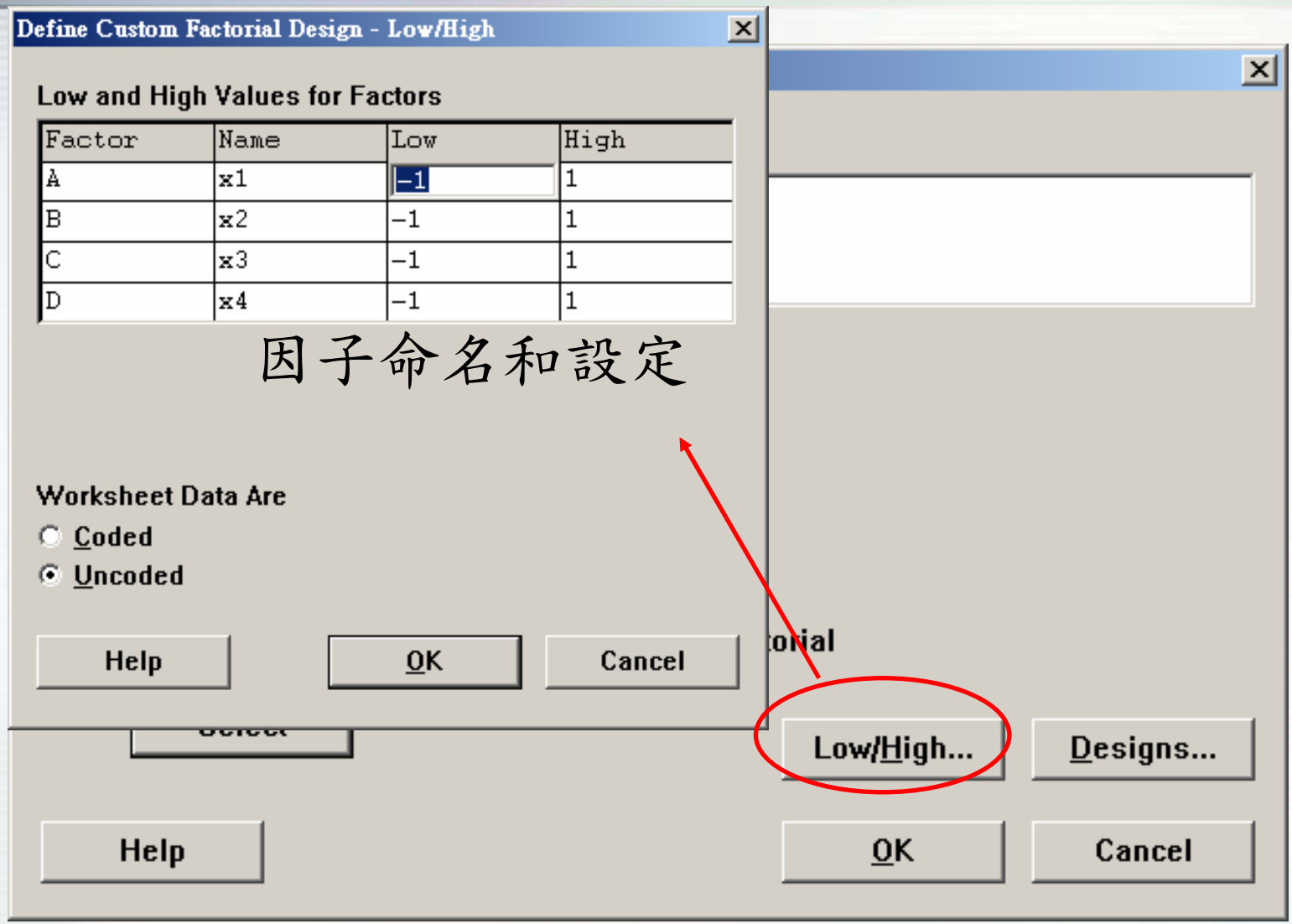
C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
x1	x2	x3	x4	y											
-1	-1	-1	-1	45											
1	-1	-1	-1	71											
-1	1	-1	-1	48											
1	1	-1	-1	65											
-1	-1	1	-1	68											
1	-1	1	-1	60											
-1	1	1	-1	80											
1	1	1	-1	65											
-1	-1	-1	1	43											
1	-1	-1	1	100											
-1	1	-1	1	45											
1	1	-1	1	104											
-1	-1	1	1	75											
1	-1	1	1	86											
-1	1	1	1	70											
1	1	1	1	96											

自定實驗規劃表

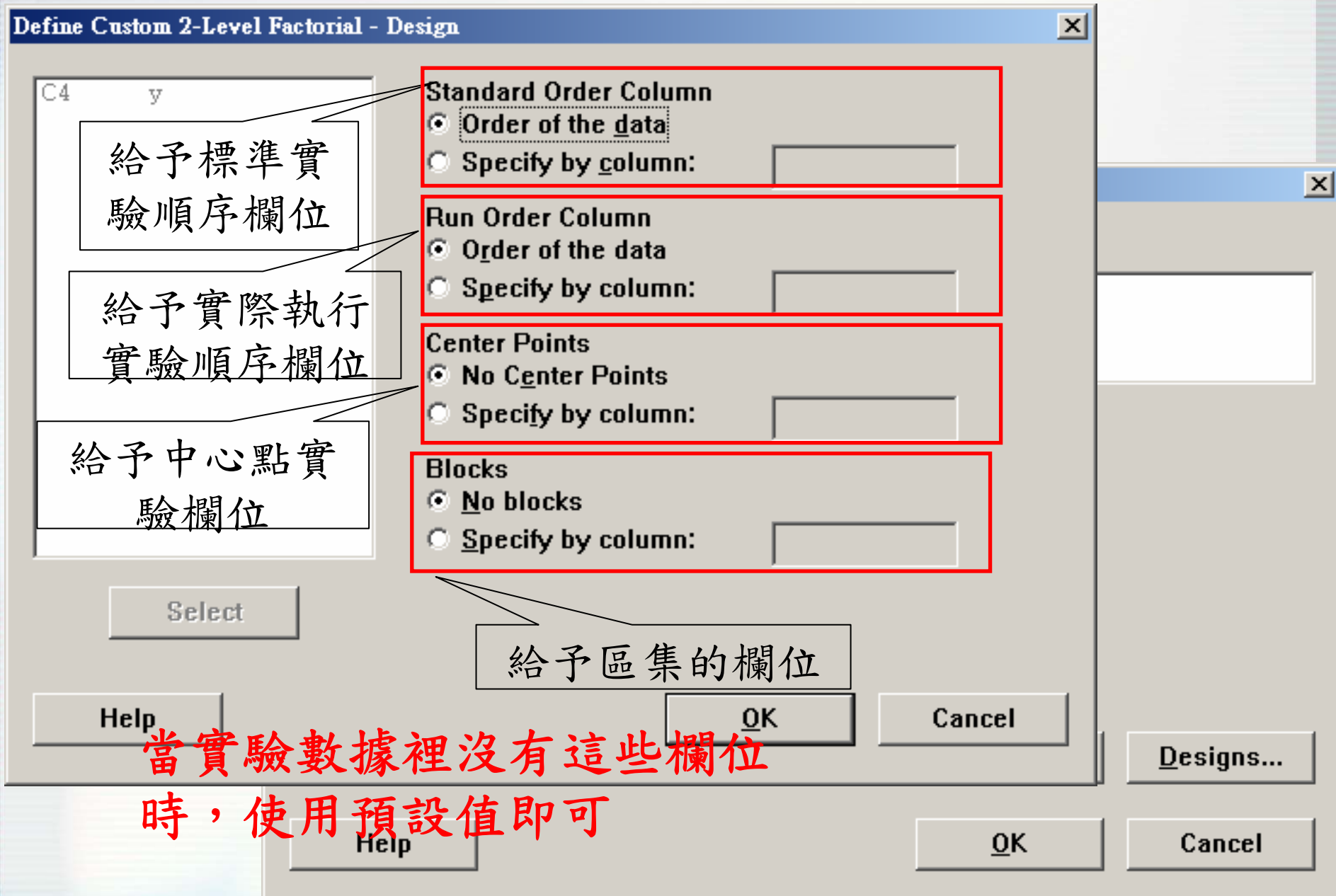
- Stat➔DOE➔Factorial➔Define Custom Factorial Design



