系統可靠度實驗室

國立雲林科技大學 工業工程與管理所

Minitab 管制圖的操作

課程名稱：6 Sigma

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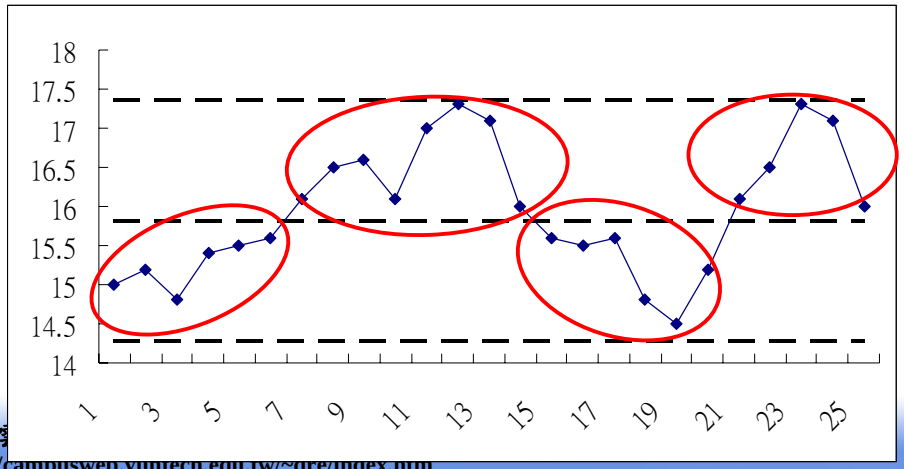
http://campusweb.yuntech.edu.tw/~qre/index.htm

管制圖的兩個階段

- 管制圖使用時必須要分成兩個階段。
- 階段1：收集資料（稱作歷史數據），繪製管制界限，將歷史數據繪製到管制圖上，若有樣本點落在管制界限外則需追查原因，若屬非機遇性原因則因剔除數據，剔除後重新繪製管制圖，若樣本點落在管制界限外是管制圖誤判導致，則應保留數據。
- 階段2：以階段1的管制圖開始監控製程，將每次的抽樣數據描繪至管制圖，以描繪的點落在的區域來判斷製程狀態。

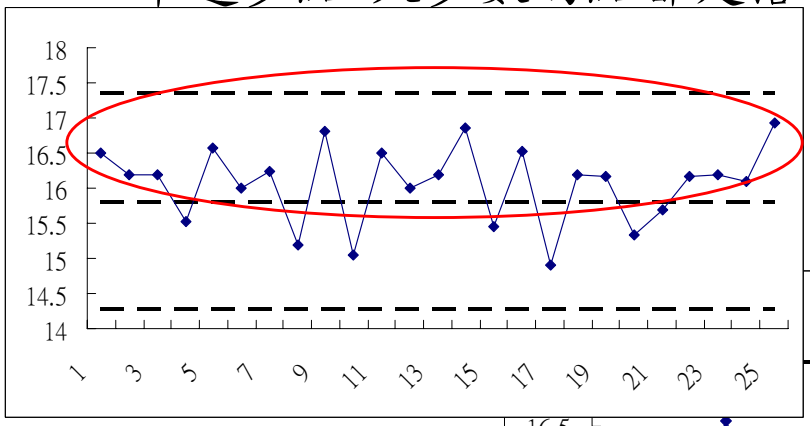
管制圖的判讀

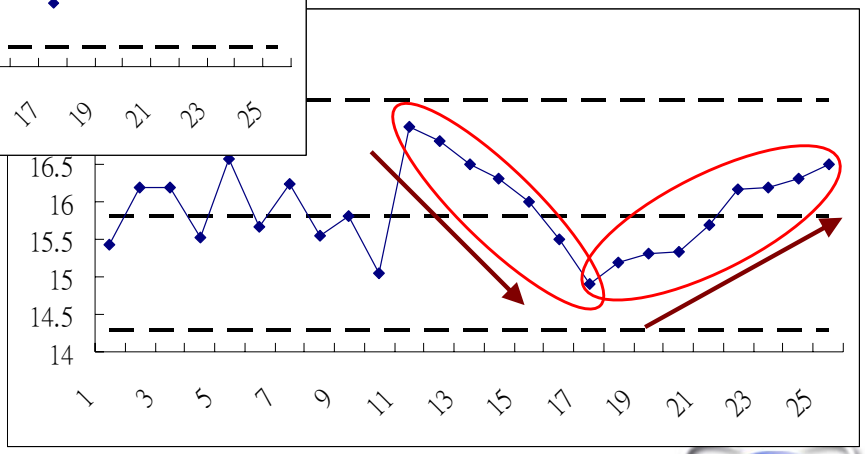
- 運用管制圖判斷製程是否失控，除了最基本的有點落在管制界限外，判斷為製程失控外，另外還有以下數種情況也隱含著製程失控的訊息。
- 1. 同邊連串-同時連續有多個點落在中心線上方的管制區域或是下方的管制區域。點並非隨機散佈在兩者區域內。



管制圖的判讀

- 2.單邊多點-大多數的點都是落在同一邊的管制區域。

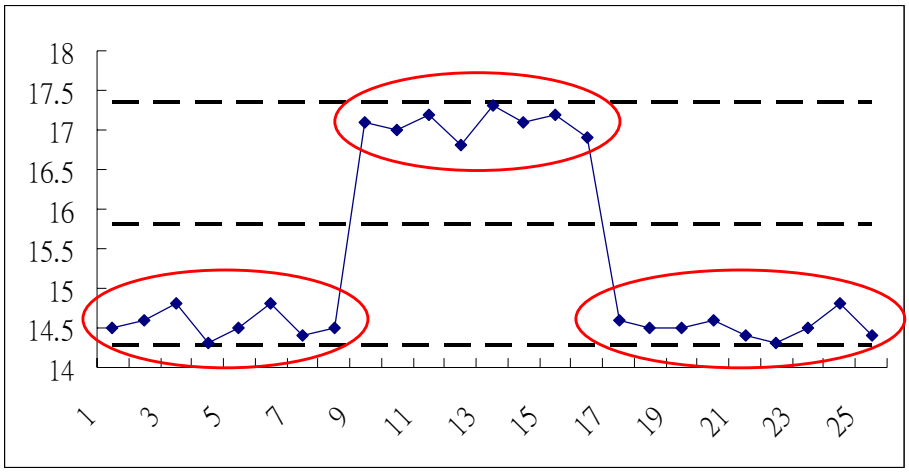




- 3.升降趨勢-有多個點朝同一個方向上升或下降。

管制圖的判讀

- 4.靠近管制界限多點-大部分的點非常靠近管制界限但又沒有超出管制界限，此似乎有非機遇性原因發生。



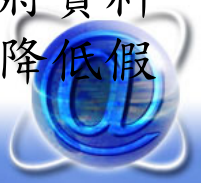
- 上述的四種現象，也都隱含著製程可能發生變異了，須立刻追查製程變異原因。

平均連串長度

- 平均連串長度（Average run length；ARL）：判讀製程異常所需的平均抽樣次數。
- **當製程實際為正常狀態**，但是管制圖卻出現異常資訊，此稱作假警報（False alarm），標準修華特管制圖（$\pm 3\sigma$ 管制界限）的$ARL_0=370.4$，表示平均執行370.4次的抽樣會發生一次假警報，此時的ARL越大表示越不容易發生假警報。
- **當製程發生變異**，偵測出製程變異所需的平均抽樣次數表示為ARL_1，此ARL_1越小表示越快偵測出製程變異，抽樣數量越大可以有效提升偵測製程變異的速度（可以降低ARL_1）。

常態數據與非常態數據的影響

- 非常態分配分成對稱分配和偏態分配。
- 從一些研究報告發現，不論觀測數據是否為常態數據，修華特平均數管制圖在偵測製程變異的速度並沒有太大差異（ ARL_1差異不大）。
- 若用修華特平均數管制圖監控**對稱分配**的數據，假警報發生機率與常態差異也不大（ARL_0會接近370.4）。但是，若用在監控**偏態分配**的數據則會經常發生假警報（ARL_0會明顯小於370.4），特別是單一觀測值的修華特管制圖更容易發生假警報（ARL_0甚至會小於100）。
- 所以建議，若觀測資料是屬於**偏態分配**，應該將資料轉換成對稱分配的資料，在進行製程監控，以降低假警報發生率。



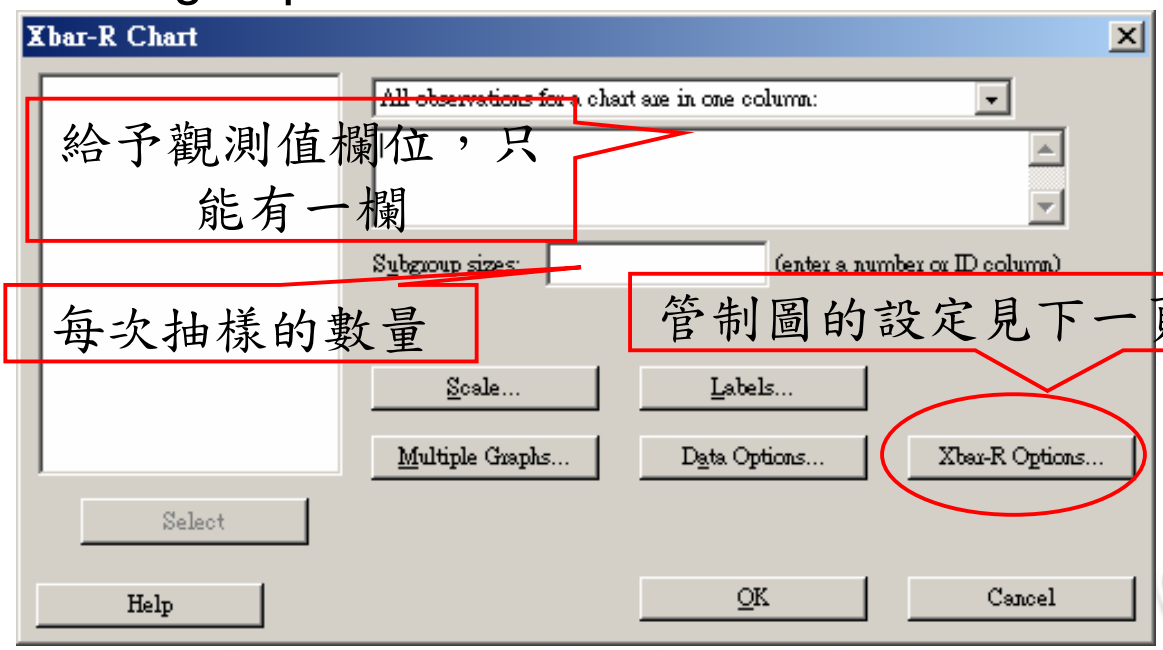
計量值修華特管制圖的種類

- 監控製程平均數：
- 1. X-bar chart（抽樣數量>1 ）
- 2.Individual Measurements chart（抽樣數量=1）

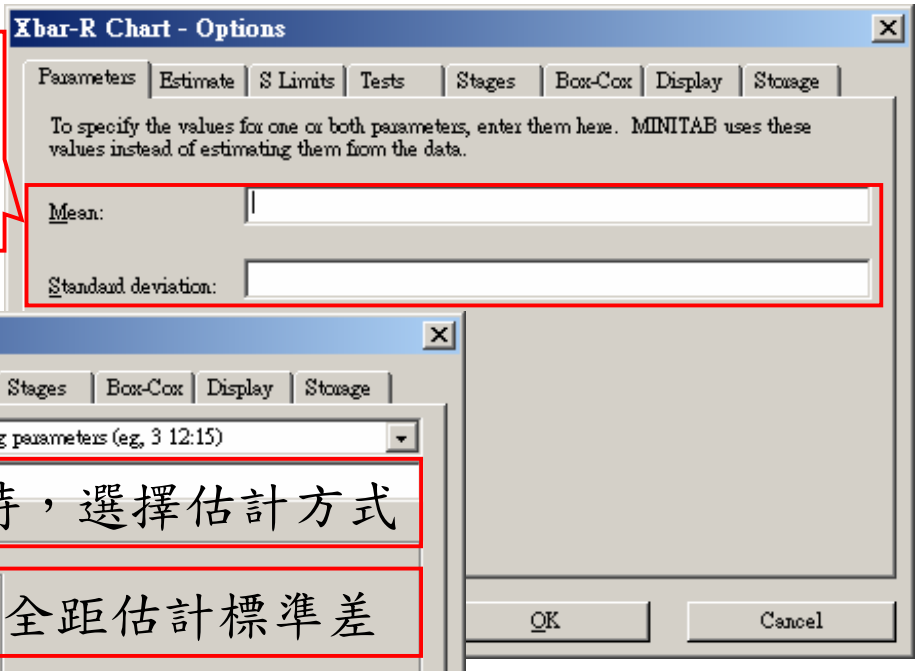
- 監控製程變異數：
- 1.R chart（抽樣數量>1，且為小樣本）
- 2.S chart（抽樣數量>1，且為大樣本）
- 3.MR chart （抽樣數量=1）

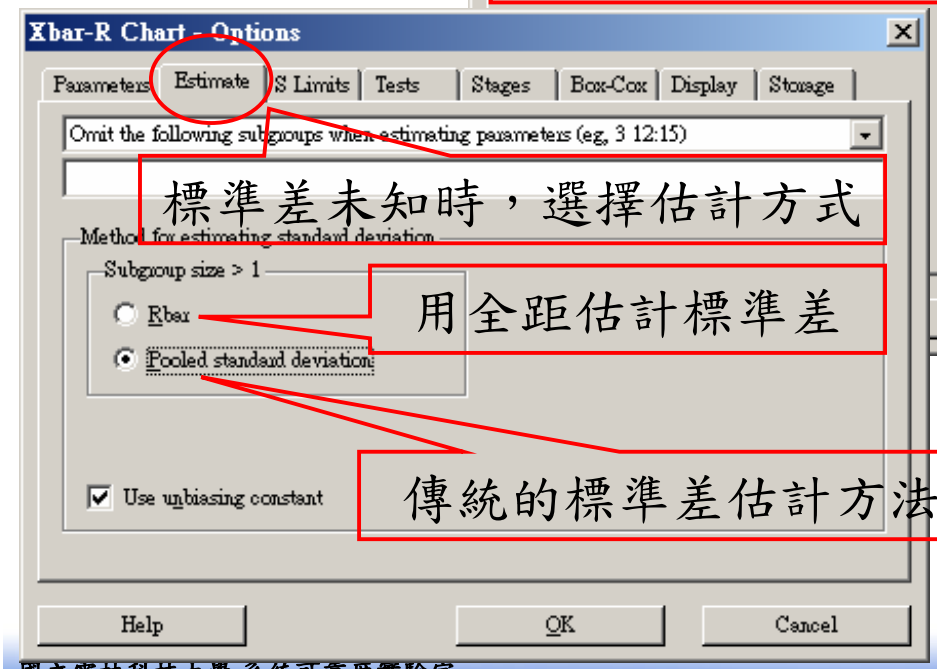
繪製Xbar - R chart

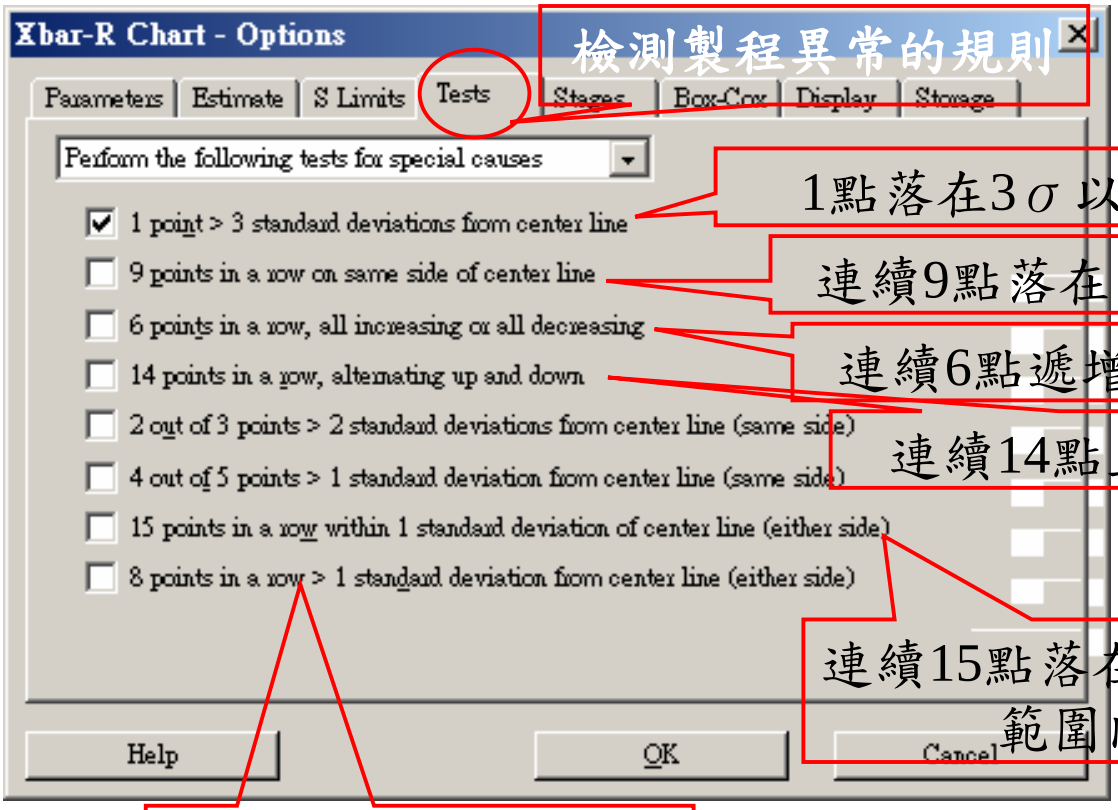
- Stat➔ Control Charts➔ Variables Charts for Subgroups➔ Xbar-R...

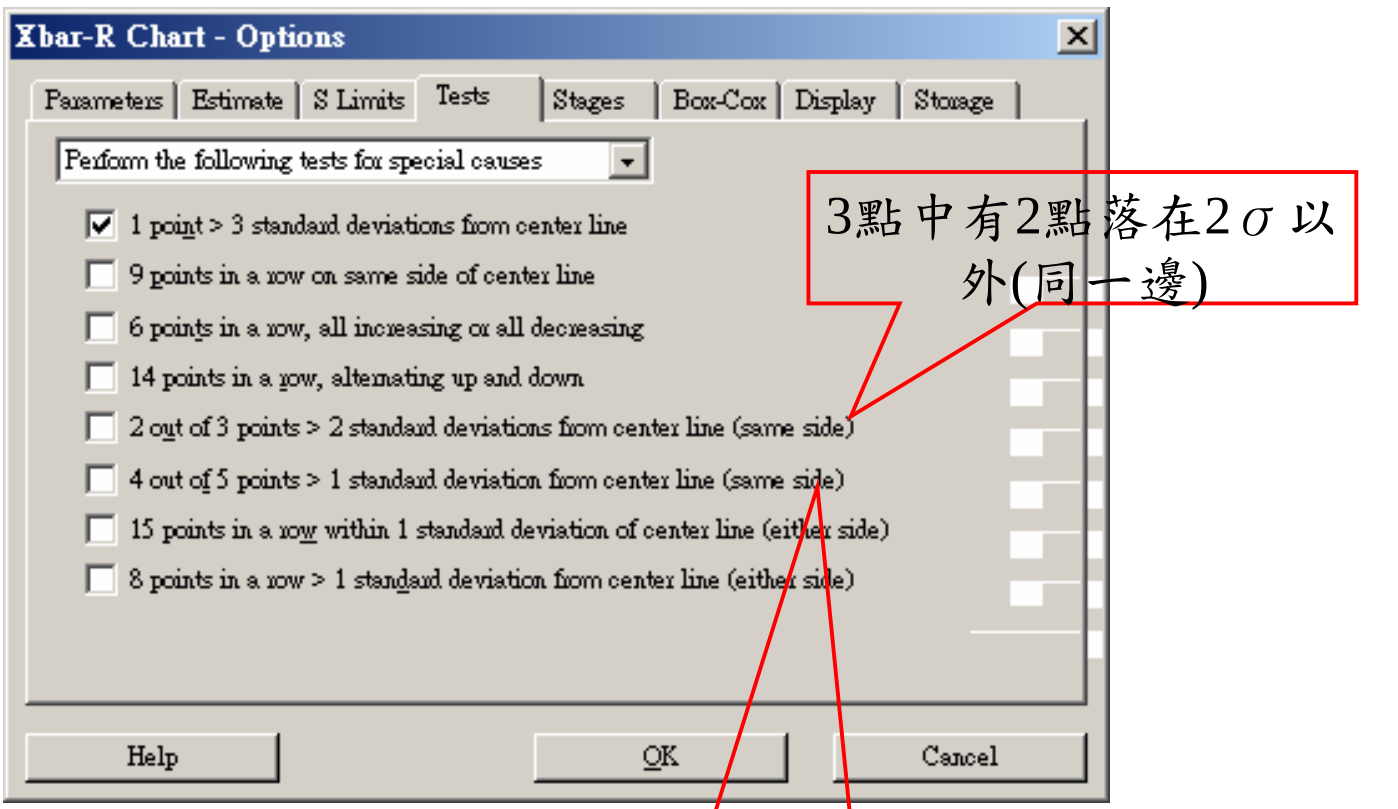


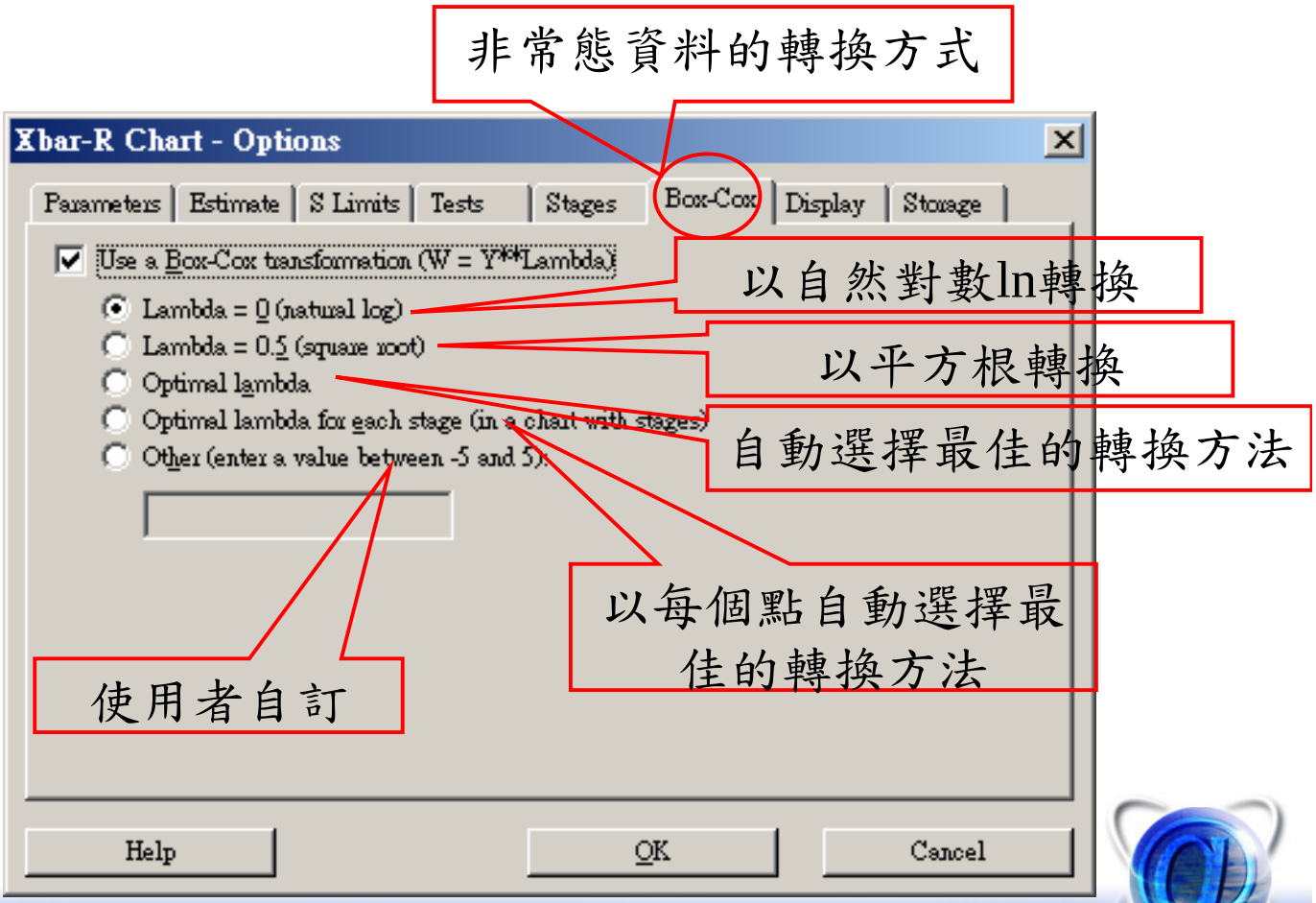
輸入已知的製程平均數和標準差，若未知則空白






Xbar-R Chart - Options
檢測製程異常的規則
Parameters
Estimate
S Limits
Tests
Stages
Box-Cox
Display
Storage
Perform the following tests for special causes
1 point > 3 standard deviations from center line
9 points in a row on same side of center line
6 points in a row, all increasing or all decreasing
14 points in a row, alternating up and down
2 out of 3 points > 2 standard deviations from center line (same side)
4 out of 5 points > 1 standard deviation from center line (same side)
15 points in a row within 1 standard deviation of center line (either side)
8 points in a row > 1 standard deviation from center line (either side)
Help
OK
Cancel
1點落在3σ以外
連續9點落在同一邊
連續6點遞增或遞減
連續14點上下循環
連續15點落在上下1σ範圍內
連續8點落在上下1σ範圍外


Xbar-R Chart - Options
Parameters
Estimate
S Limits
Tests
Stages
Box-Cox
Display
Storage
Perform the following tests for special causes
1 point > 3 standard deviations from center line
9 points in a row on same side of center line
6 points in a row, all increasing or all decreasing
14 points in a row, alternating up and down
2 out of 3 points > 2 standard deviations from center line (same side)
4 out of 5 points > 1 standard deviation from center line (same side)
15 points in a row within 1 standard deviation of center line (either side)
8 points in a row > 1 standard deviation from center line (either side)
Help
OK
Cancel
3點中有2點落在2σ以外(同一邊)
5點中有4點落在1σ以外(同一邊)



Box-Cox轉換函數

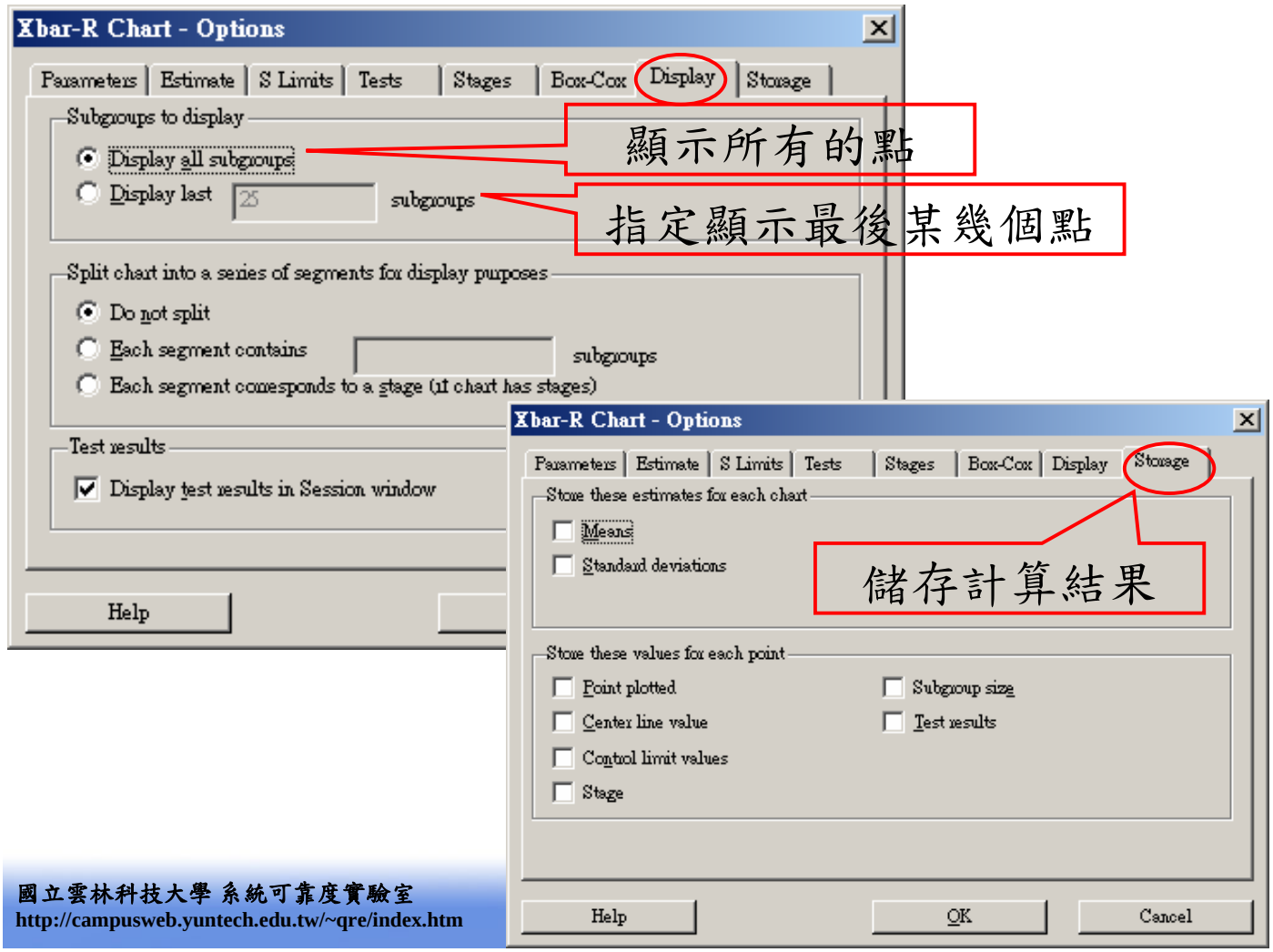
- 原始的Box-Cox轉換函數

$$w(y,\lambda)=\begin{cases}\left(y^{\lambda}-1\right)/\lambda, & \text{if } \lambda\neq 0\\ \ln(y), & \text{if } \lambda=0\end{cases}$$

- Minitab的Box-Cox轉換函數

$$w(y,\lambda)=\begin{cases}y^{\lambda}, & \text{if } \lambda\neq 0\\ \ln(y), & \text{if } \lambda=0\end{cases}$$

λ	轉換函數
2	$w=y^2$
0.5	$w=\sqrt{y}$
0	$w=\ln(y)$
-0.5	$w=1/\sqrt{y}$
-2	$w=1/y^2$

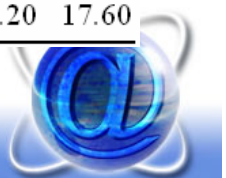


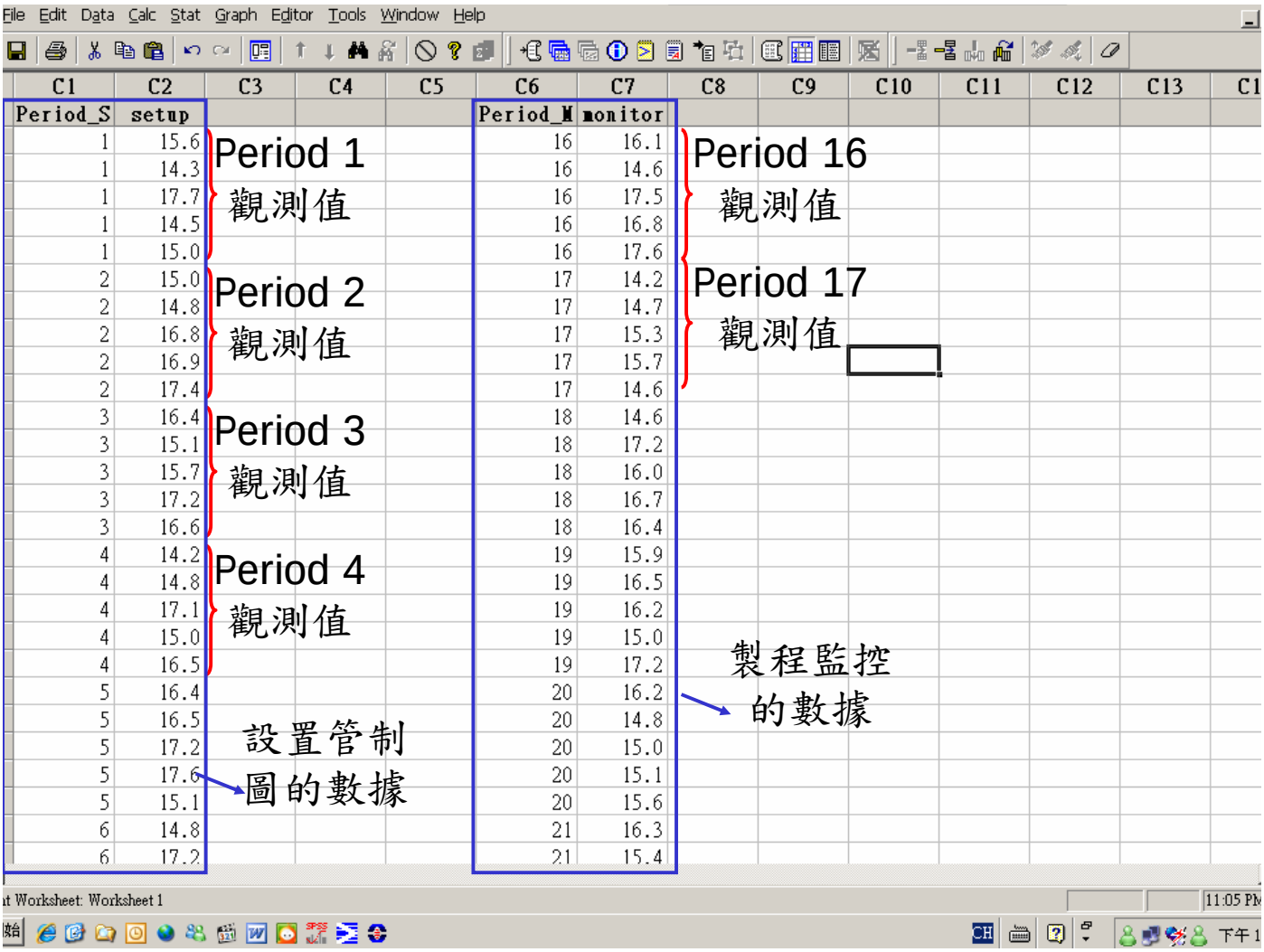
繪製Xbar-R Chart 實例 (Ex. 1)

- 請用Period 1~15期的數據設置Xbar - R chart管制界限，用Period 16~25期數據進行製程監控。

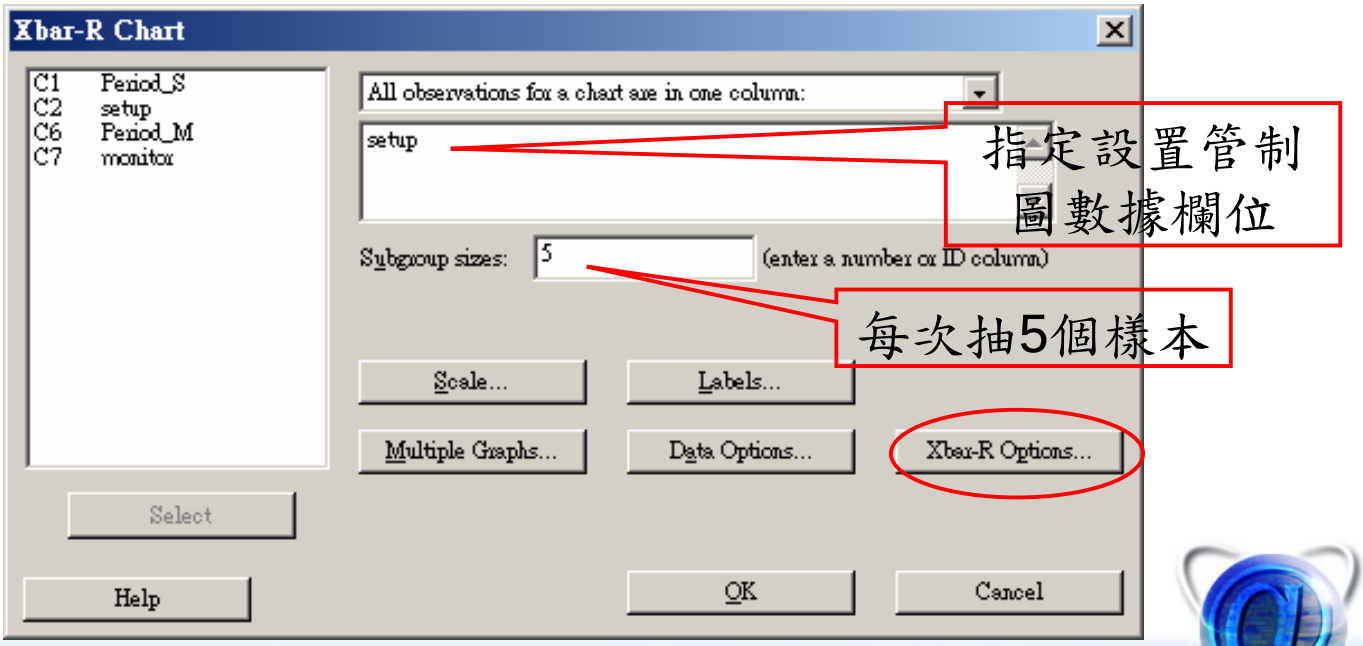
Period	x1	x2	x3	x4	x5
1	15.60	14.30	17.70	14.50	15.00
2	15.00	14.80	16.80	16.90	17.40
3	16.40	15.10	15.70	17.20	16.60
4	14.20	14.80	17.10	15.00	16.50
5	16.40	16.50	17.20	17.60	15.10
6	14.80	17.20	16.80	15.30	14.20
7	17.60	17.20	14.80	17.00	14.60
8	14.20	17.60	16.80	14.20	14.90
9	17.20	16.70	15.30	14.60	15.20
10	14.80	14.30	14.70	16.50	14.90
11	14.60	15.50	15.80	14.80	14.20
12	15.10	15.30	15.90	15.00	17.20
13	17.40	15.20	16.80	16.20	15.40
14	15.30	16.90	17.80	17.20	17.10
15	14.80	15.10	16.60	16.30	14.50

Period	x1	x2	x3	x4	x5
16	16.10	14.60	17.50	16.80	17.60
17	14.20	14.70	15.30	15.70	14.60
18	14.60	17.20	16.00	16.70	16.40
19	15.90	16.50	16.20	15.00	17.20
20	16.20	14.80	15.00	15.10	15.60
21	16.30	15.40	14.60	17.40	14.80
22	15.00	17.20	14.80	17.00	16.80
23	16.40	15.90	16.70	15.70	16.20
24	16.60	15.10	14.60	17.20	17.00
25	17.00	17.10	16.80	16.20	17.60

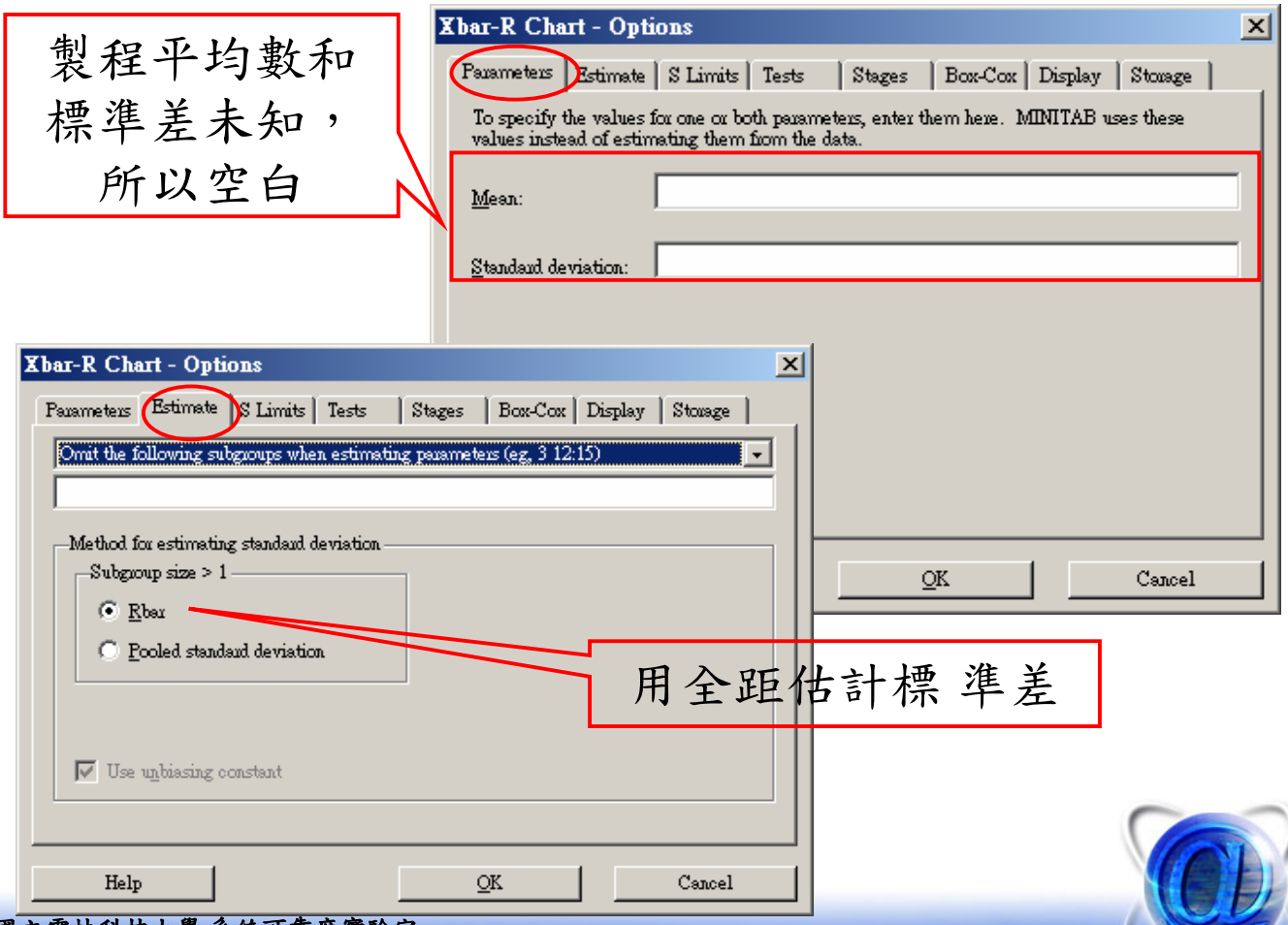




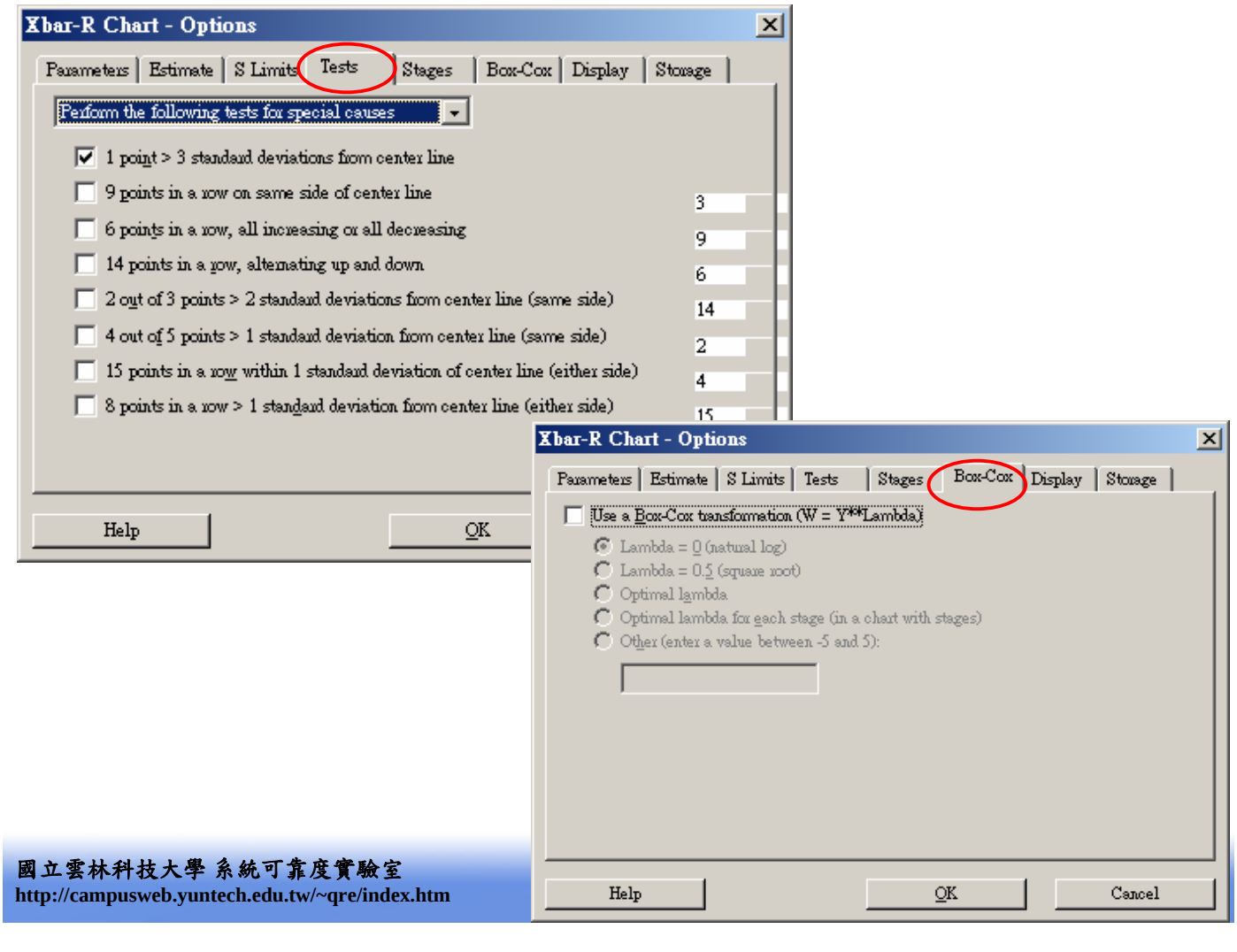
- Stat➔ Control Charts➔ Variables Charts for Subgroups➔ Xbar-R...