自定實驗規劃表


Define Custom Factorial Design - Low/High
Low and High Values for Factors
Factor | Name | Low | High
A | x1 | -1 | 1
B | x2 | -1 | 1
C | x3 | -1 | 1
D | x4 | -1 | 1
因子命名和設定
Worksheet Data Are
Coded
Uncoded
Help
OK
Cancel
Low/High...
Designs...
Help
OK
Cancel

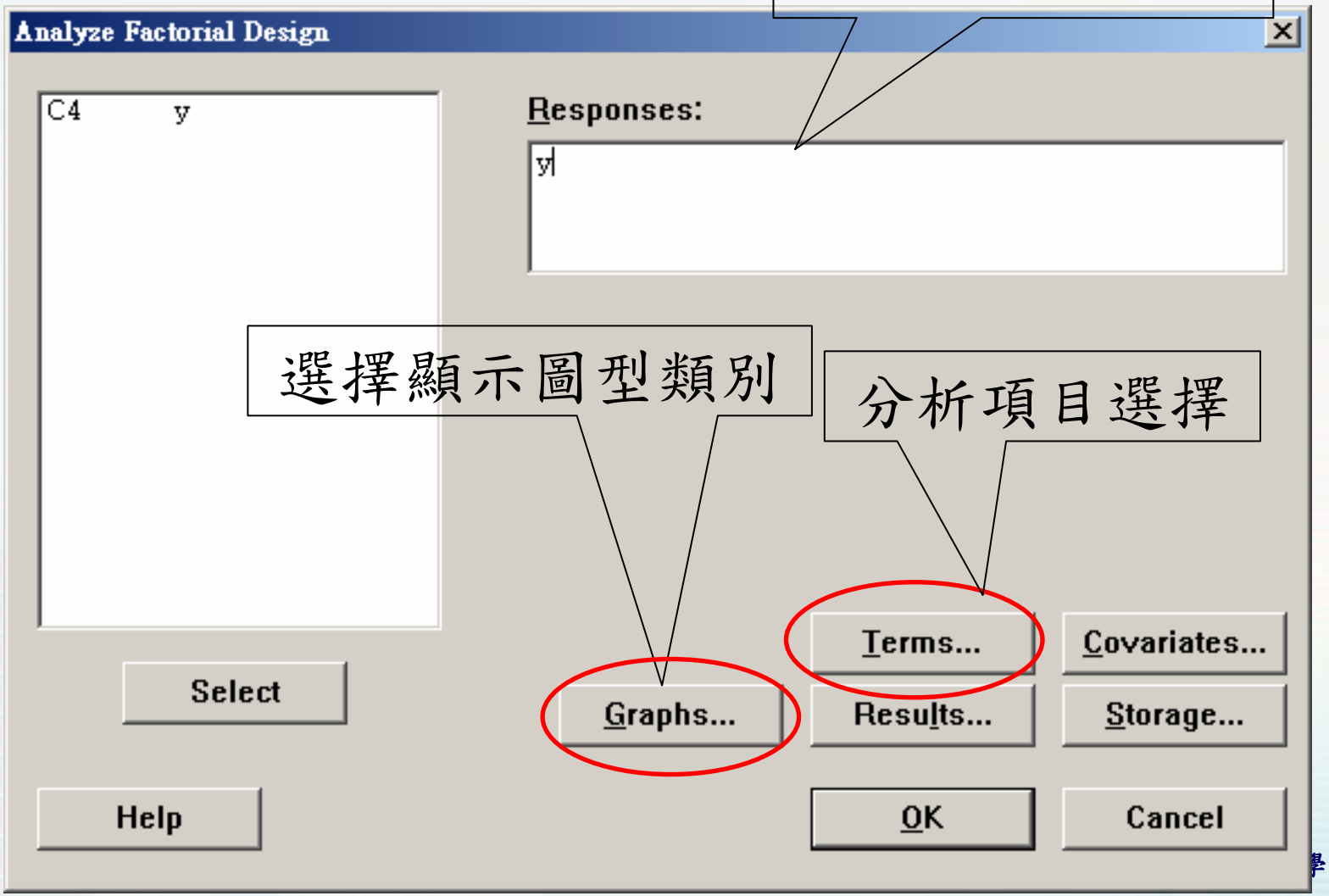
自定實驗規劃表


Define Custom 2-Level Factorial - Design
C4 y
給予標準實驗順序欄位
給予實際執行實驗順序欄位
給予中心點實驗欄位
Standard Order Column
Order of the data
Specify by column:
Run Order Column
Order of the data
Specify by column:
Center Points
No Center Points
Specify by column:
Blocks
No blocks
Specify by column:
Select
給予區集的欄位
Help
OK
Cancel
當實驗數據裡沒有這些欄位時，使用預設值即可
Designs...
Help
OK
Cancel