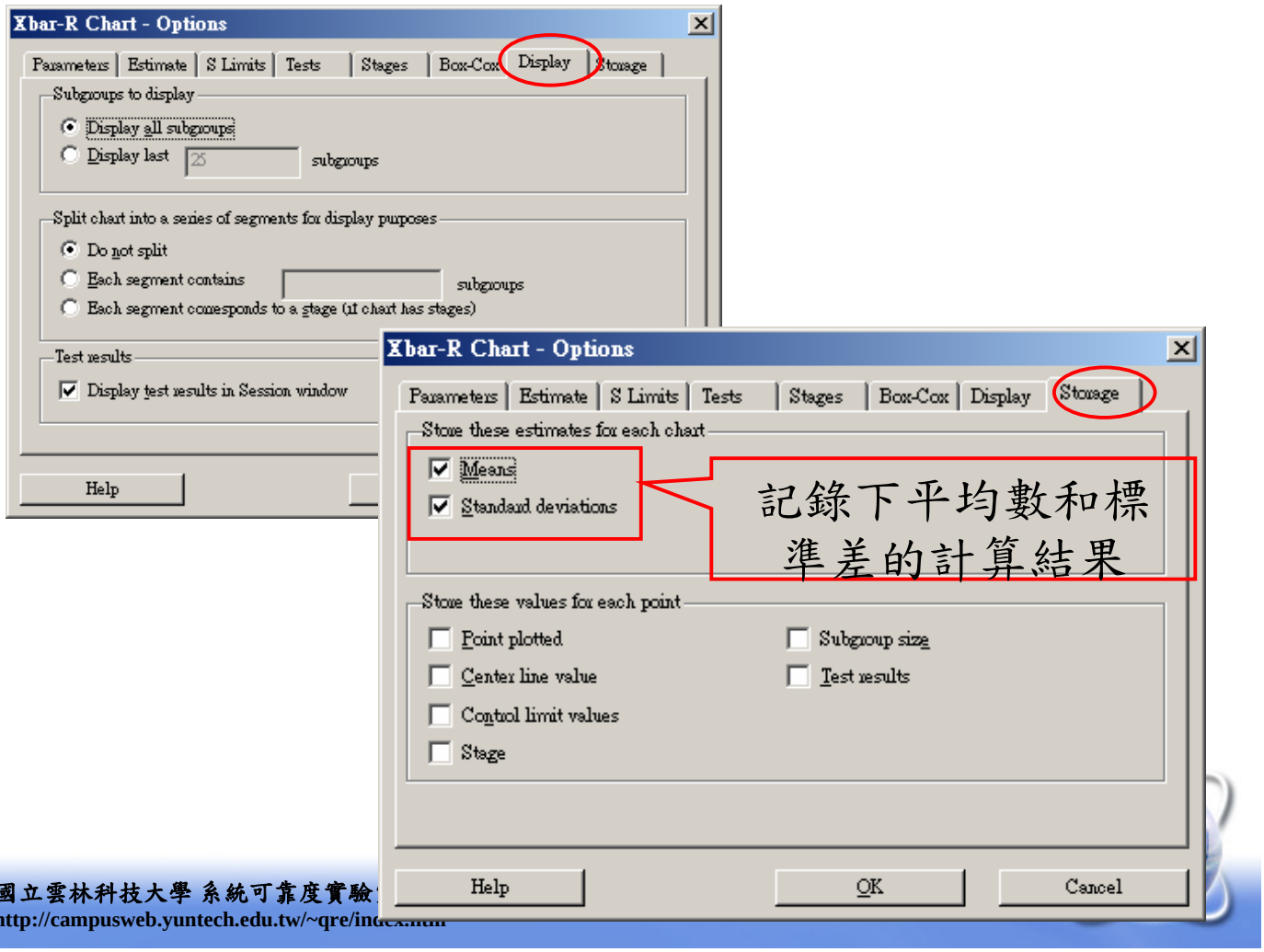


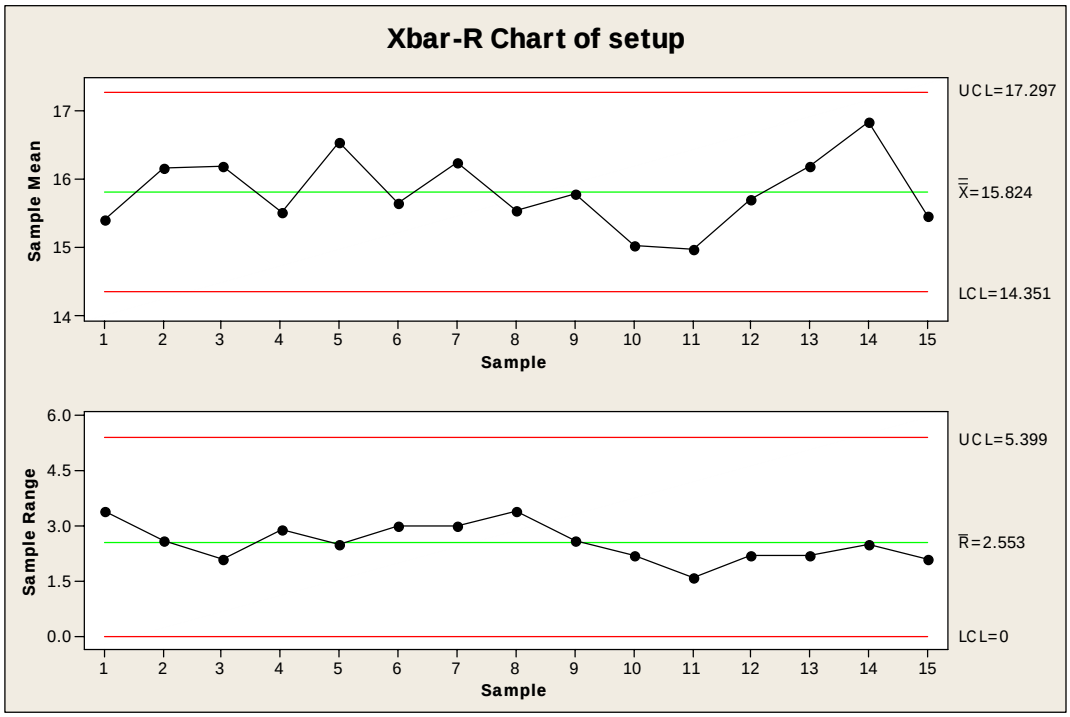
製程平均數和標準差未知，所以空白



用全距估計標 準差

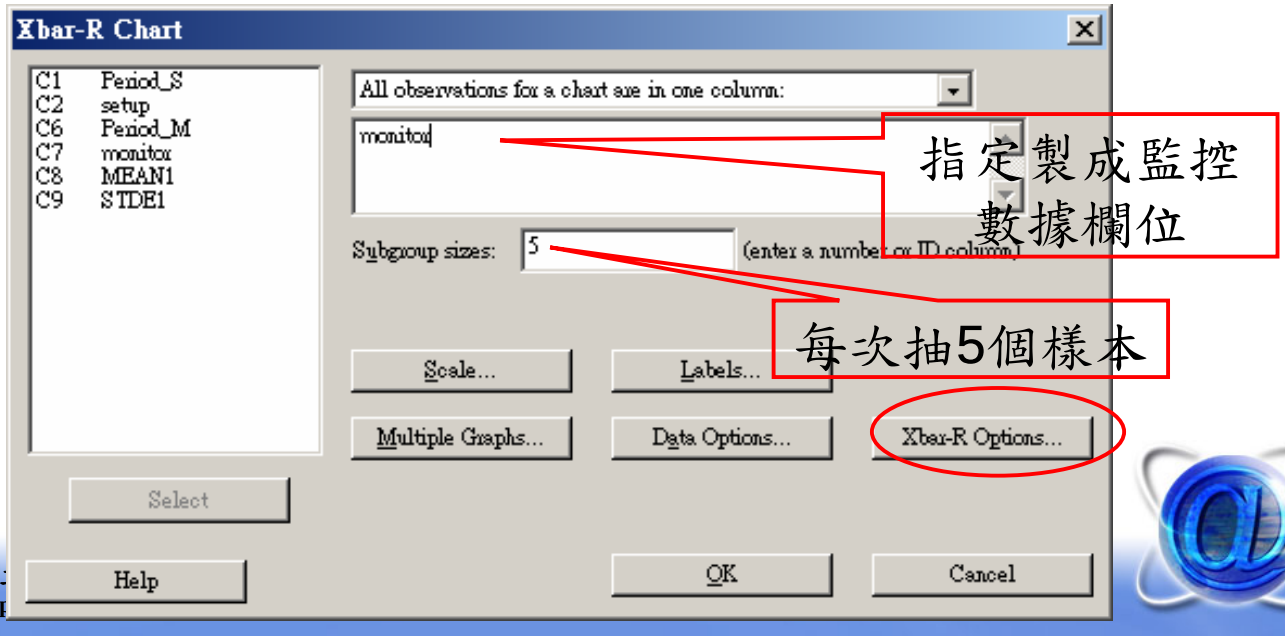




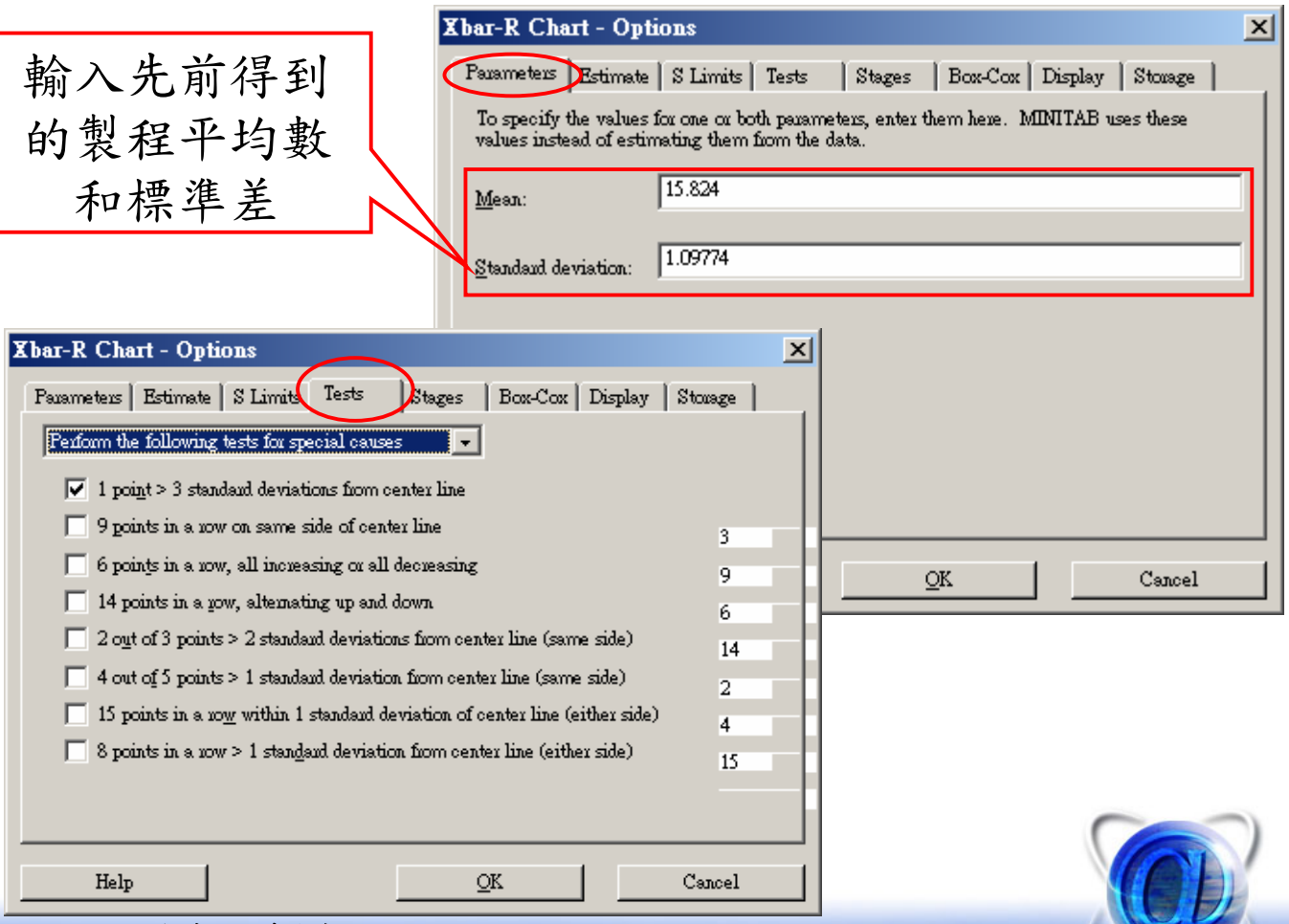


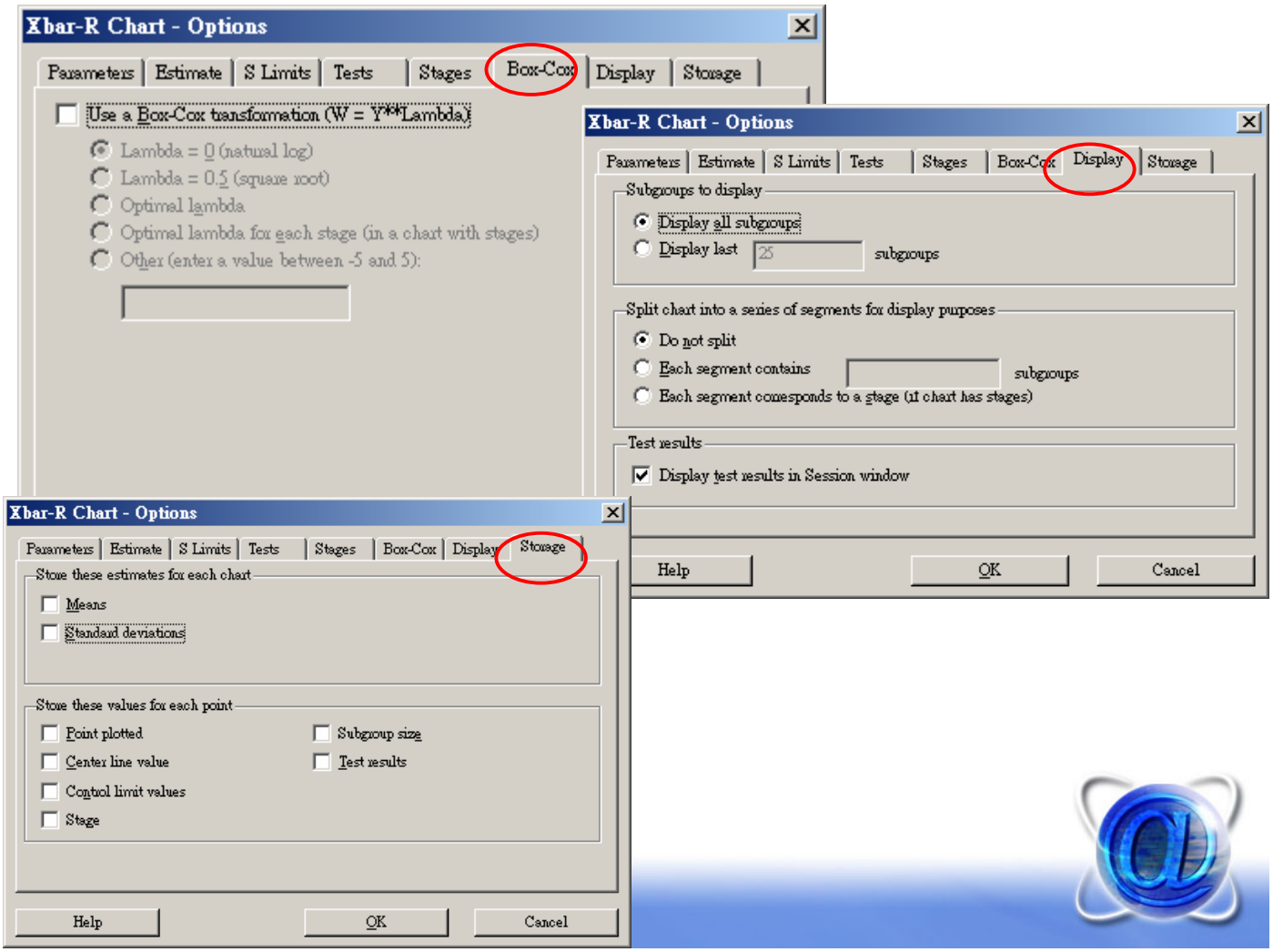
- 完成管制界限設置，圖中沒有落在管制界限外的數據，平均數為15.824，標準差為1.09774

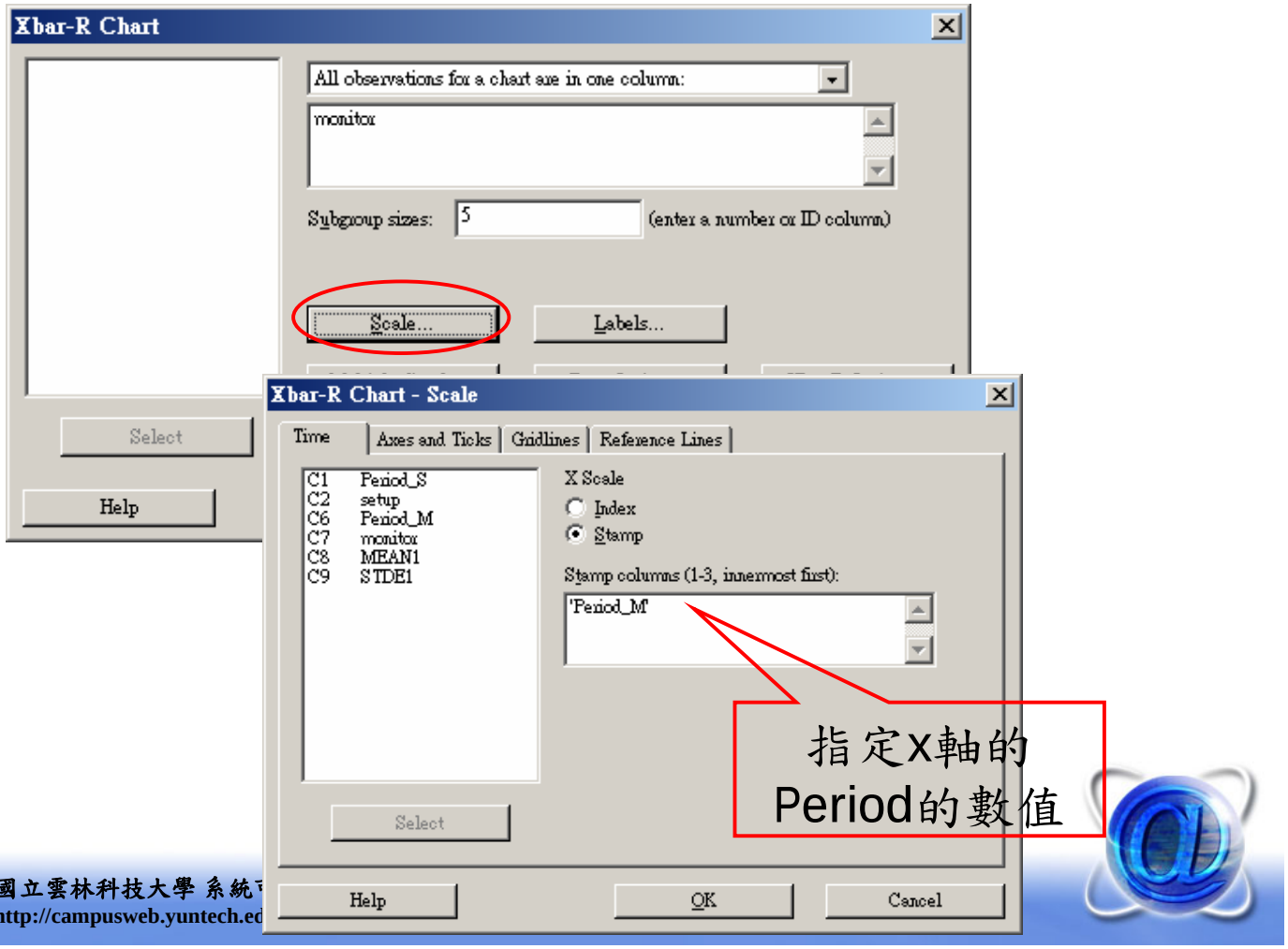
- 開始製程監控，
- Stat➔ Control Charts➔ Variables Charts for Subgroups➔ Xbar-R...

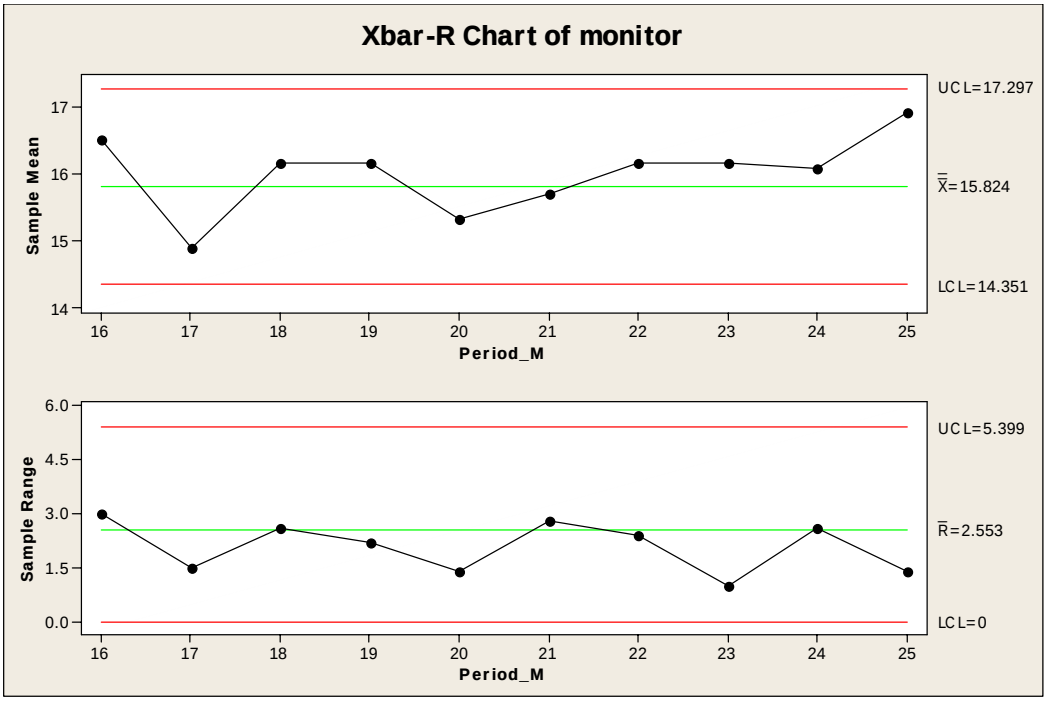


輸入先前得到的製程平均數和標準差




Xbar-R Chart - Options
Parameters
Estimate
S Limits
Tests
Stages
Box-Cox
Display
Storage
Use a Box-Cox transformation (W = Y**Lambda)
Lambda = 0 (natural log)
Lambda = 0.5 (square root)
Optimal lambda
Optimal lambda for each stage (in a chart with stages)
Other (enter a value between -5 and 5):
Xbar-R Chart - Options
Subgroups to display
Display all subgroups
Display last
25
subgroups
Split chart into a series of segments for display purposes
Do not split
Each segment contains
subgroups
Each segment corresponds to a stage (if chart has stages)
Test results
Display test results in Session window
Help
OK
Cancel
Xbar-R Chart - Options
Store these estimates for each chart
Means
Standard deviations
Store these values for each point
Point plotted
Center line value
Control limit values
Stage
Subgroup size
Test results
Help
OK
Cancel

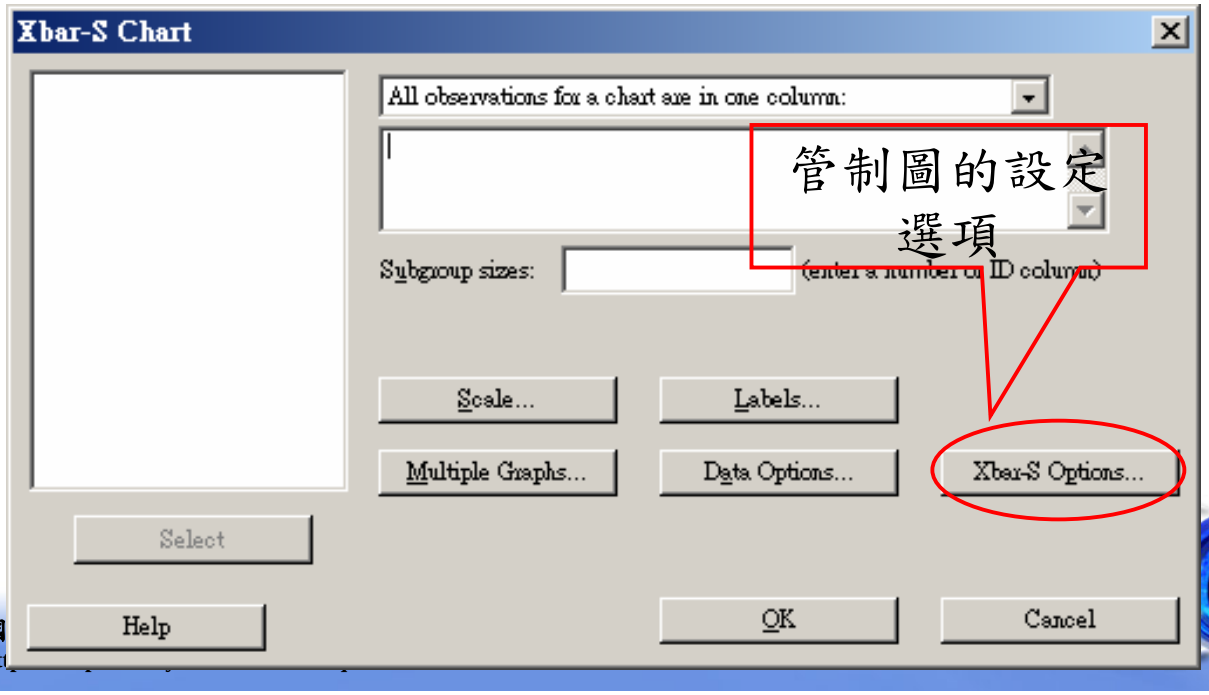

Xbar-R Chart
All observations for a chart are in one column:
monitor
Subgroup sizes:
5
(enter a number or ID column)
Scale...
Labels...
Select
Help
Xbar-R Chart - Scale
Time
Axes and Ticks
Gridlines
Reference Lines
C1 Period_S
C2 setup
C6 Period_M
C7 monitor
C8 MEAN1
C9 STDE1
X Scale
Index
Stamp
Stamp columns (1-3, innermost first):
'Period_M'
Select
Help
OK
Cancel
指定X軸的
Period的數值

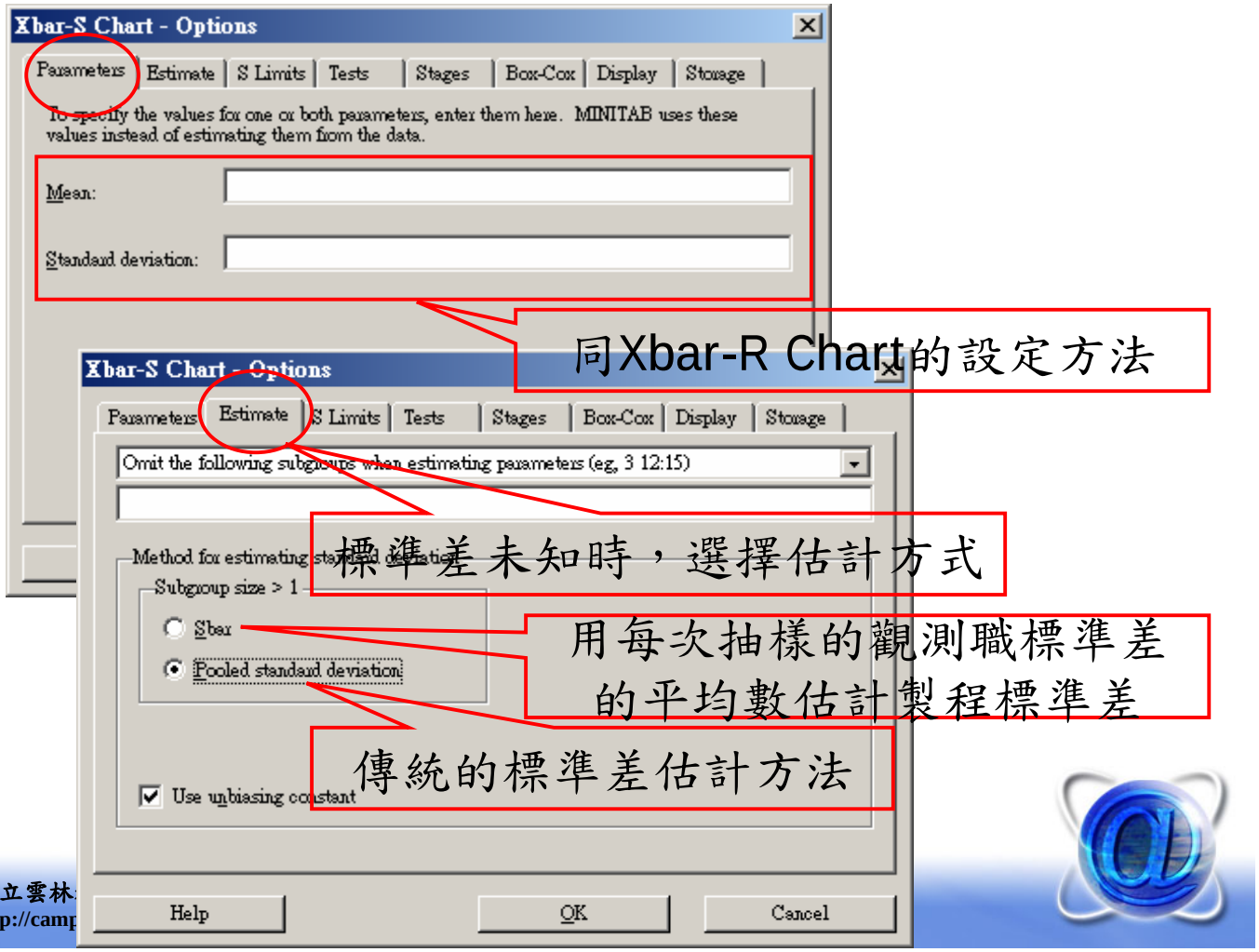


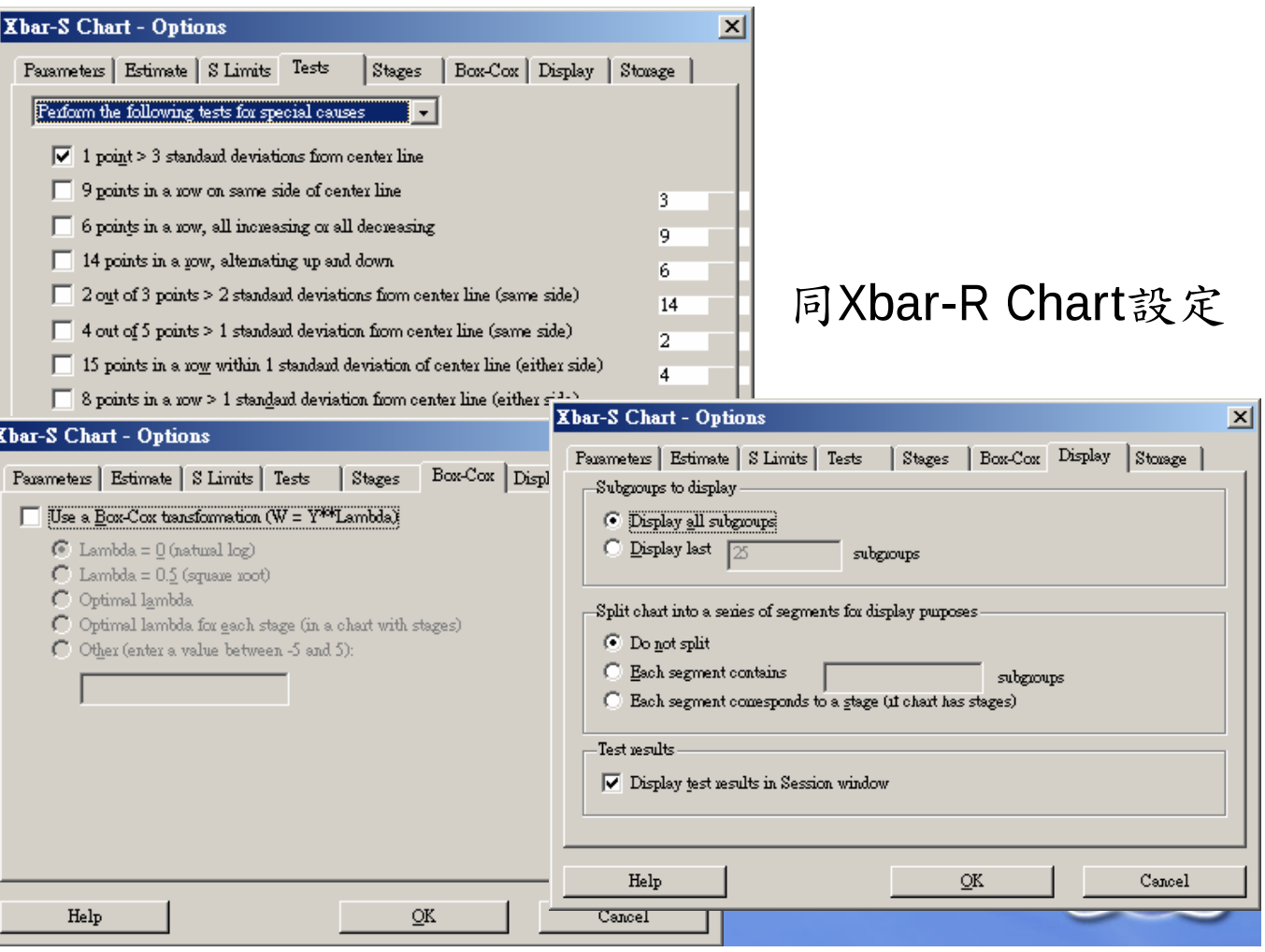
- 沒有點落在管制界限外，所以判讀製程為正常狀態。

繪製Xbar - S chart

- Stat➔ Control Charts➔ Variables Charts for Subgroups➔ Xbar-S...
- 設定方法如同Xbar - R chart

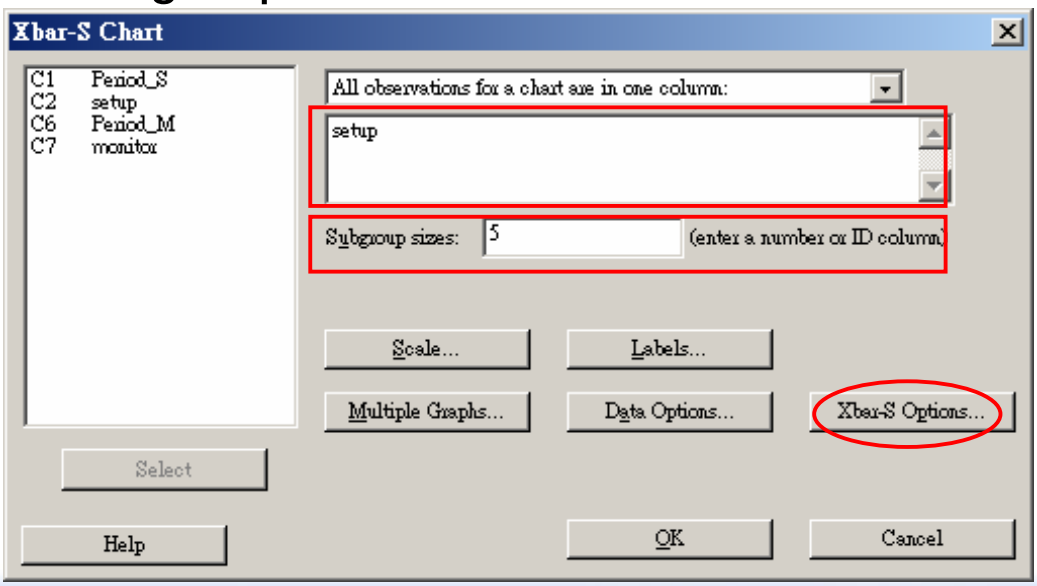



Xbar-S Chart - Options
Parameters
Estimate
S Limits
Tests
Stages
Box-Cox
Display
Storage
To specify the values for one or both parameters, enter them here. MINITAB uses these values instead of estimating them from the data.
Mean:
Standard deviation:
同Xbar-R Chart的設定方法
Omit the following subgroups when estimating parameters (eg, 3 12:15)
Method for estimating standard deviation
Subgroup size > 1
Sbar
Pooled standard deviation
Use unbiasing constant
標準差未知時，選擇估計方式
用每次抽樣的觀測職標準差的平均數估計製程標準差
傳統的標準差估計方法
Help
OK
Cancel

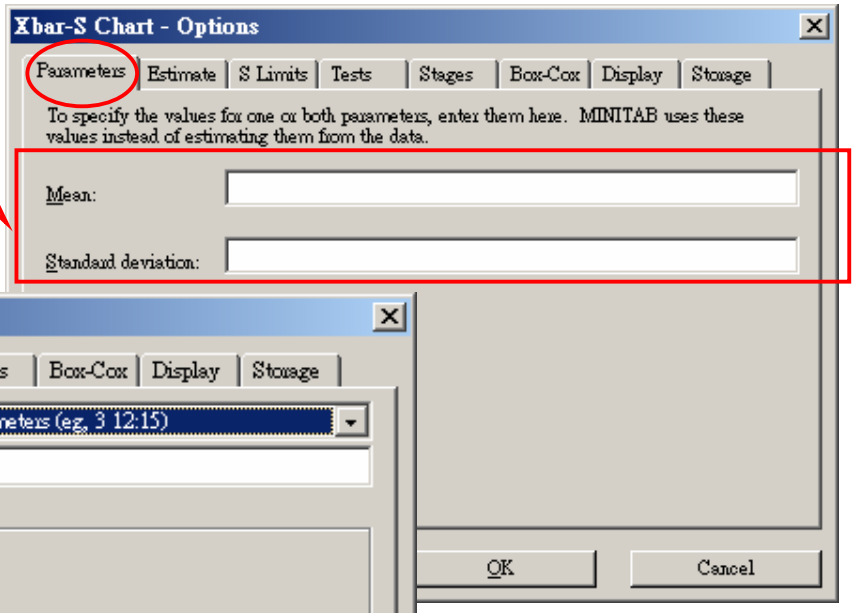

Xbar-S Chart - Options
Parameters
Estimate
S Limits
Tests
Stages
Box-Cox
Display
Storage
Perform the following tests for special causes
1 point > 3 standard deviations from center line
9 points in a row on same side of center line
6 points in a row, all increasing or all decreasing
14 points in a row, alternating up and down
2 out of 3 points > 2 standard deviations from center line (same side)
4 out of 5 points > 1 standard deviation from center line (same side)
15 points in a row within 1 standard deviation of center line (either side)
3
9
6
14
2
4
同Xbar-R Chart設定
Use a Box-Cox transformation (W = Y**Lambda)
Lambda = 0 (natural log)
Lambda = 0.5 (square root)
Optimal lambda
Optimal lambda for each stage (in a chart with stages)
Other (enter a value between -5 and 5):
Subgroups to display
Display all subgroups
Display last
25
subgroups
Split chart into a series of segments for display purposes
Do not split
Each segment contains
subgroups
Each segment corresponds to a stage (if chart has stages)
Test results
Display test results in Session window
Help
OK
Cancel

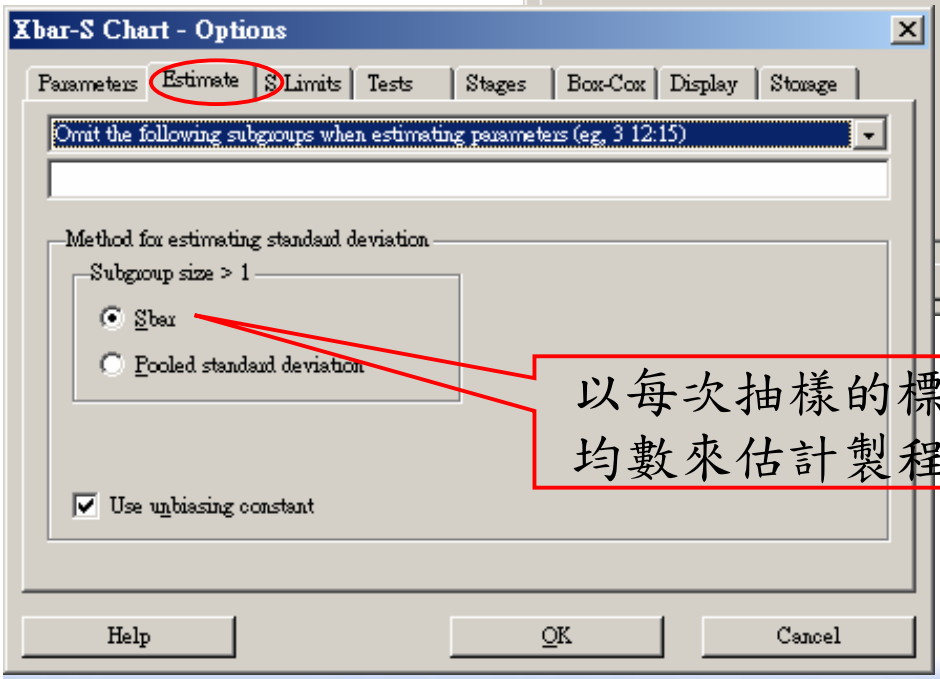
繪製Xbar-S Chart 實例 (Ex. 2)

- 以Ex. 1數據做說明
- Stat➔ Control Charts➔ Variables Charts for Subgroups➔ Xbar-S...