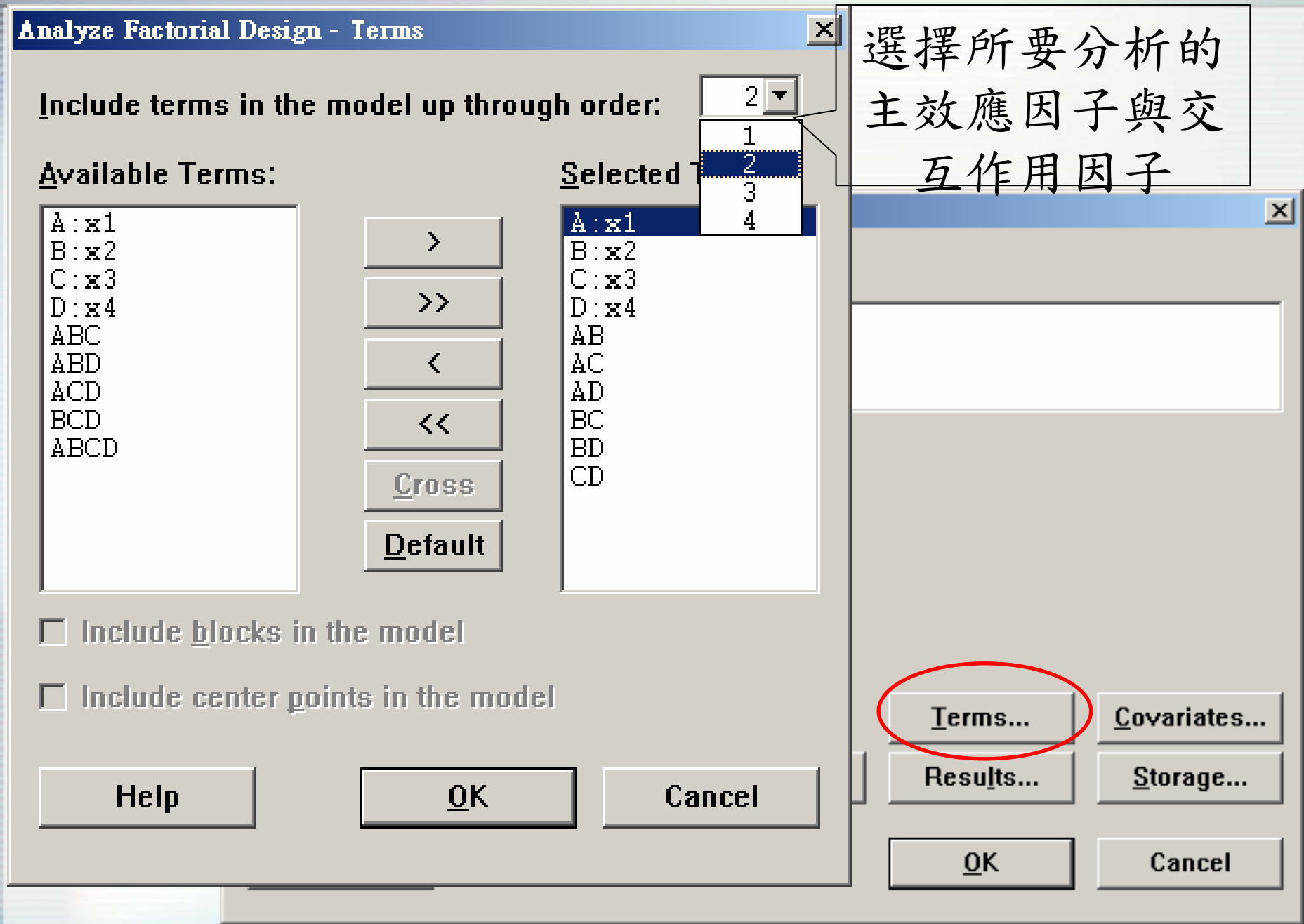
C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C1
x1	x2	x3	x4	y	StdOrder	RunOrder	Blocks	CenterPt							
-1	-1	-1	-1	45	1	1	1	1							
1	-1	-1	-1	71	2	2	1	1							
-1	1	-1	-1	48	3	3	1	1							
1	1	-1	-1	65	4	4	1	1							
-1	-1	1	-1	68	5	5	1	1							
1	-1	1	-1	60	6	6	1	1							
-1	1	1	-1	80	7	7	1	1							
1	1	1	-1	65	8	8	1	1							
-1	-1	-1	1	43	9	9	1	1							
1	-1	-1	1	100	10	10	1	1							
-1	1	-1	1	45	11	11	1	1							
1	1	-1	1	104	12	12	1	1							
-1	-1	1	1	75	13	13	1	1							
1	-1	1	1	86	14	14	1	1							
-1	1	1	1	70	15	15	1	1							
1	1	1	1	96	16	16	1	1							

分析因子設計

- Stat➔DOE➔Factorial➔Analyze Factorial Design
- 延續先前例子



分析因子設計


Analyze Factorial Design - Terms
Include terms in the model up through order:
2
1
2
3
4
選擇所要分析的主效應因子與交互作用因子
Available Terms:
A:x1
B:x2
C:x3
D:x4
ABC
ABD
ACD
BCD
ABCD
>
>>
<
<<
Cross
Default
Selected T
A:x1
B:x2
C:x3
D:x4
AB
AC
AD
BC
BD
CD
Include blocks in the model
Include center points in the model
Help
OK
Cancel
Terms...
Covariates...
Results...
Storage...
OK
Cancel

分析因子設計

Fractional Factorial Fit: y versus x1, x2, x3, x4

Estimated Effects and Coefficients for y (coded units)

Term	Effect	Coef	SE Coef	T	P	
Constant		70.063	1.264	55.43	0.000	*
x1	21.625	10.812	1.264	8.55	0.000	*
x2	3.125	1.562	1.264	1.24	0.271	
x3	9.875	4.937	1.264	3.91	0.011	
x4	14.625	7.312	1.264	5.79	0.002	*
x1*x2	0.125	0.062	1.264	0.05	0.962	
x1*x3	-18.125	-9.063	1.264	-7.17	0.001	*
x1*x4	16.625	8.313	1.264	6.58	0.001	*
x2*x3	2.375	1.188	1.264	0.94	0.391	
x2*x4	-0.375	-0.187	1.264	-0.15	0.888	
x3*x4	-1.125	-0.563	1.264	-0.45	0.675	

*表示顯著因子

Analysis of Variance for y (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	4	3155.2	3155.2	788.81	30.86	0.001
2-Way Interactions	6	2447.9	2447.9	407.98	15.96	0.004
Residual Error	5	127.8	127.8	25.56		
Total	15	5730.9				