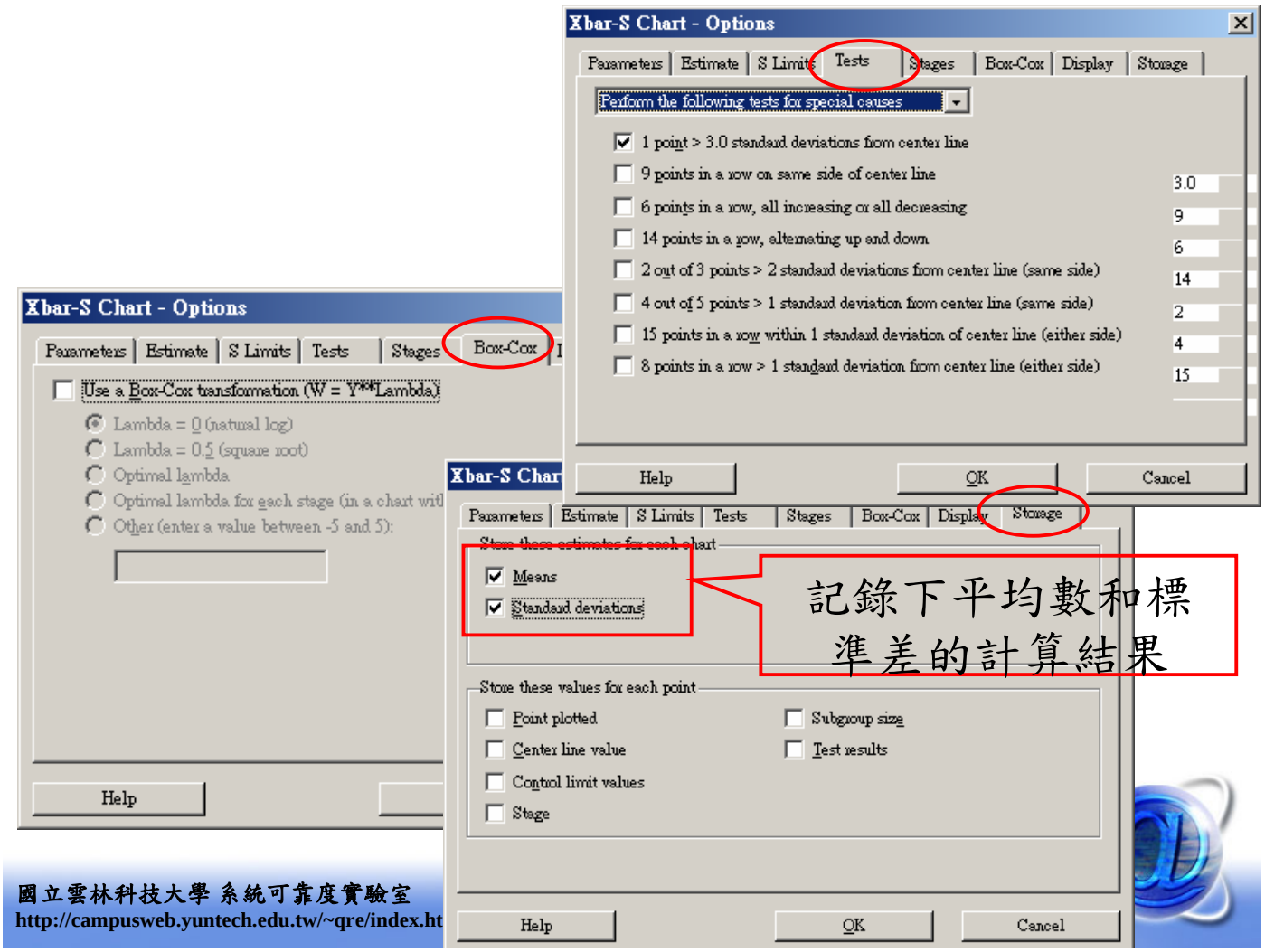


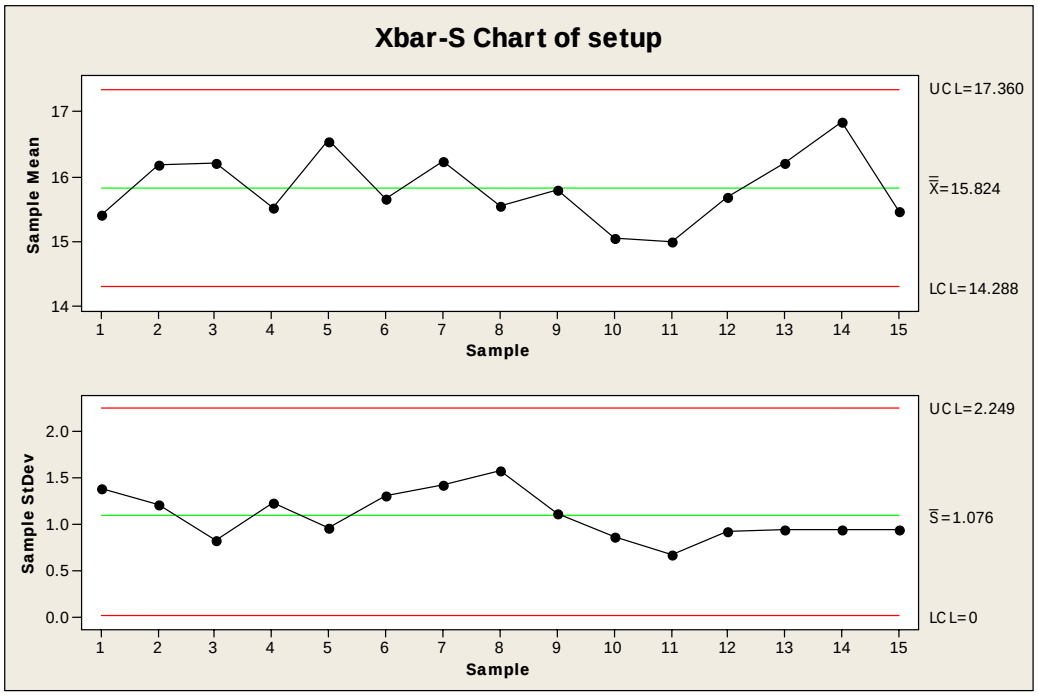
製程平均數和標準差未知，所以空白





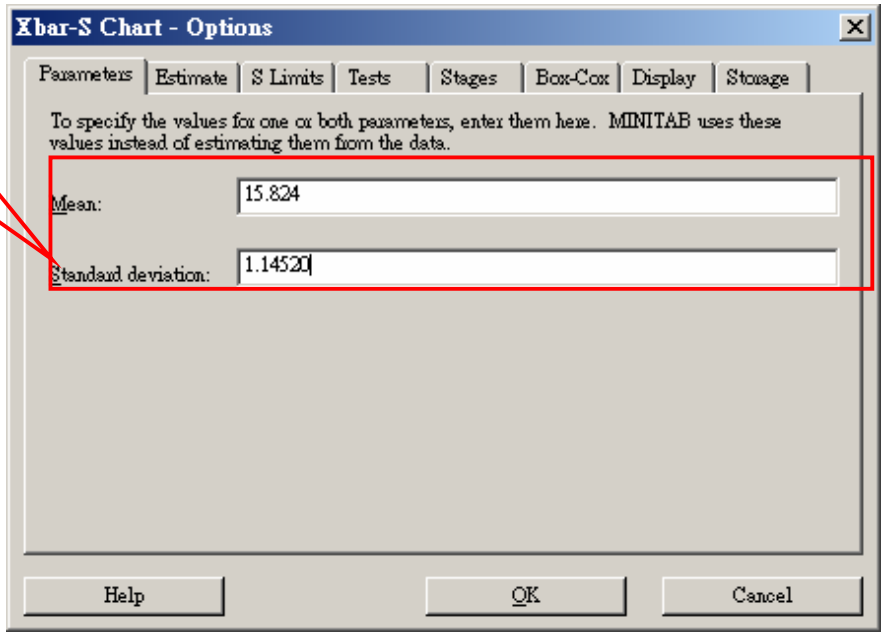
以每次抽樣的標準差平均數來估計製程標準差



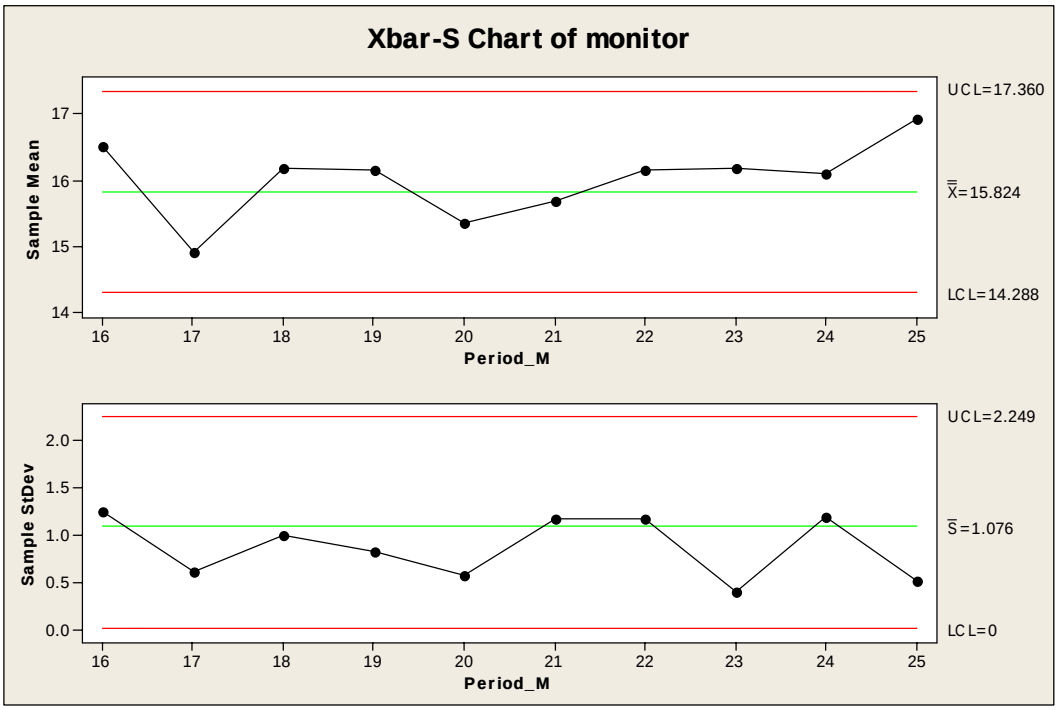


- 完成管制界限設置，圖中沒有落在管制界限外的數據，平均數為15.824，標準差為1.14520

輸入先前得到的製程平均數和標準差



- 其他設定與Xbar-R Chart相同



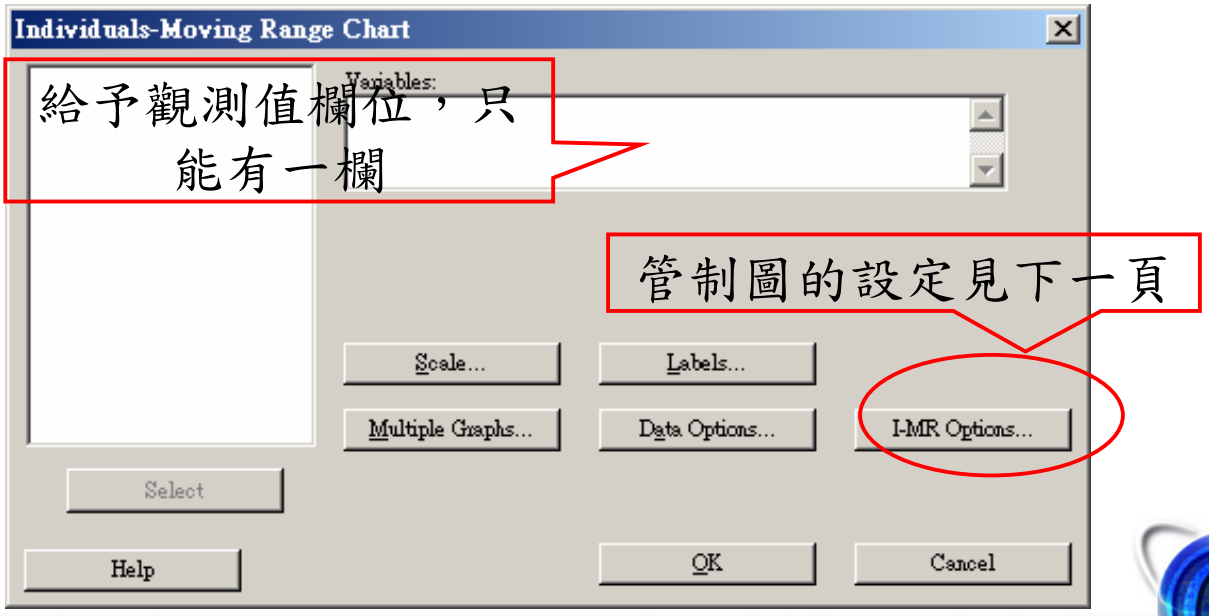
- 沒有點落在管制界限外，所以判讀製程為正常狀態。

Xbar chart、S chart 和 R chart

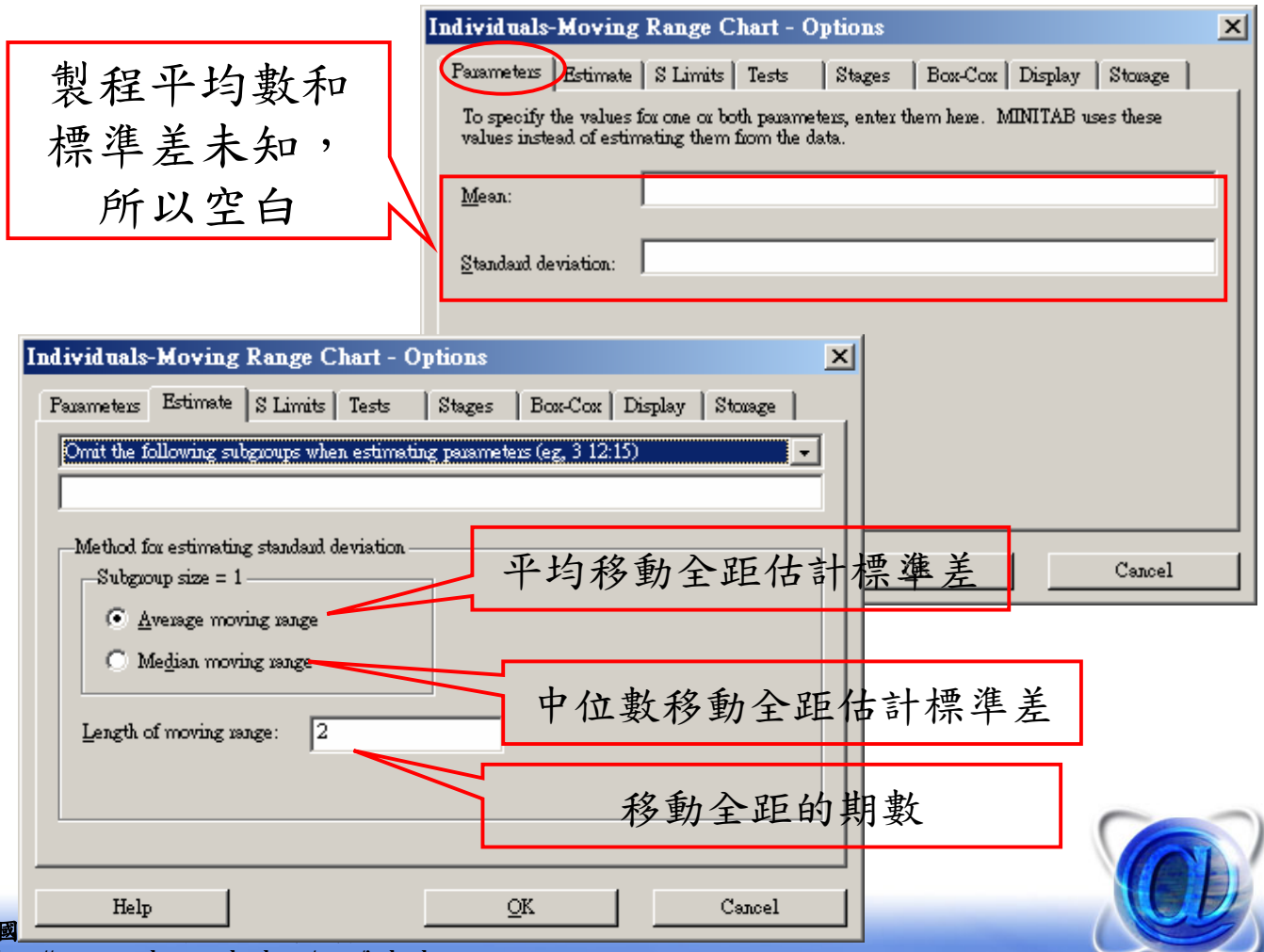
- 其餘的三個管制圖的設定與使用與Xbar – R chart相同。

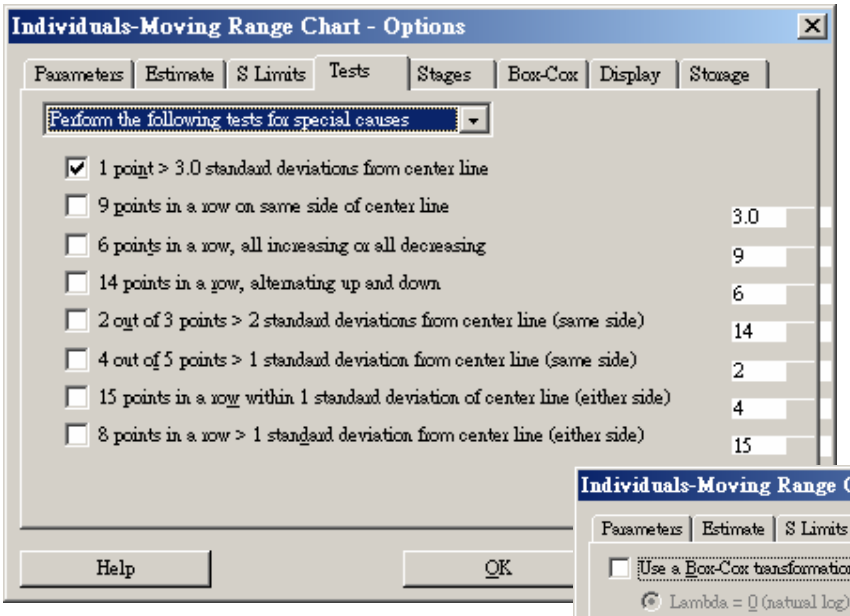
繪製IM - MR chart

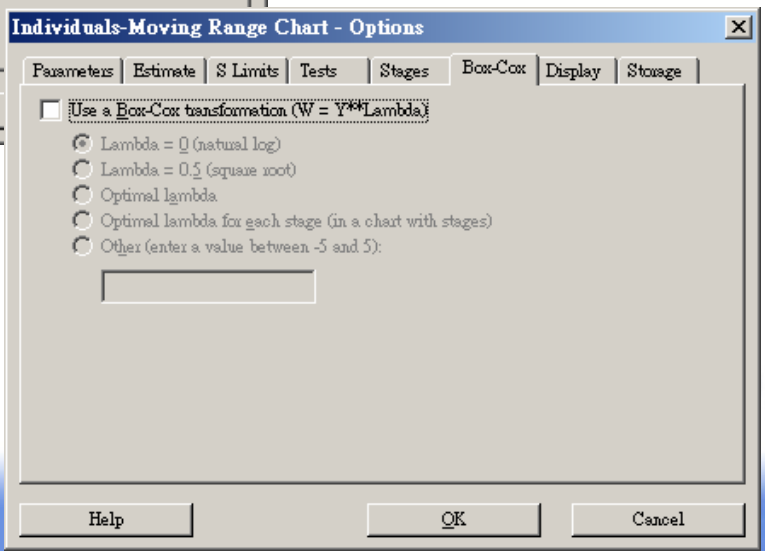
- Stat➔ Control Charts➔ Control Charts for Individuals ➔ I-MR...



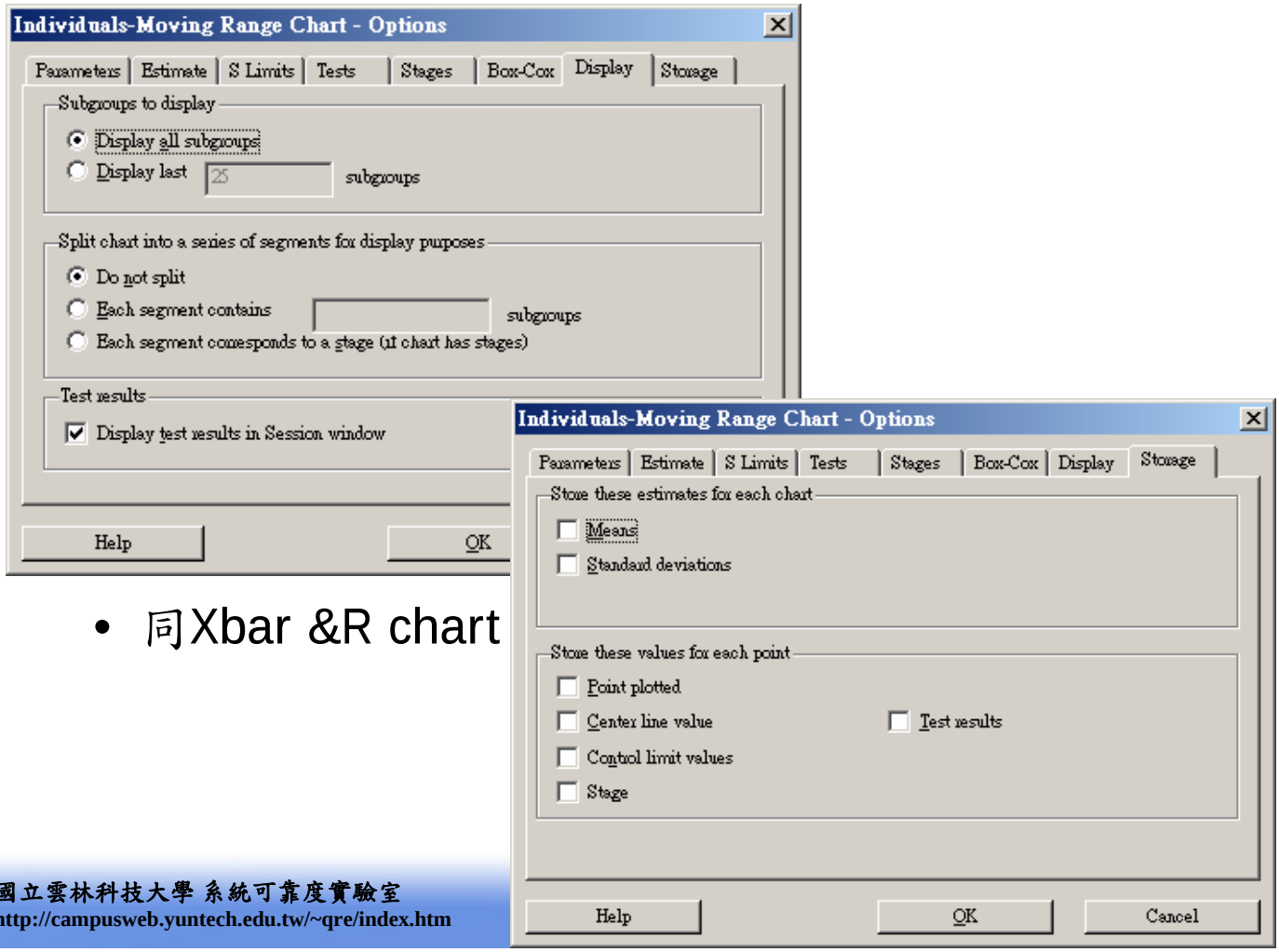
製程平均數和標準差未知，所以空白







- 同Xbar &R chart



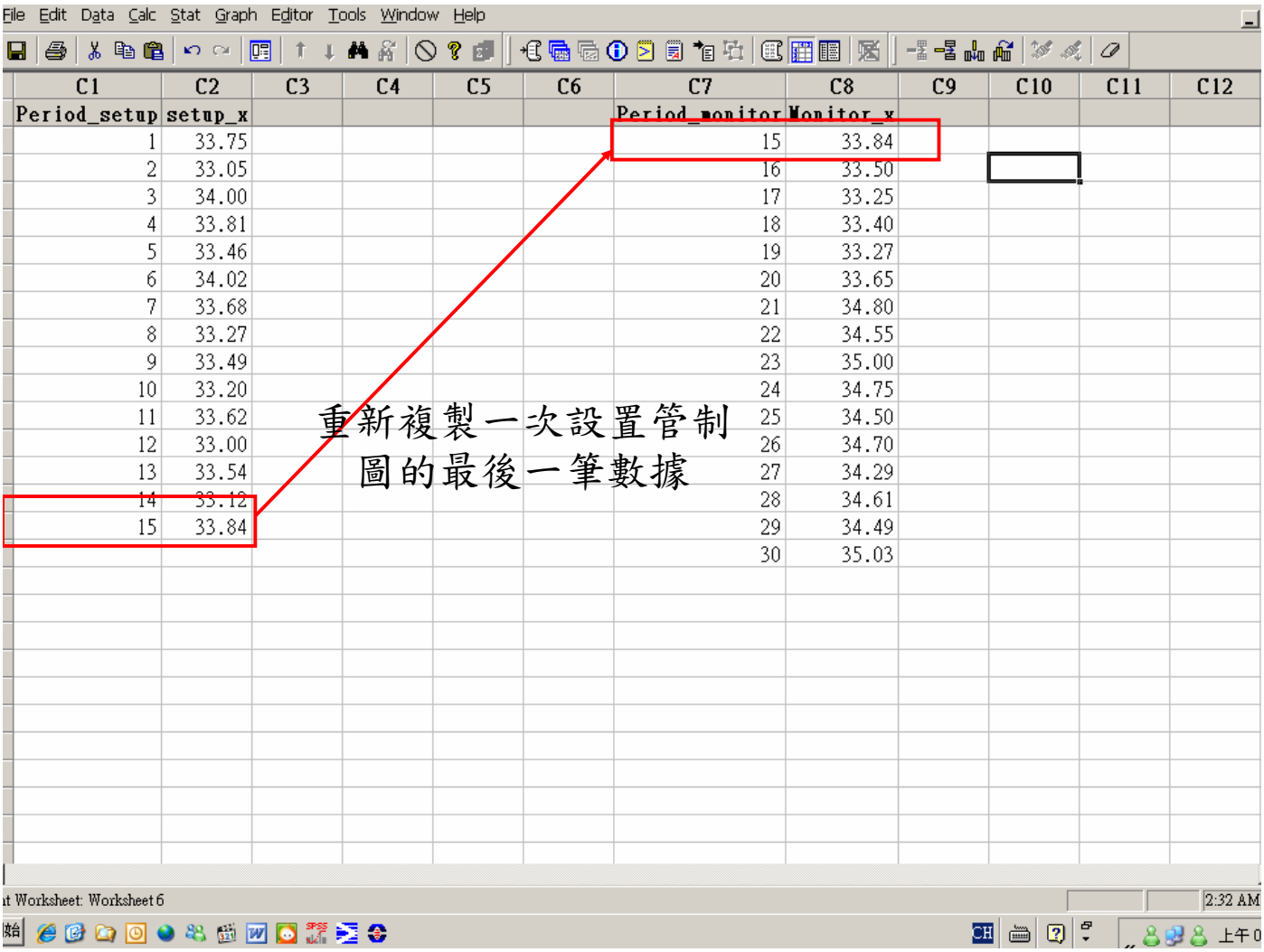
- 同Xbar &R chart

繪製IM-MR Chart 實例 (Ex. 3)

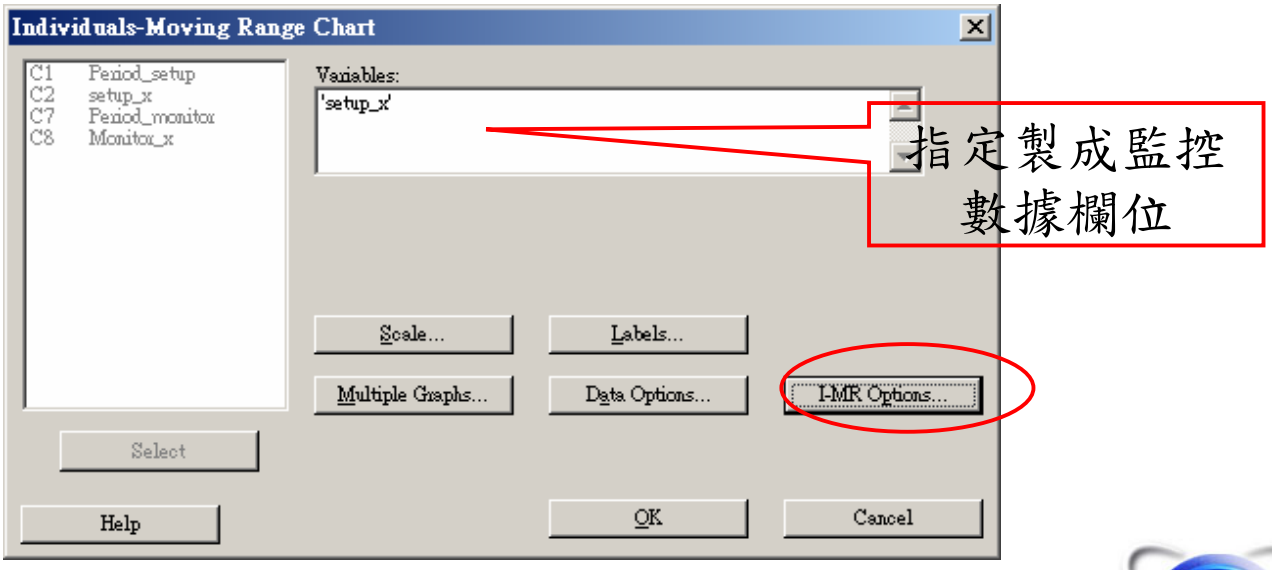
- 以period 1~15數據設置IM-MR Chart管制界限
以Period 16~30數據監控製程

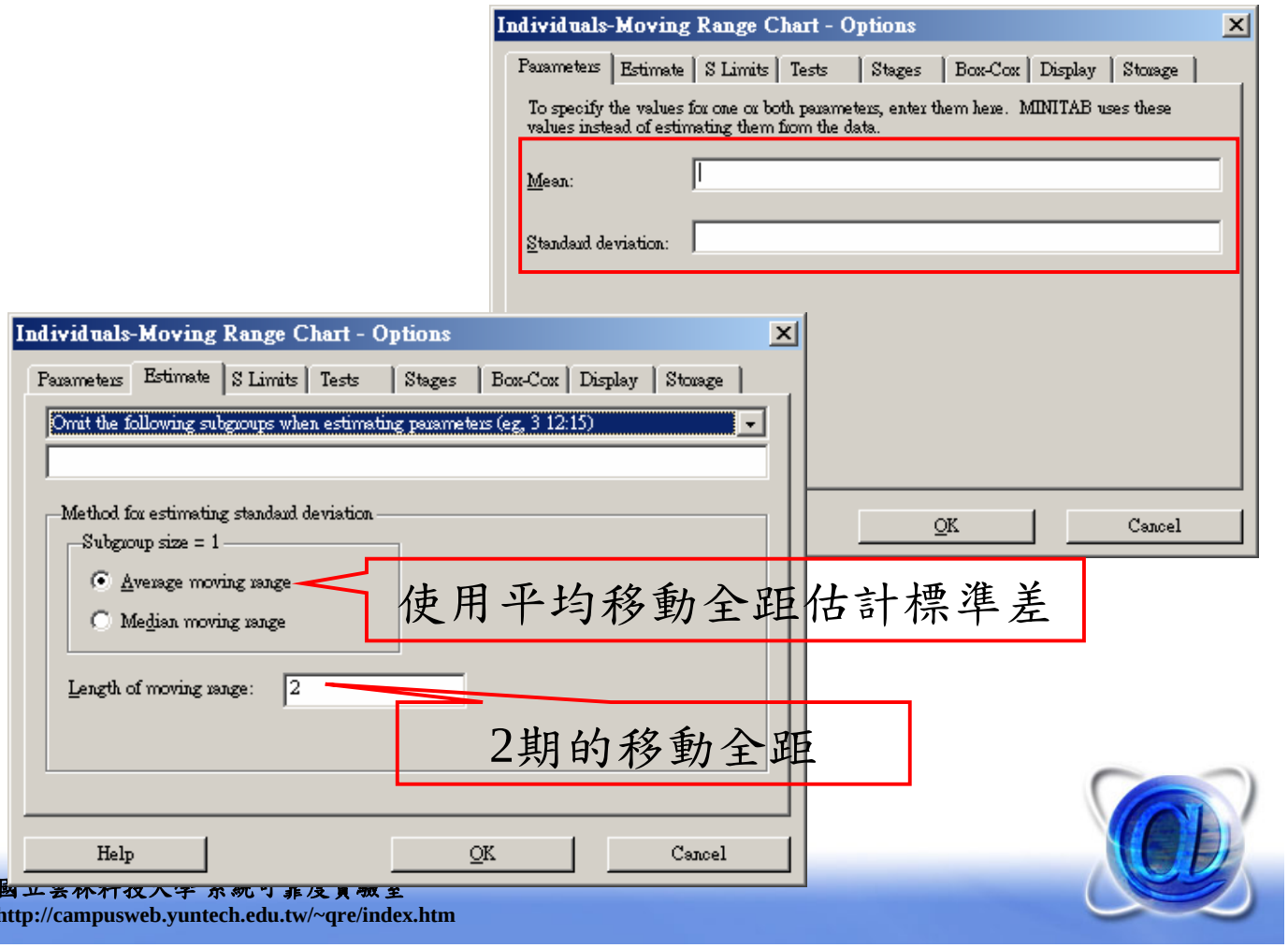
Period_setup	setup_x
1	33.75
2	33.05
3	34
4	33.81
5	33.46
6	34.02
7	33.68
8	33.27
9	33.49
10	33.2
11	33.62
12	33
13	33.54
14	33.12
15	33.84

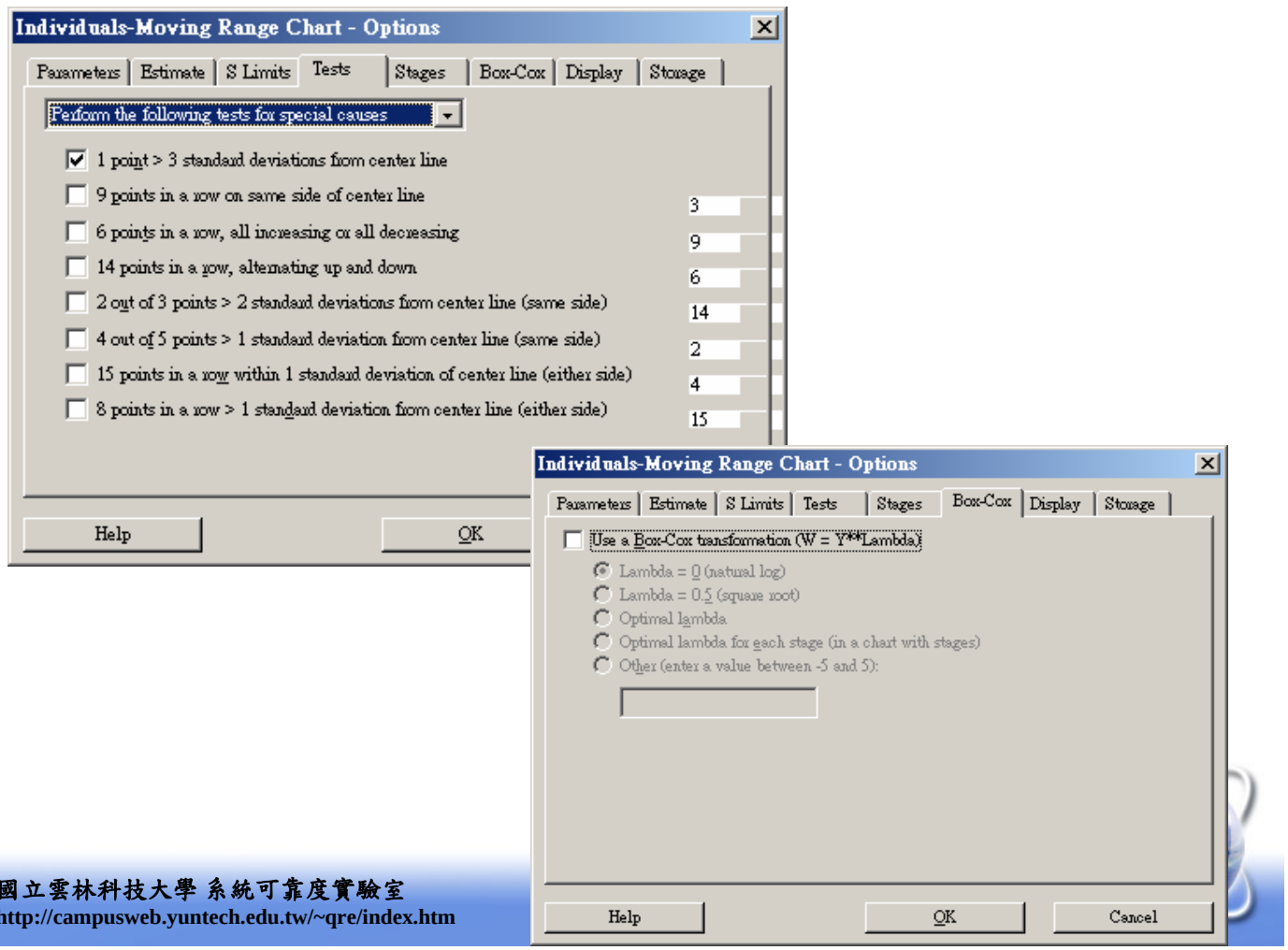
Period_monitor	Monitor_x
16	33.5
17	33.25
18	33.4
19	33.27
20	33.65
21	34.8
22	34.55
23	35
24	34.75
25	34.5
26	34.7
27	34.29
28	34.61
29	34.49
30	35.03

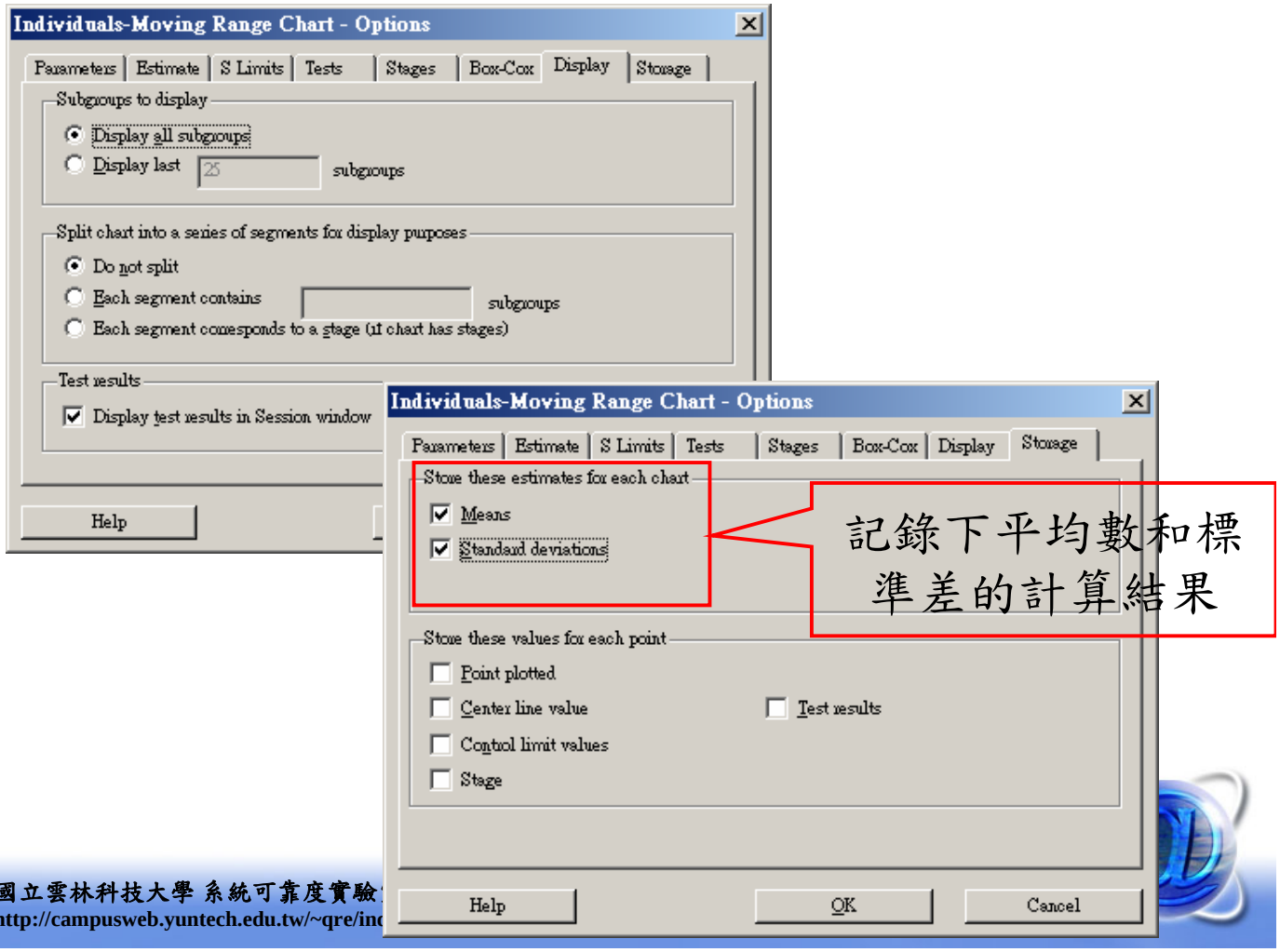


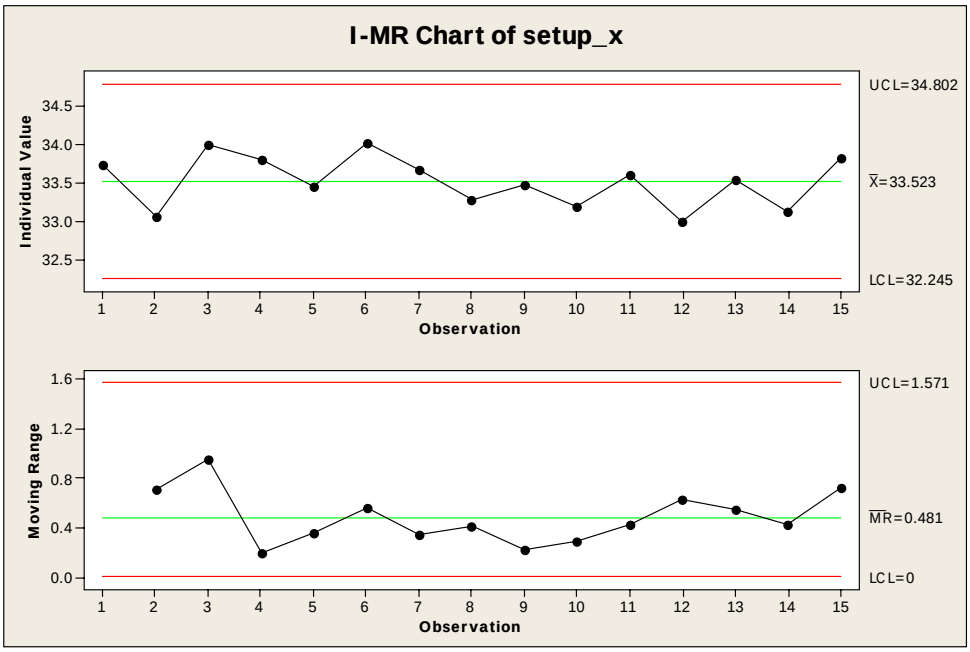
- Stat➔ Control Charts➔ Control Charts for Individuals ➔ I-MR...




Individuals-Moving Range Chart - Options
Parameters
Estimate
S Limits
Tests
Stages
Box-Cox
Display
Storage
To specify the values for one or both parameters, enter them here. MINITAB uses these values instead of estimating them from the data.
Mean:
Standard deviation:
OK
Cancel
Individuals-Moving Range Chart - Options
Omit the following subgroups when estimating parameters (eg, 3 12:15)
Method for estimating standard deviation
Subgroup size = 1
Average moving range
Median moving range
使用平均移動全距估計標準差
Length of moving range:
2
2期的移動全距
Help
OK
Cancel

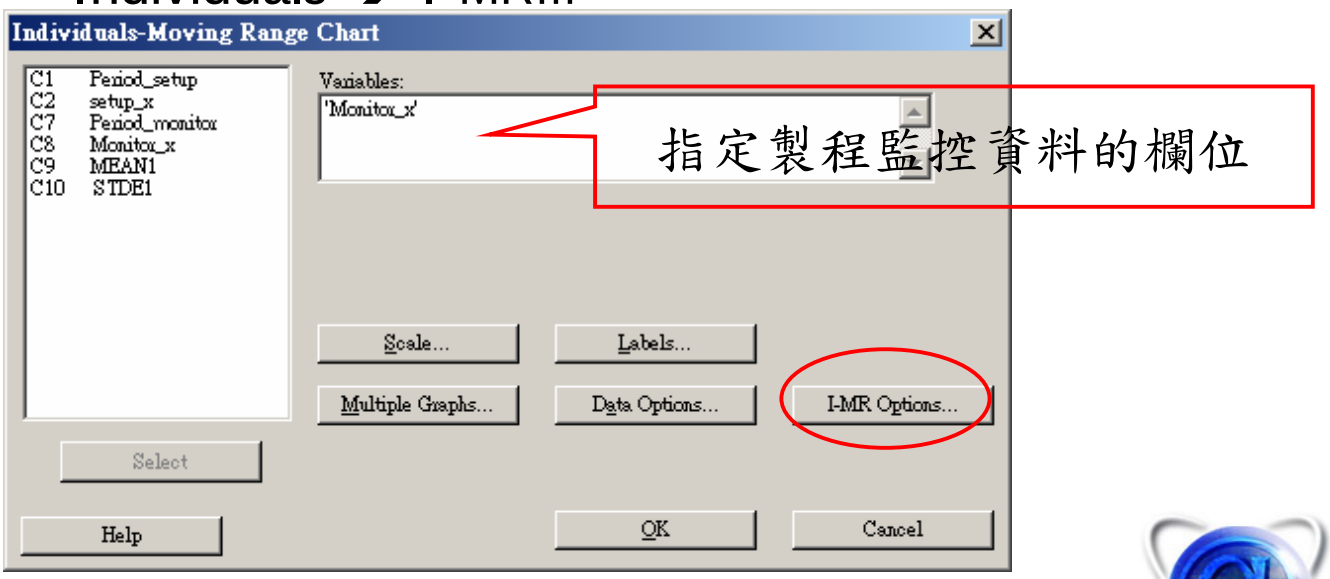

Individuals-Moving Range Chart - Options
Parameters
Estimate
S Limits
Tests
Stages
Box-Cox
Display
Storage
Perform the following tests for special causes
1 point > 3 standard deviations from center line
9 points in a row on same side of center line
6 points in a row, all increasing or all decreasing
14 points in a row, alternating up and down
2 out of 3 points > 2 standard deviations from center line (same side)
4 out of 5 points > 1 standard deviation from center line (same side)
15 points in a row within 1 standard deviation of center line (either side)
8 points in a row > 1 standard deviation from center line (either side)
3
9
6
14
2
4
15
Help
OK
Individuals-Moving Range Chart - Options
Use a Box-Cox transformation (W = Y**Lambda)
Lambda = 0 (natural log)
Lambda = 0.5 (square root)
Optimal lambda
Optimal lambda for each stage (in a chart with stages)
Other (enter a value between -5 and 5):
Help
OK
Cancel



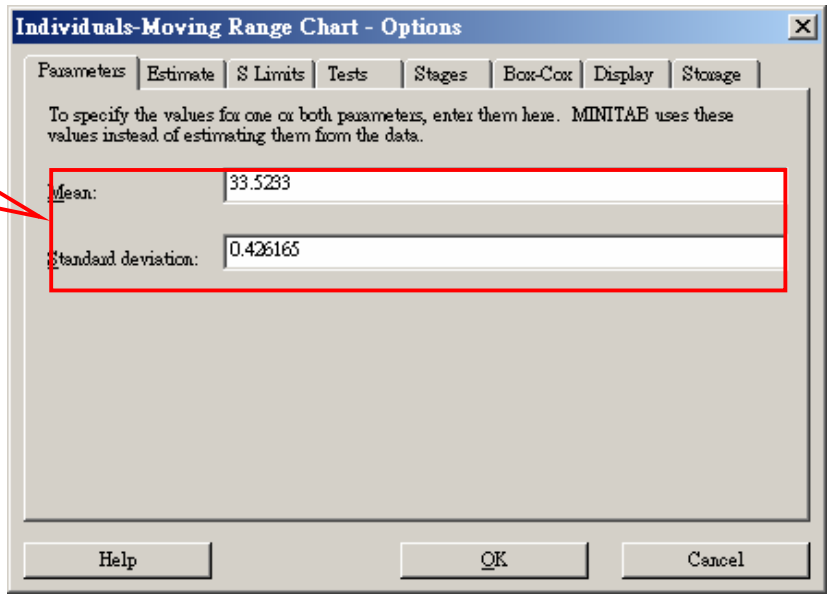


- 沒有點落在管制界限外。平均數33.5233，標準差0.426165

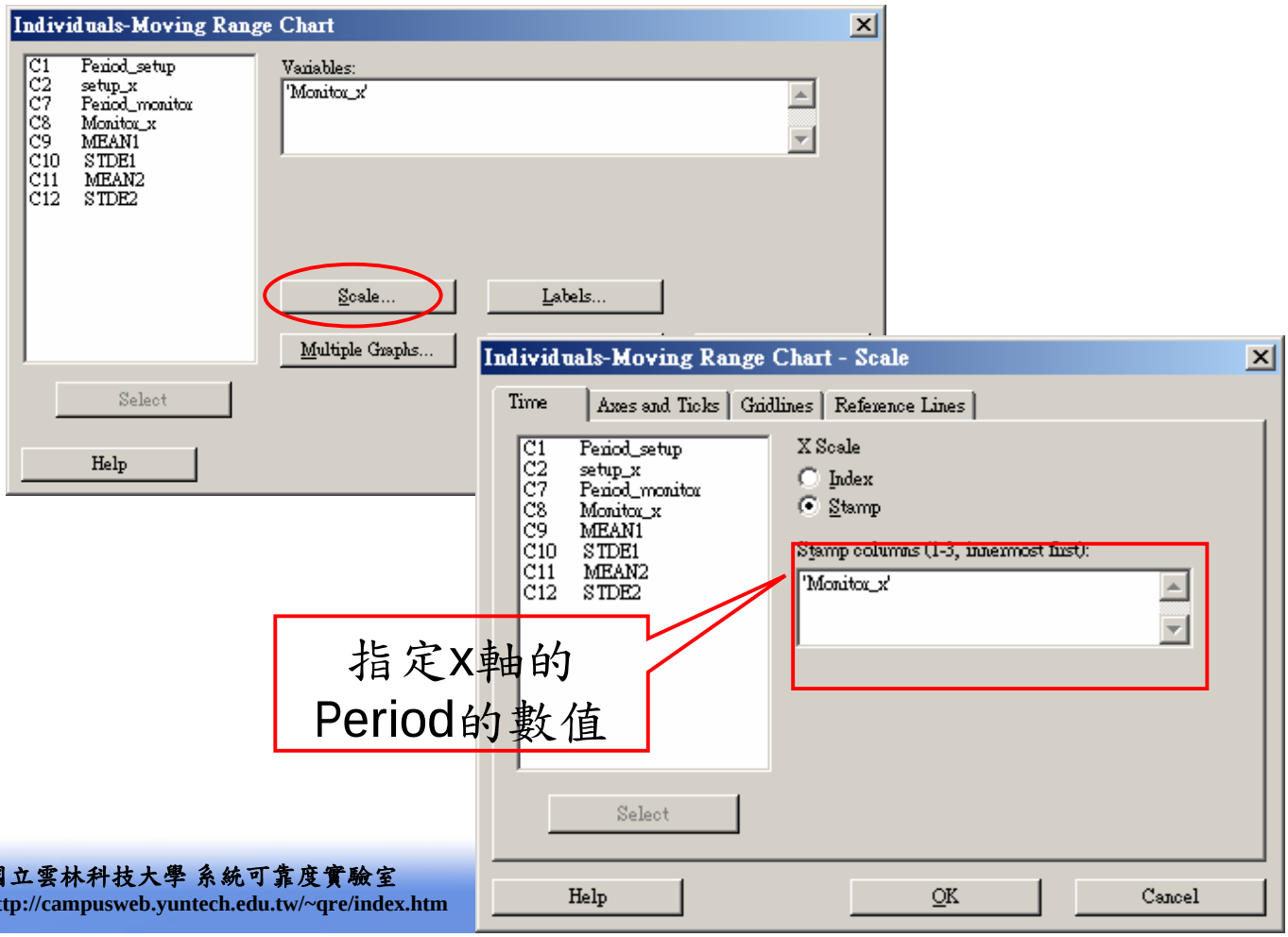
- Stat➔ Control Charts➔ Control Charts for Individuals ➔ I-MR...