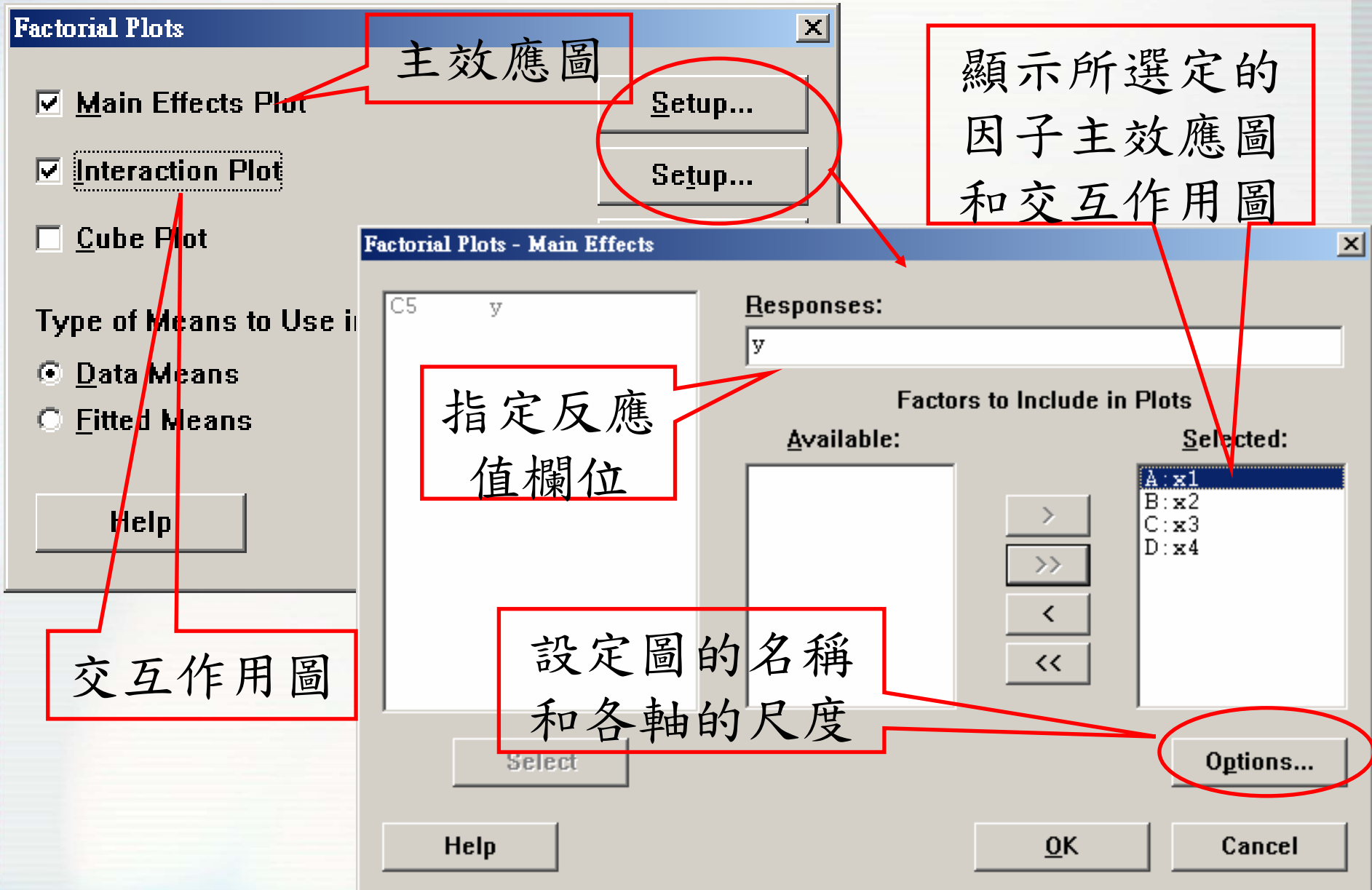
主效應與二因子交互作用均顯著

Unusual Observations for y

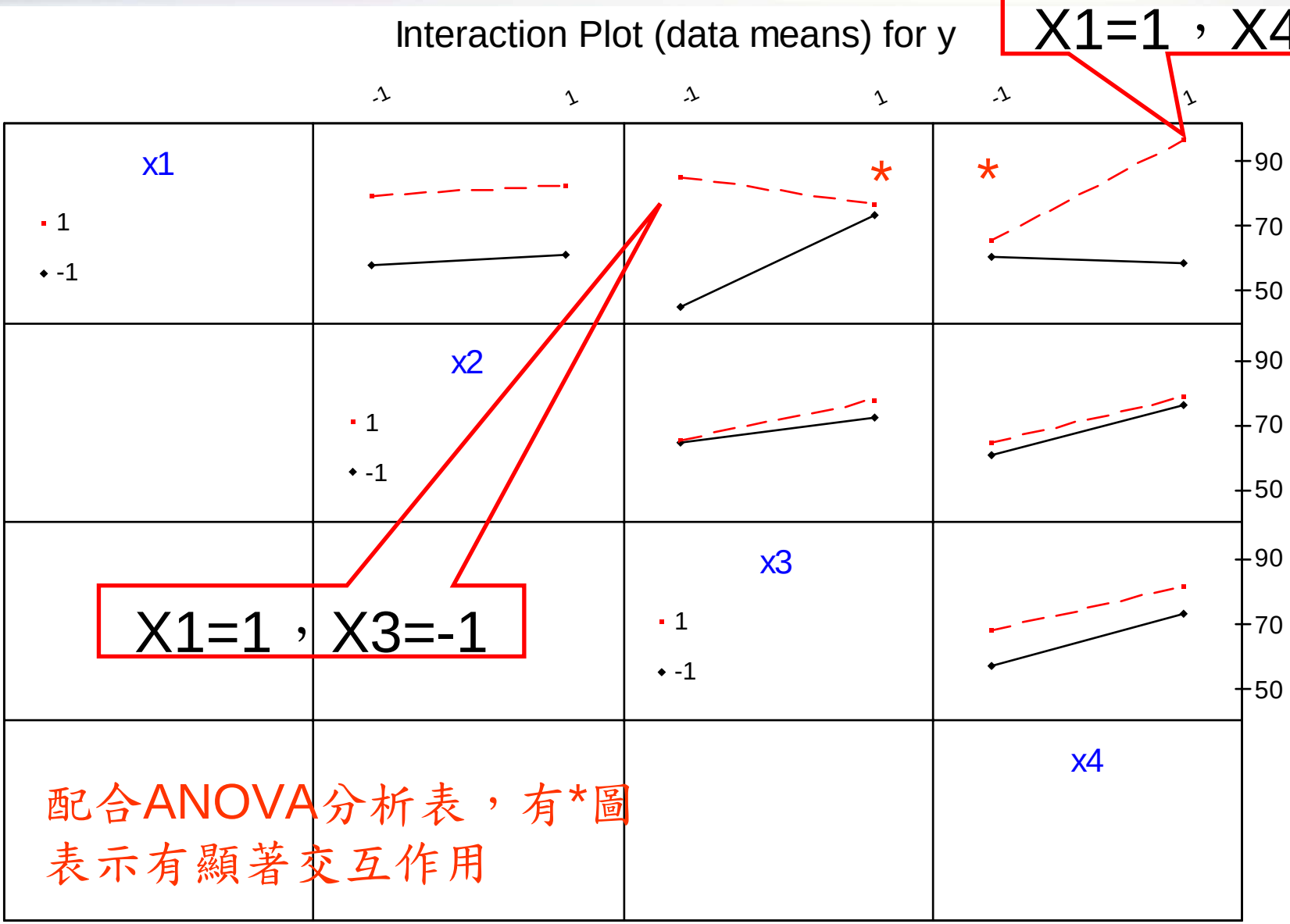
Obs	y	Fit	SE Fit	Residual	St Resid
13	75.000	69.188	4.192	5.813	2.06R