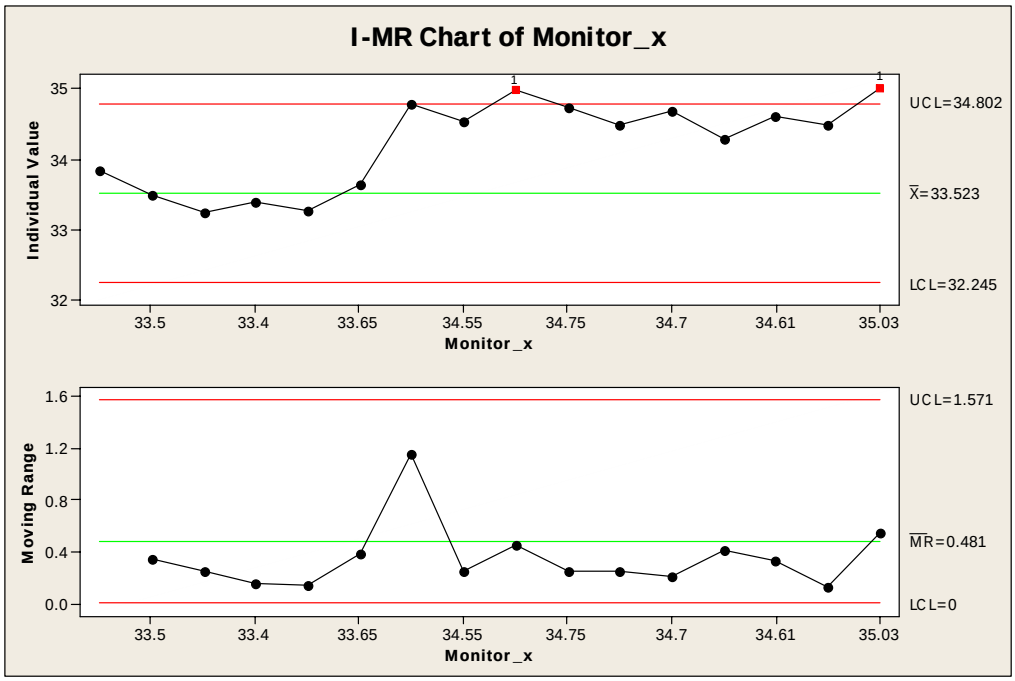


輸入先前得到的製程平均數和標準差



- 其他的設定維持不變





- 有兩點落在管制界限外，製程可能發生變異，需追查原因。

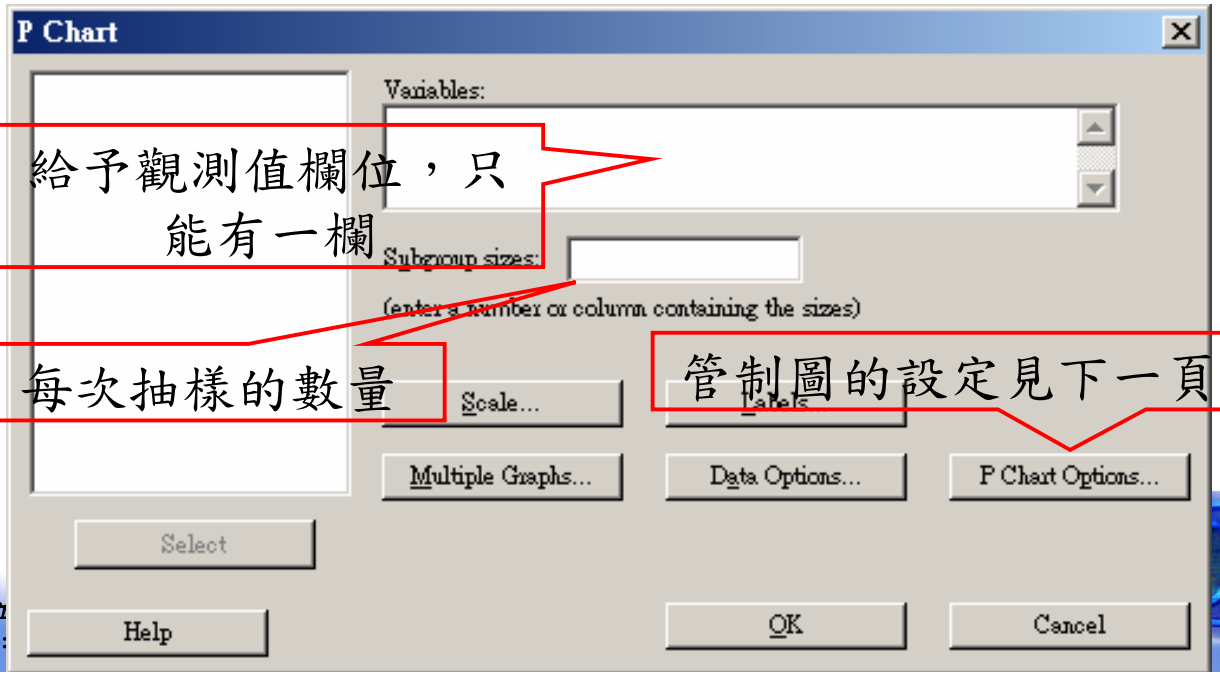
國立雲林科技大學 系統可靠度實驗室
http://campusweb.yuntech.edu.tw/~qre/index.htm

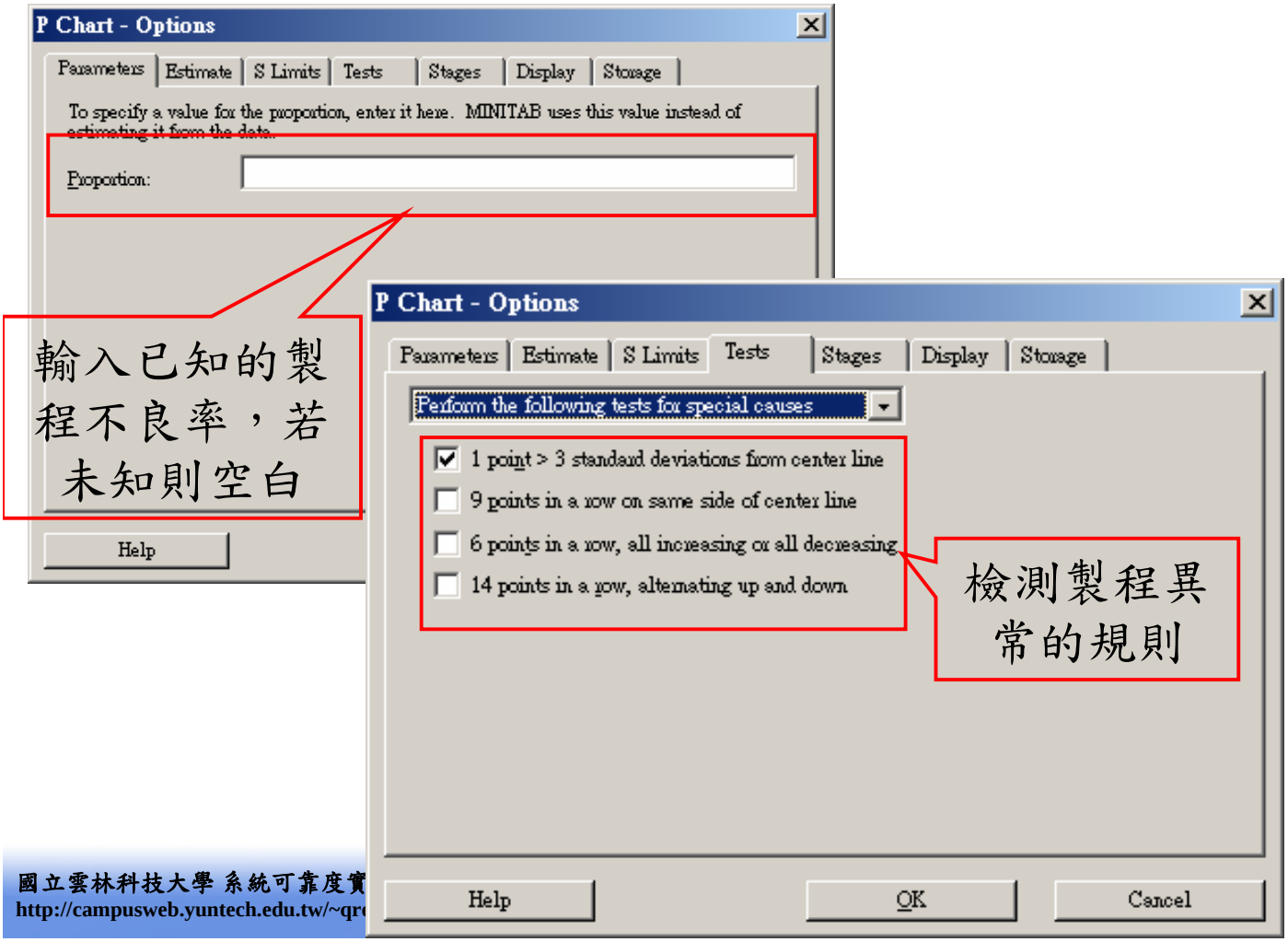
計數值修華特管制圖的種類

- 不合格率：P Chart；NP Chart
- 缺點數：C Chart；U Chart

繪製P Chart和NP Chart

- Stat➔ Control Charts➔ Attributes Charts ➔ P...
- Stat➔ Control Charts➔ Attributes Charts ➔ NP...
- 兩者畫面一樣





繪製P Chart 實例 (Ex. 4)

- 以Period 1~30數據設置P Chart，以Period 31~54數據監控製程。

PS：每次抽樣數為50

Period	D	Period	D
1	12	16	8
2	15	17	10
3	8	18	5
4	10	19	13
5	4	20	11
6	7	21	20
7	16	22	18
8	9	23	24
9	14	24	15
10	10	25	9
11	5	26	12
12	6	27	7
13	17	28	13
14	12	29	9
15	22	30	6

Period	D	Period	D
31	9	43	3
32	6	44	6
33	12	45	5
34	5	46	4
35	6	47	8
36	4	48	5
37	6	49	6
38	3	50	7
39	7	51	5
40	6	52	6
41	2	53	3
42	4	54	5

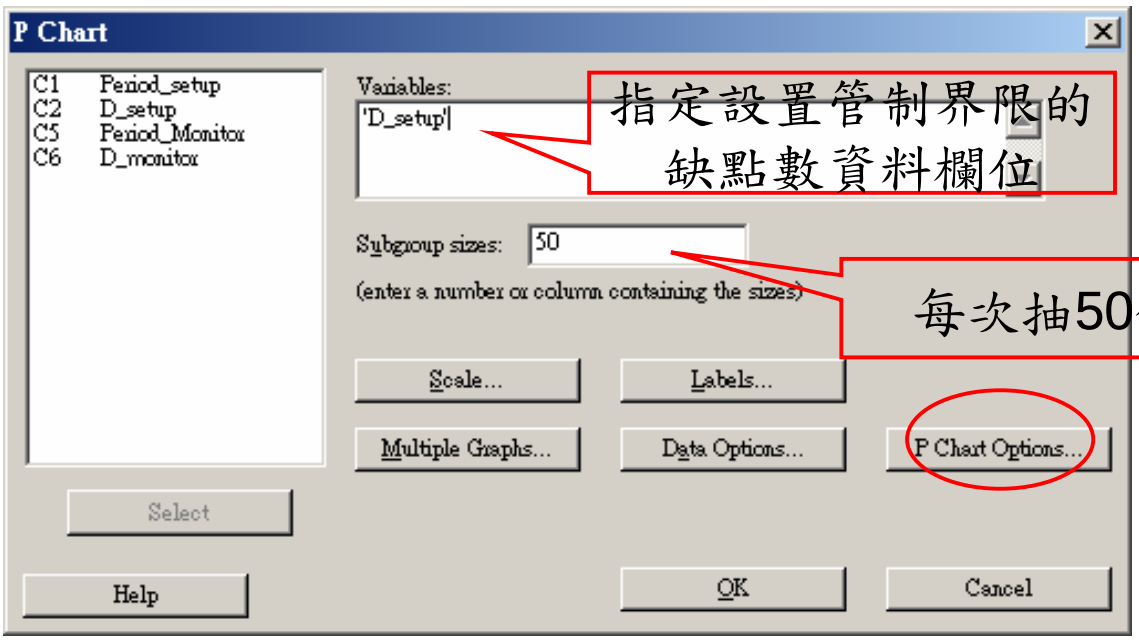
File Edit Data Calc Stat Graph Editor Tools Window Help

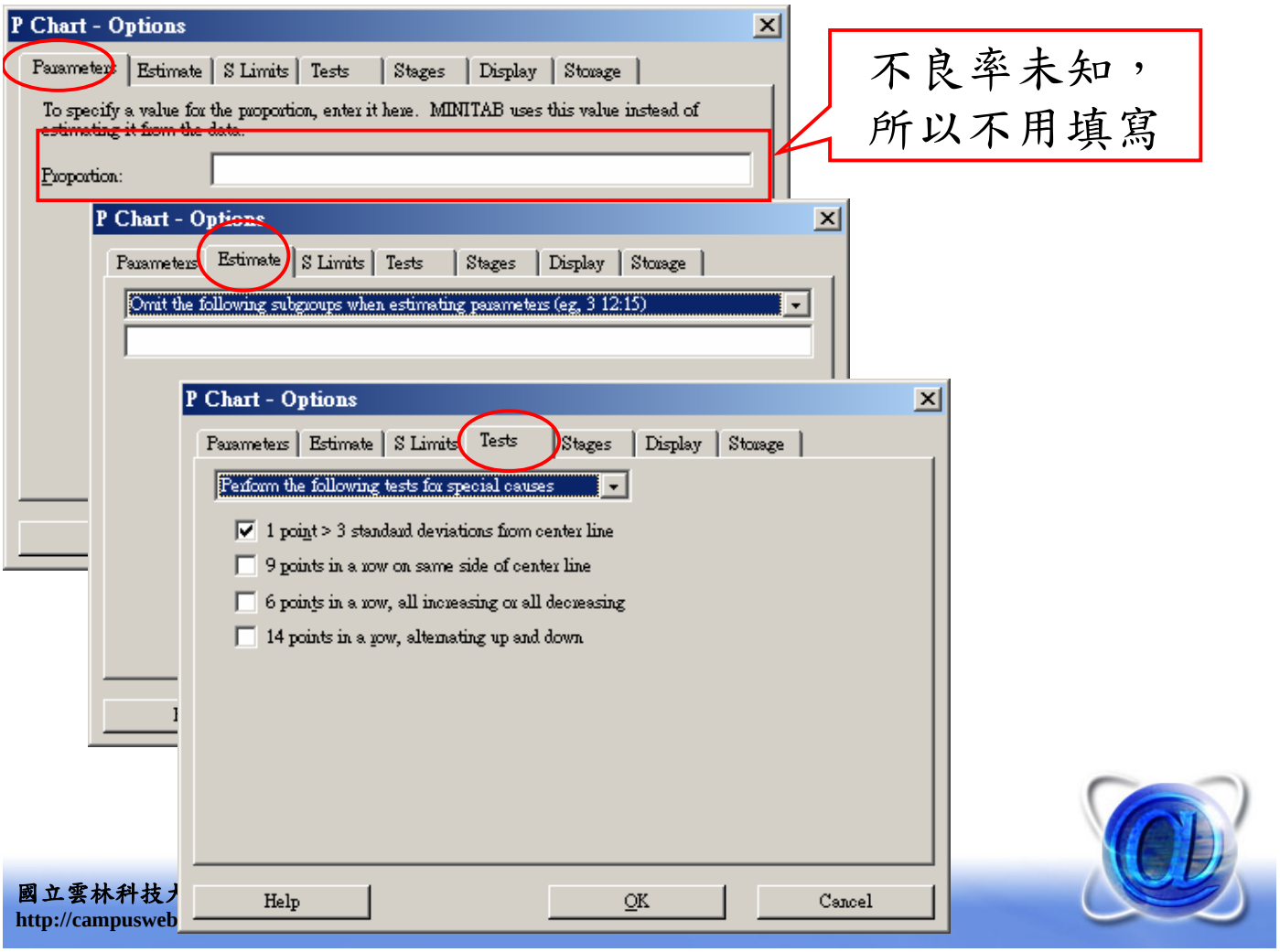
C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Period_setup	D_setup			Period_Monitor	D_monitor						
1	12			31	9						
2	15			32	6						
3	8			33	12						
4	10			34	5						
5	4			35	6						
6	7			36	4						
7	16			37	6						
8	9			38	3						
9	14			39	7						
10	10			40	6						
11	5			41	2						
12	6			42	4						
13	17			43	3						
14	12			44	6						
15	22			45	5						
16	8			46	4						
17	10			47	8						
18	5			48	5						
19	13			49	6						
20	11			50	7						
21	20			51	5						
22	18			52	6						
23	24			53	3						
24	15			54	5						
25	9										
26	12										
27	7										

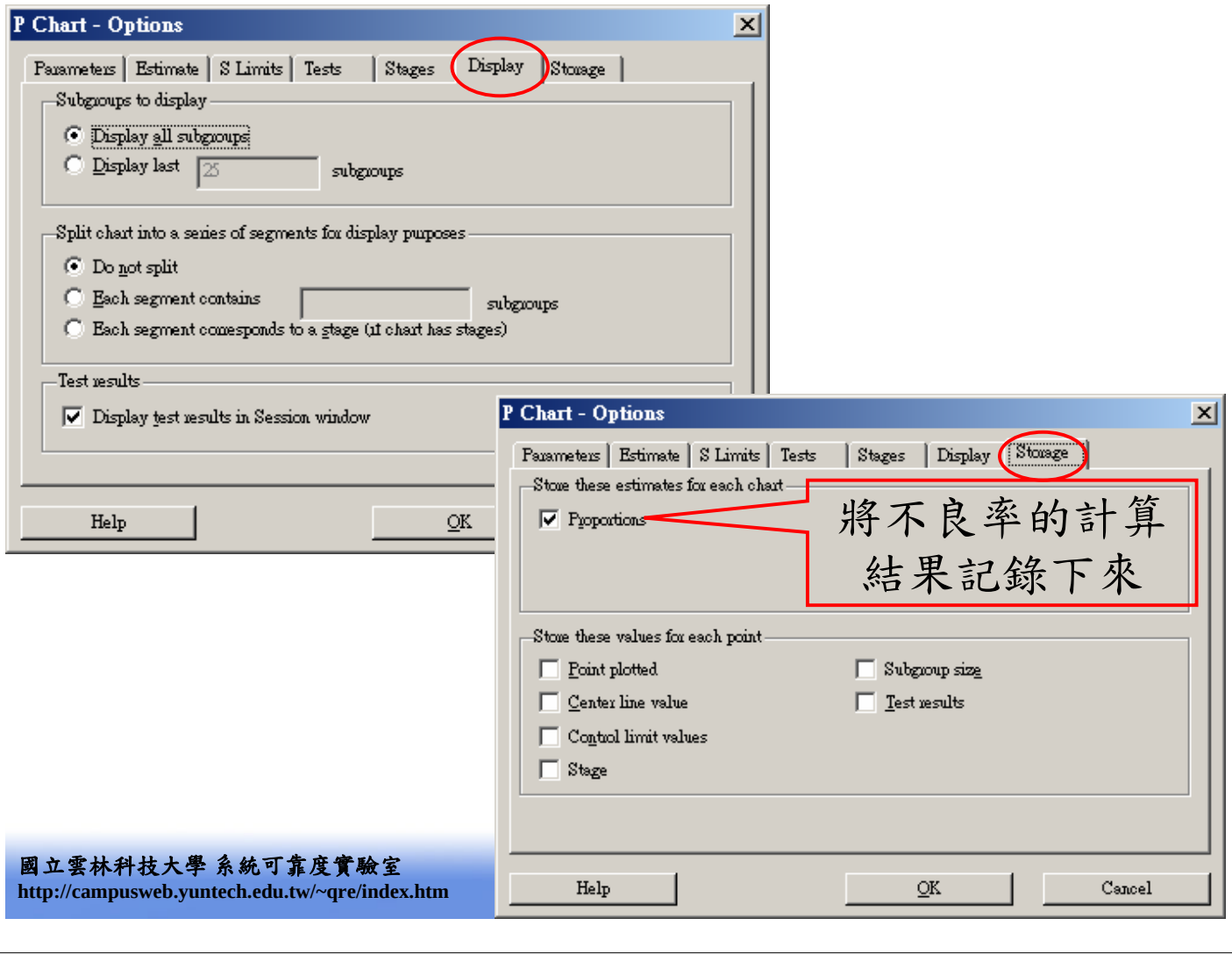
t Worksheet: Worksheet 3

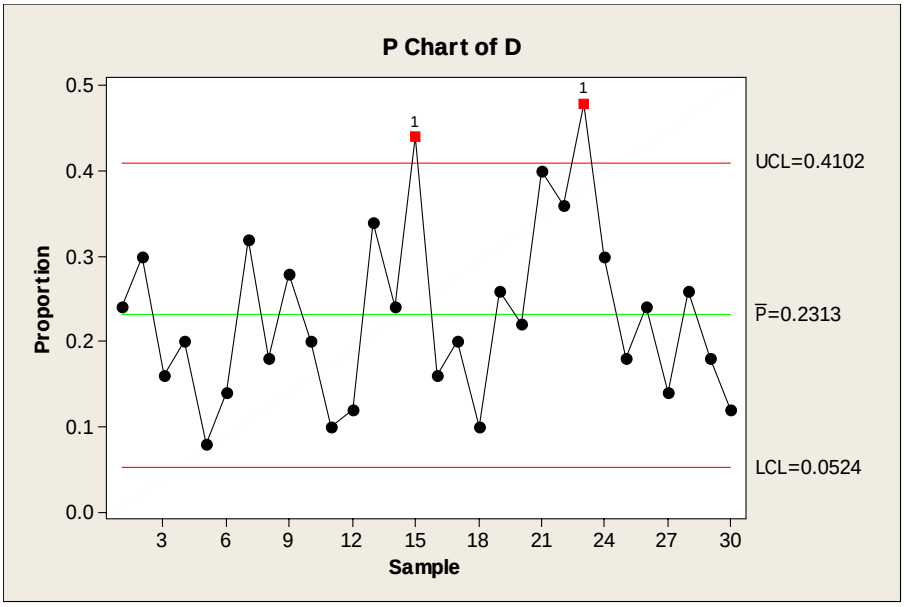
12:38 AM

- Stat➔ Control Charts➔ Attributes Charts ➔ P...