顯示主效應交互作用圖

- Stat➔DOE➔Factorial➔Factorial Plot

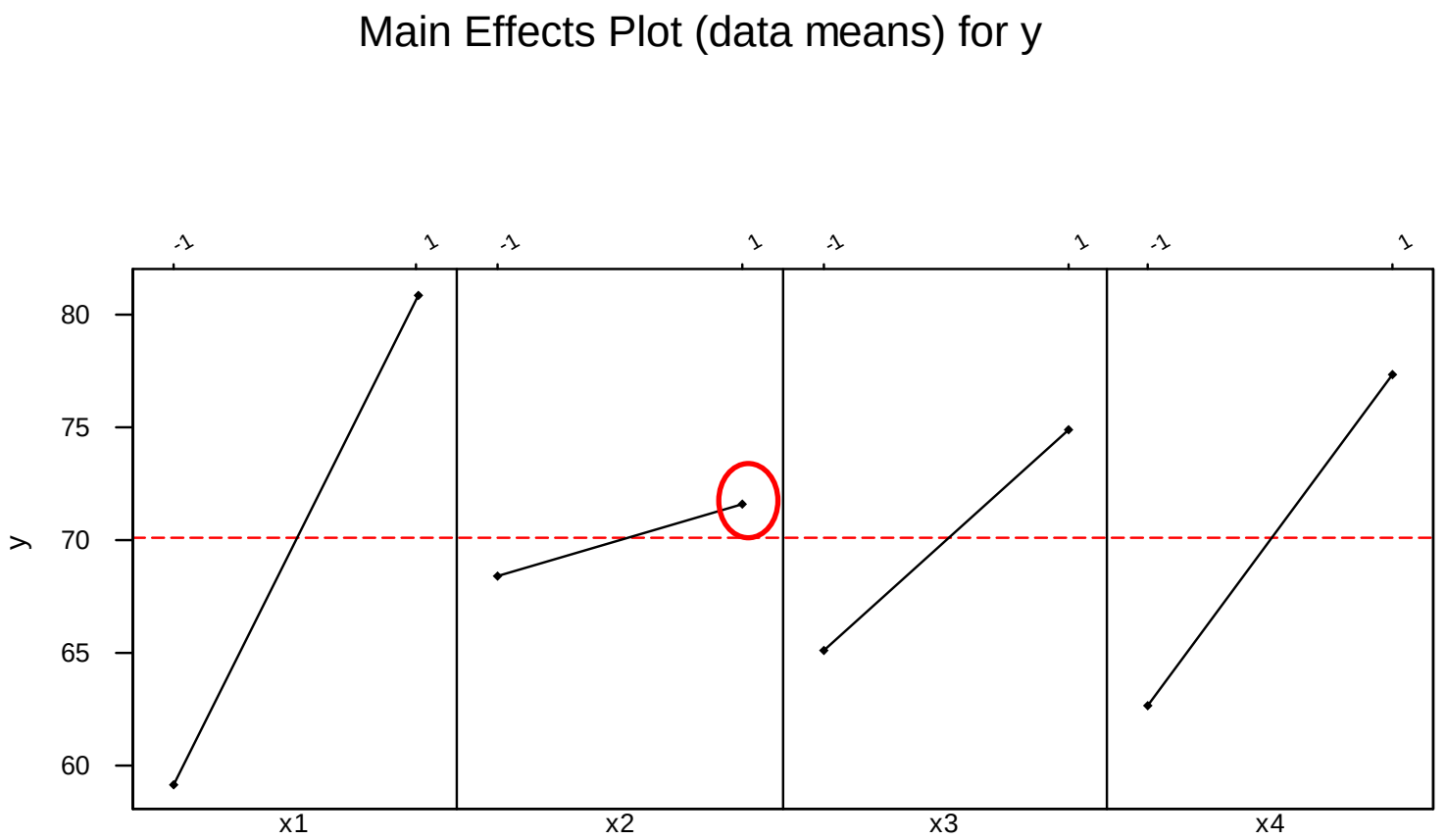


顯示主效應交互作用圖-交互作用圖



配合ANOVA分析表，有*圖
表示有顯著交互作用

顯示主效應交互作用圖-主效應圖



配合ANOVA分析表，X2不顯著，所以水準值的選擇影響不大，若執意要選擇一個水準，則X2=1

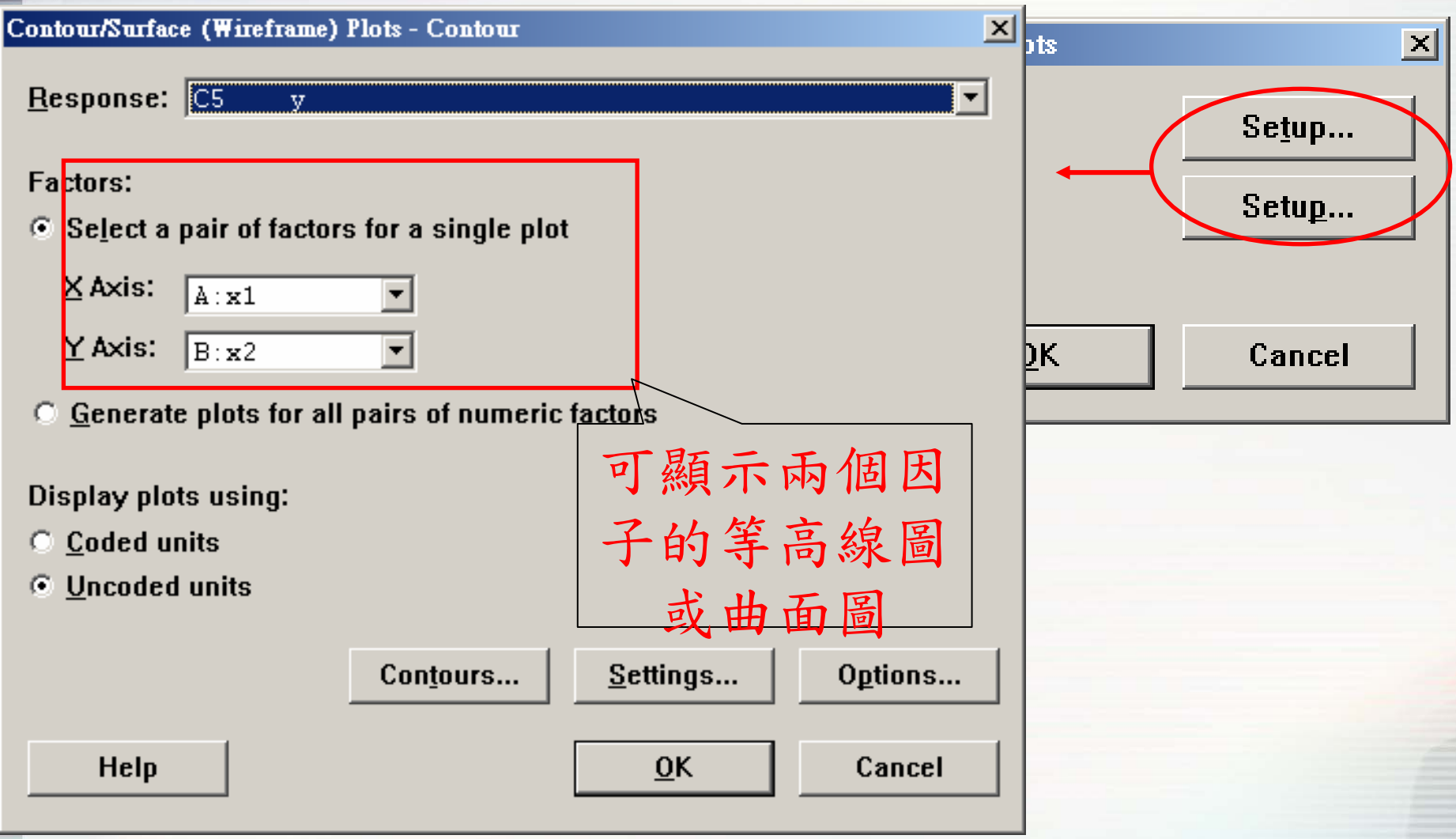
搭配交互作用圖結果，最佳參數水準為

X1=1，X2=1，X3=-1，X4=1

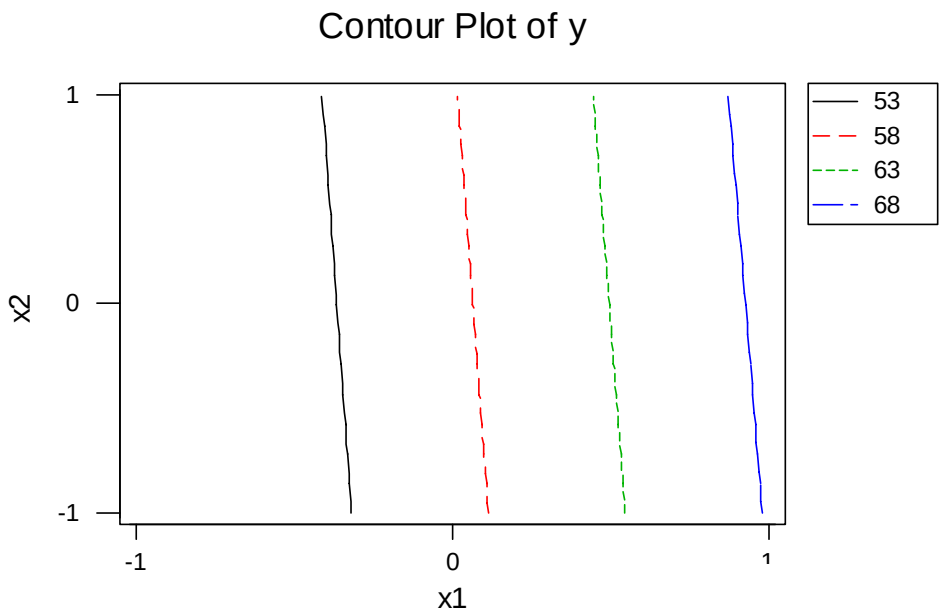
產生反應曲面圖和等高線圖

- 延續先前例子
- Stat➔DOE➔Factorial➔ Contour Surface （Wireframe） Plots

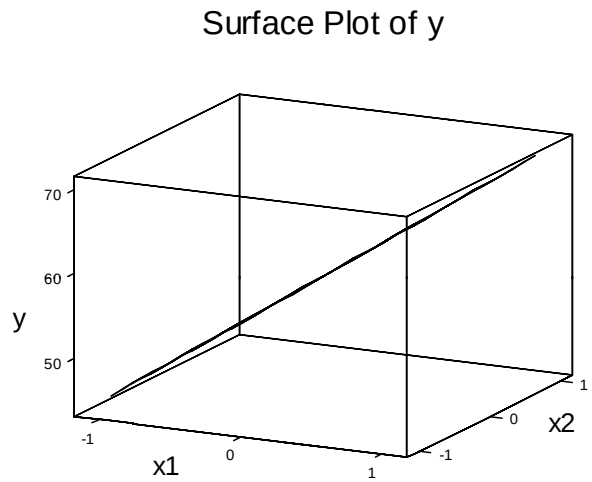
產生反應曲面圖和等高線圖



產生反應曲面圖和等高線圖



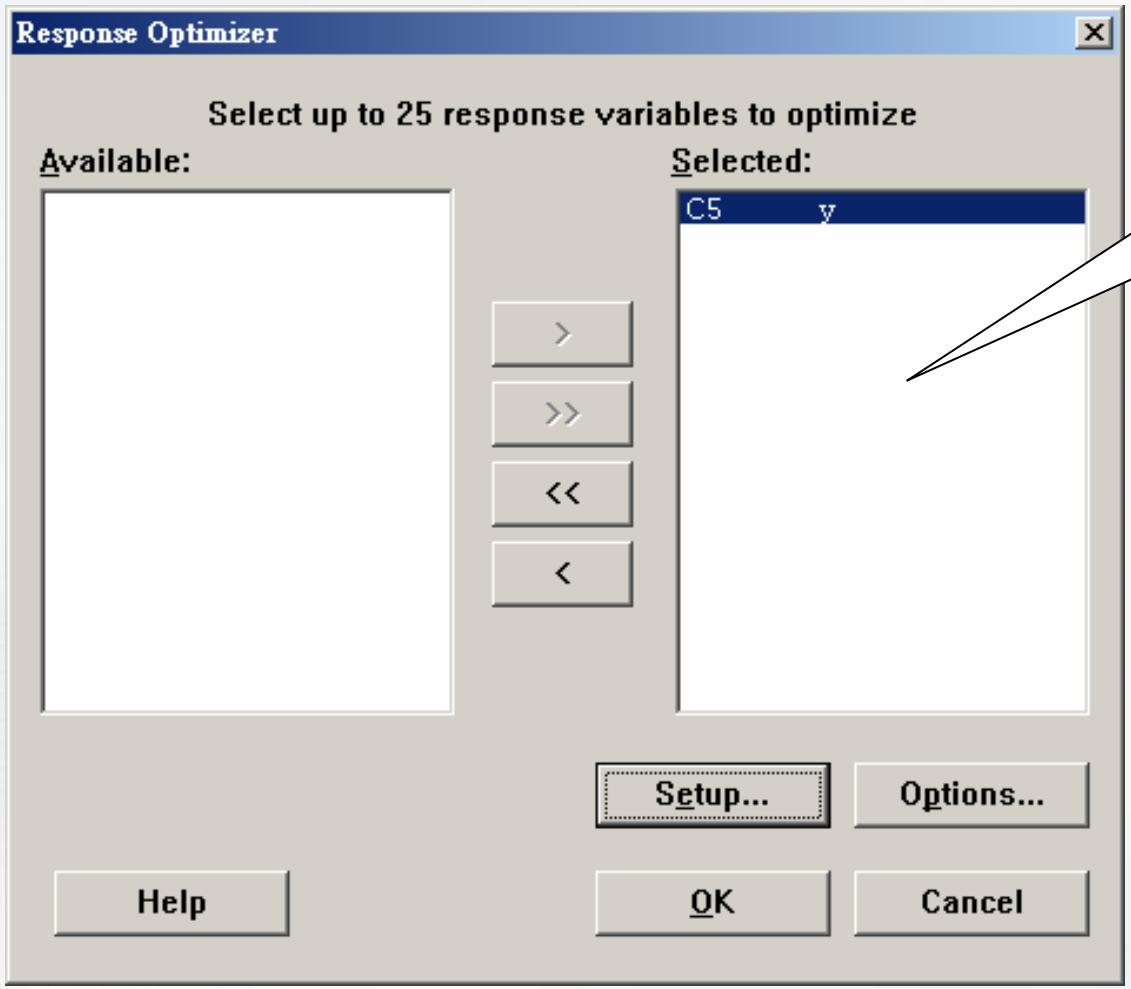
Hold values: x3:-1.0 x4:-1.0



Hold values: x3:-1.0 x4:-1.0

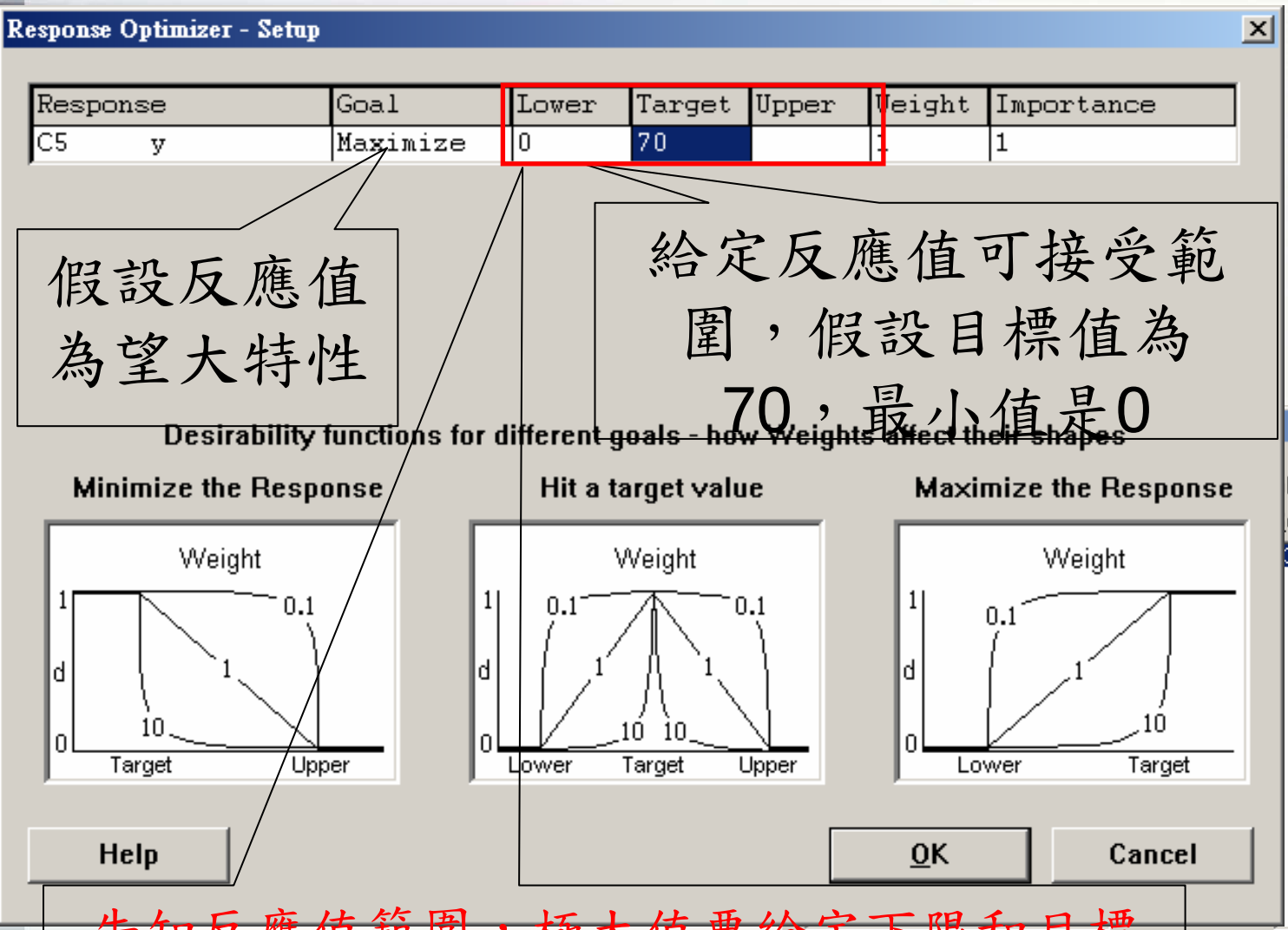
參數最佳化

- 延續先前例題
- Stat➔DOE➔ Factorial ➔ Response Optimizer



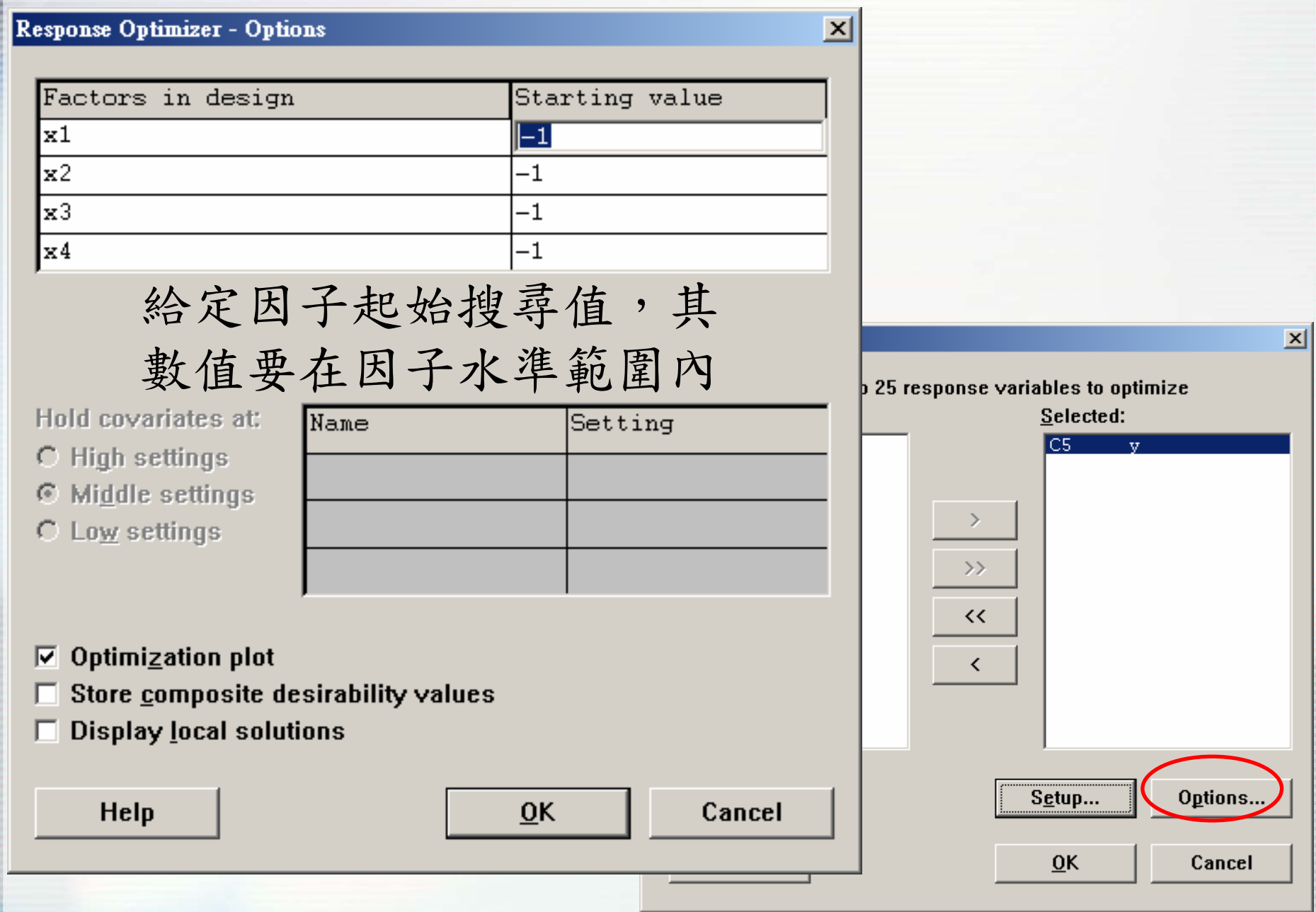
指定所要探討的反應值

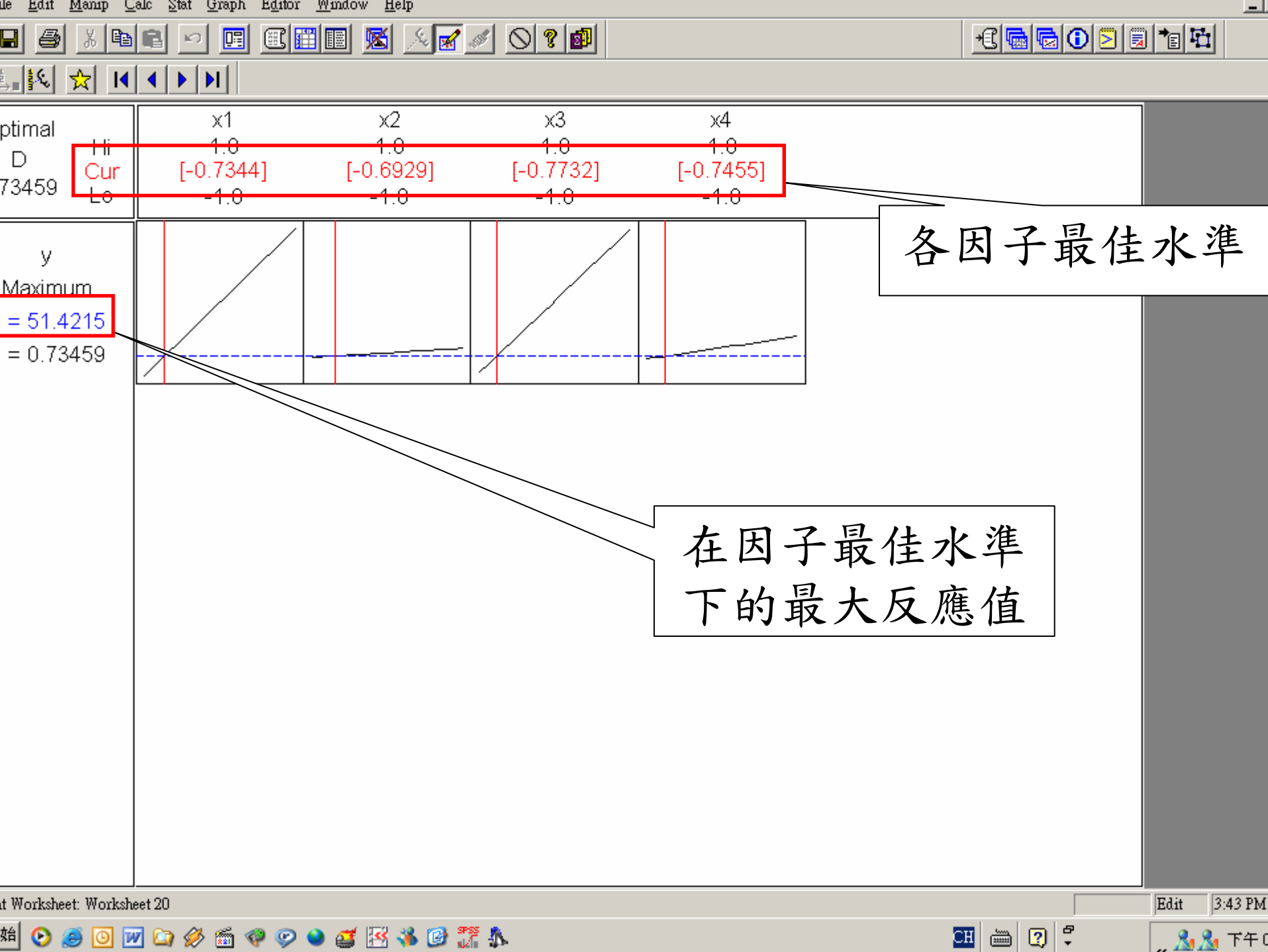
參數最佳化



告知反應值範圍，極大值要給定下限和目標值，極小值要給定上限和目標值，若是望目特性，必須給予三個數值

參數最佳化


Response Optimizer - Options
Factors in design
Starting value
x1
-1
x2
-1
x3
-1
x4
-1
給定因子起始搜尋值，其
數值要在因子水準範圍內
Hold covariates at:
High settings
Middle settings
Low settings
Name
Setting
Optimization plot
Store composite desirability values
Display local solutions
Help
OK
Cancel
25 response variables to optimize
Selected:
C5 y
Setup...
Options...
OK
Cancel


ptimal
D
73459
x1
x2
x3
x4
Hi
1.0
1.0
1.0
1.0
Cur
[-0.7344]
[-0.6929]
[-0.7732]
[-0.7455]
Lo
-1.0
-1.0
-1.0
-1.0
y
Maximum
= 51.4215
= 0.73459
各因子最佳水準
在因子最佳水準
下的最大反應值

品質與可靠度工程實驗室
Quality and Reliability Engineering Lab.

The END~~

Thank you