P Chart - Options
Parameters
Estimate
S Limits
Tests
Stages
Display
Storage
To specify a value for the proportion, enter it here. MINITAB uses this value instead of estimating it from the data.
Proportion:
不良率未知，
所以不用填寫
Omit the following subgroups when estimating parameters (eg, 3 12:15)
Perform the following tests for special causes
1 point > 3 standard deviations from center line
9 points in a row on same side of center line
6 points in a row, all increasing or all decreasing
14 points in a row, alternating up and down
Help
OK
Cancel

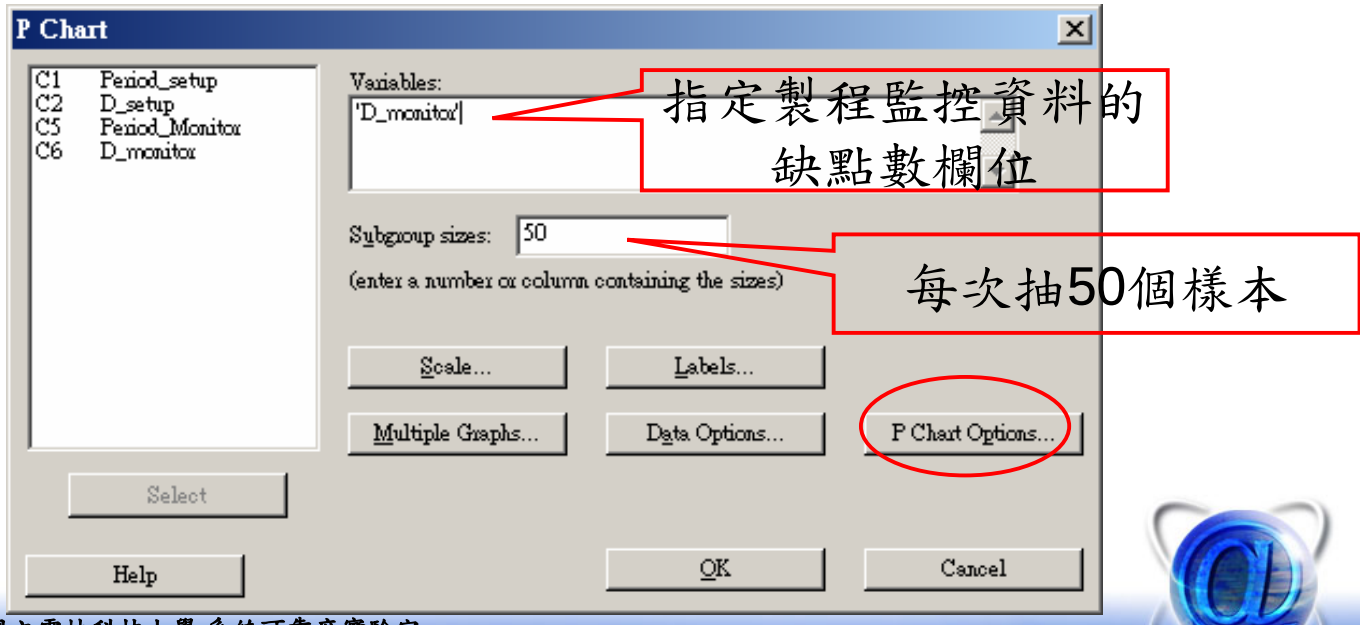

P Chart - Options
Parameters
Estimate
S Limits
Tests
Stages
Display
Storage
Subgroups to display
Display all subgroups
Display last
25
subgroups
Split chart into a series of segments for display purposes
Do not split
Each segment contains
subgroups
Each segment corresponds to a stage (if chart has stages)
Test results
Display test results in Session window
Help
OK
Store these estimates for each chart
Proportions
將不良率的計算
結果記錄下來
Store these values for each point
Point plotted
Center line value
Control limit values
Stage
Subgroup size
Test results
Cancel

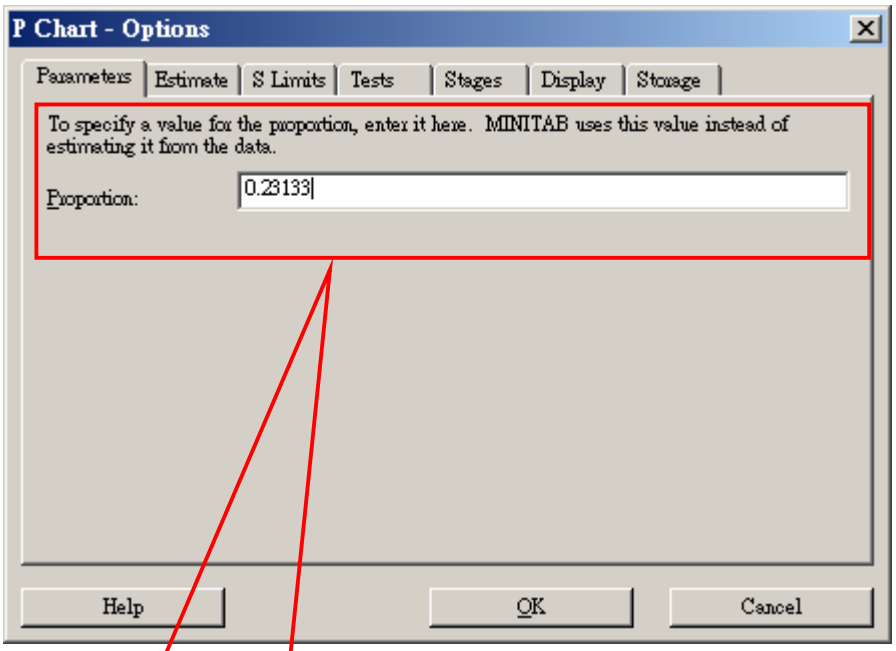


- 有兩個點落在管制界限外，追查原因後，發現是管制圖誤判，所以保留兩筆數據。

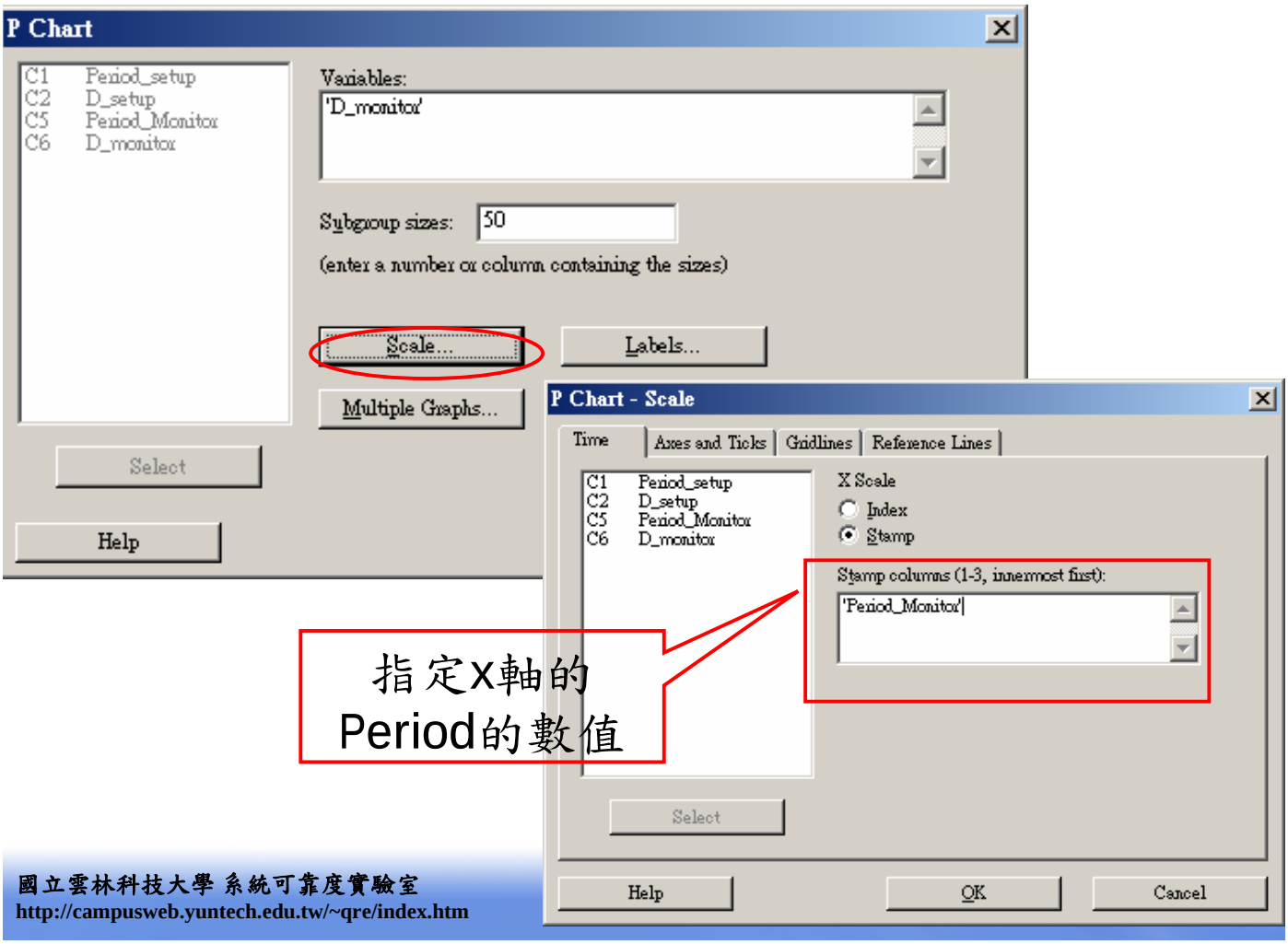
$$\overline{P} = 0.231333$$

- Stat➔ Control Charts➔ Attributes Charts ➔ P...

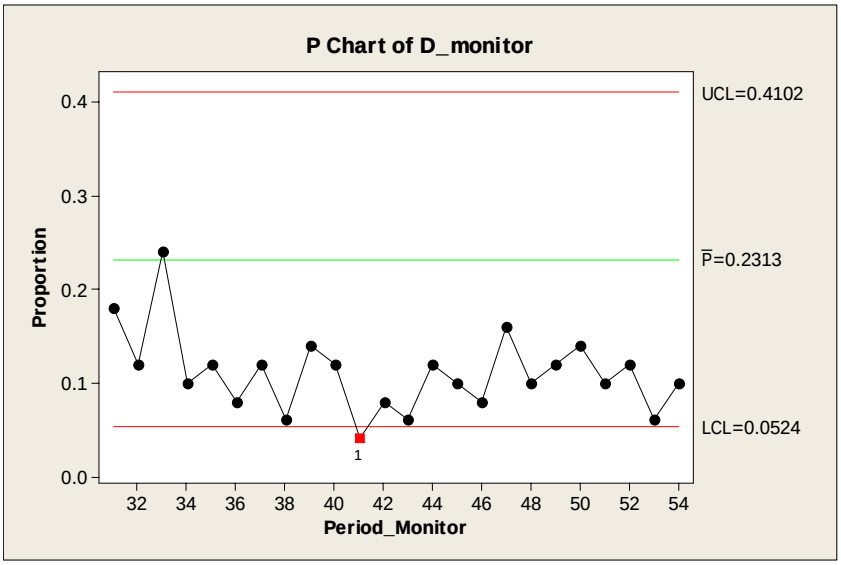




輸入先前得到的不良率，其他的設定不變



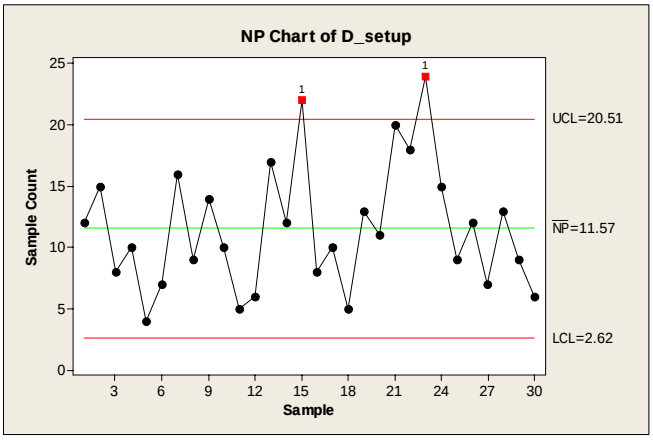
指定X軸的Period的數值



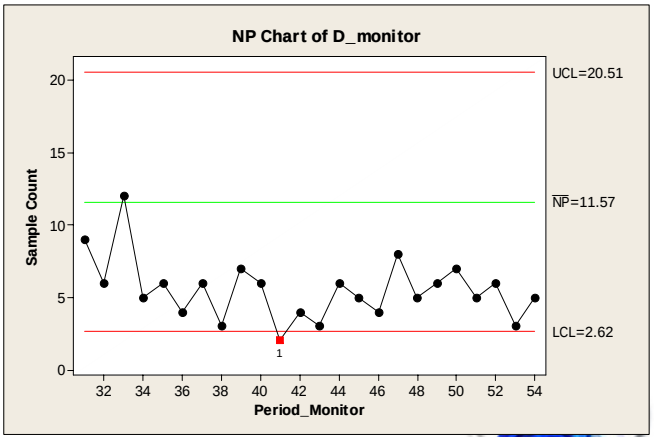
- 有一個點落在管制界限外，表示製程發生異常，需追查原因。

繪製NP Chart 實例 (Ex. 5)

- 以Ex. 4數據繪製NP Chart。
- Stat➔ Control Charts➔ Attributes Charts ➔ NP...
- 作法和設定方法如同P Chart



管制圖的設置



製程的監控

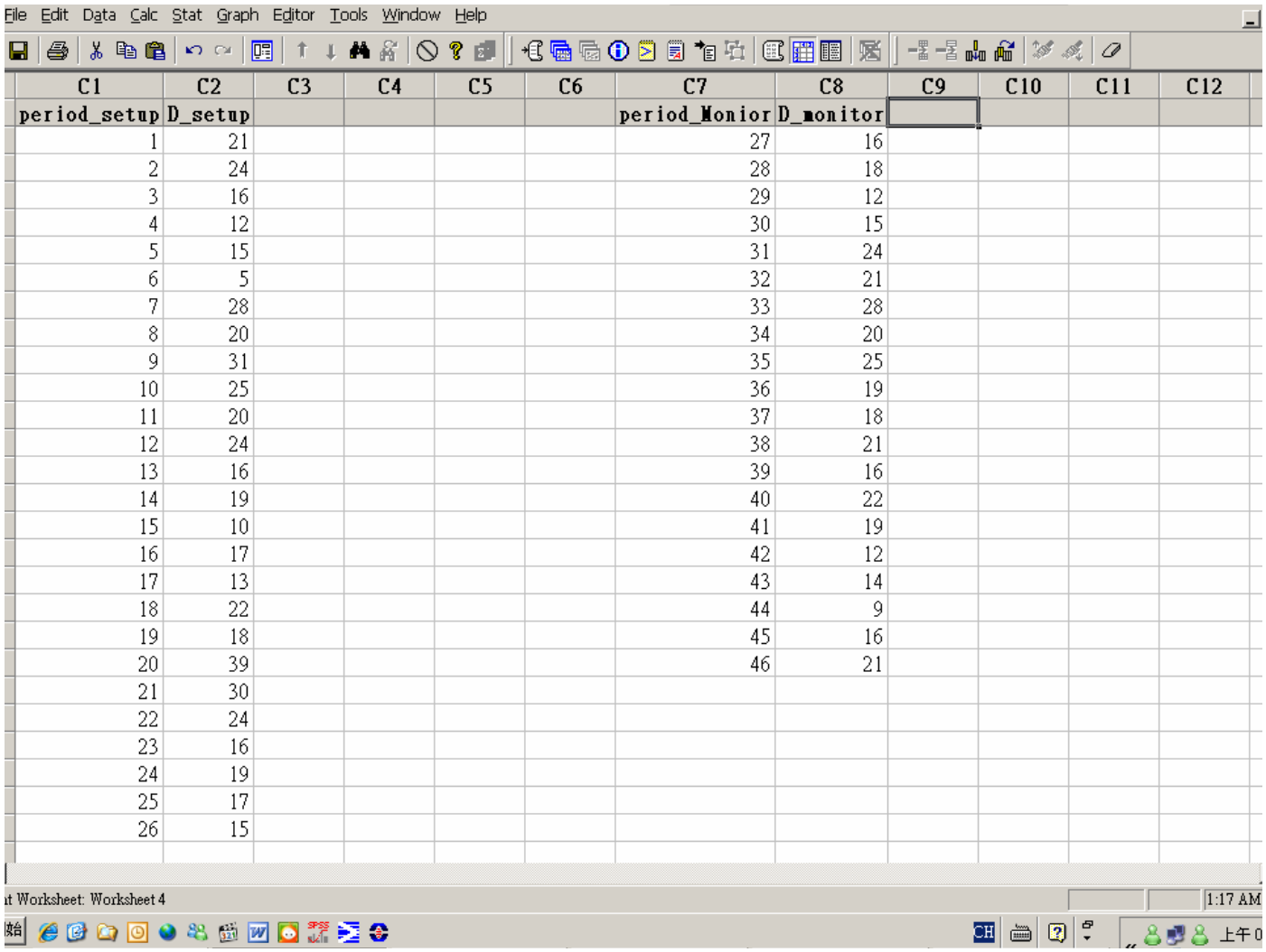
繪製C Chart 實例 (Ex. 6)

- 以Period 1~25數據設置C Chart，以Period 26~46數據監控製程。

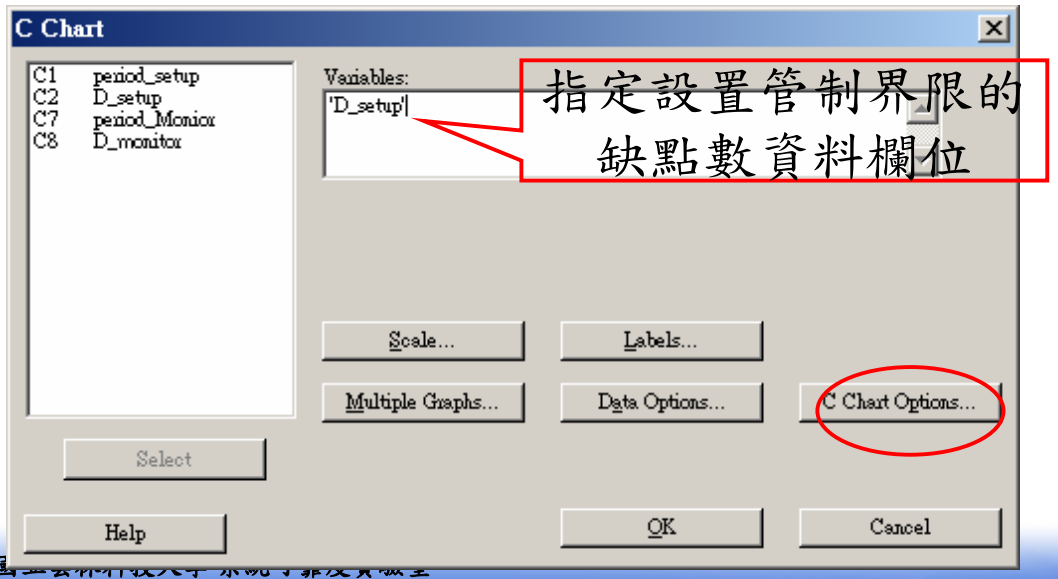
PS：每次抽樣數為100

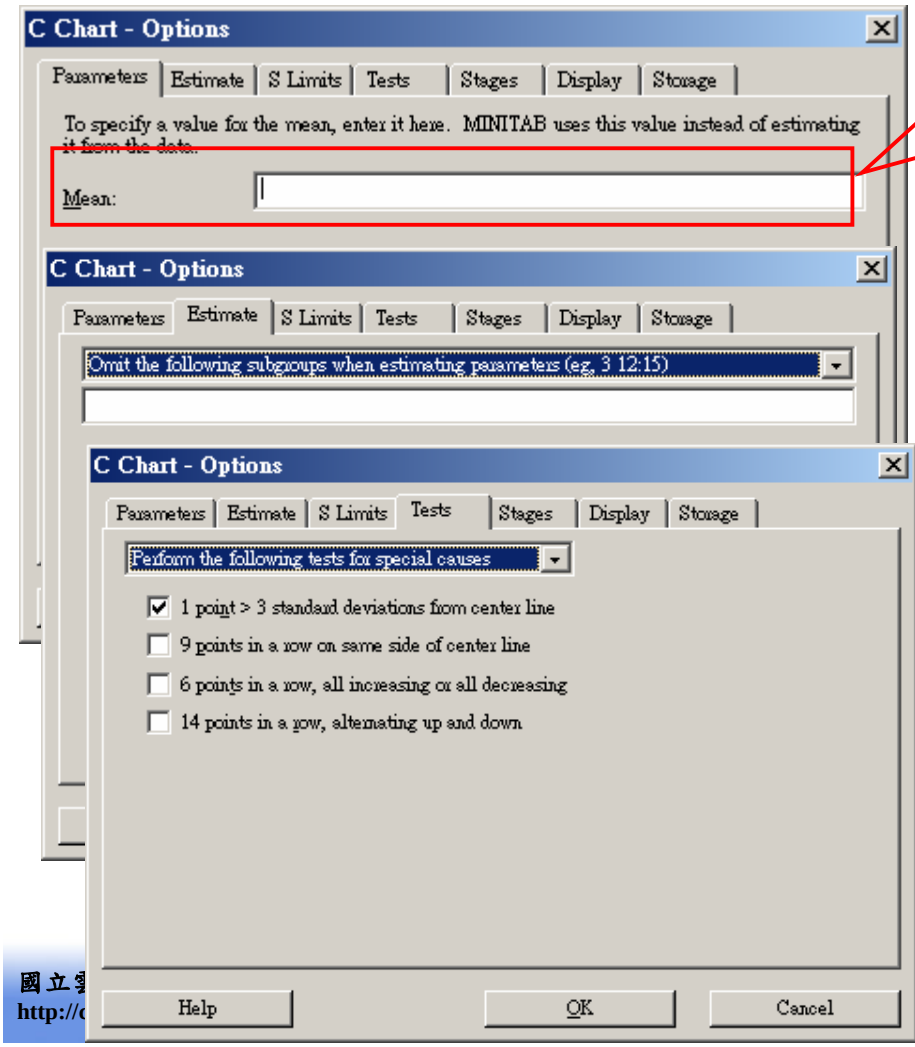
period	C	period	C
1	21	14	19
2	24	15	10
3	16	16	17
4	12	17	13
5	15	18	22
6	5	19	18
7	28	20	39
8	20	21	30
9	31	22	24
10	25	23	16
11	20	24	19
12	24	25	17

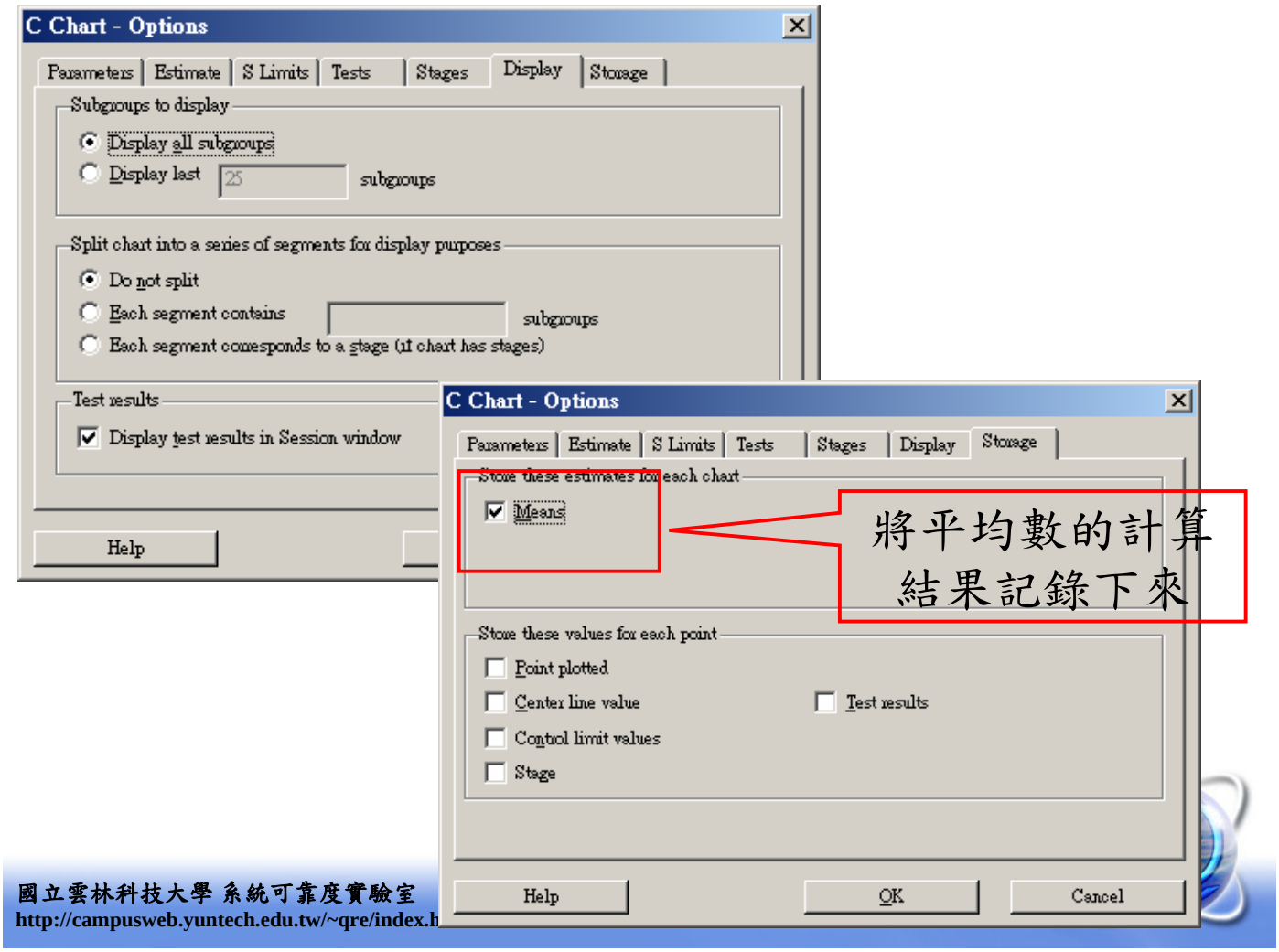
Period	C	Period	C
27	16	37	18
28	18	38	21
29	12	39	16
30	15	40	22
31	24	41	19
32	21	42	12
33	28	43	14
34	20	44	9
35	25	45	16
36	19	46	21

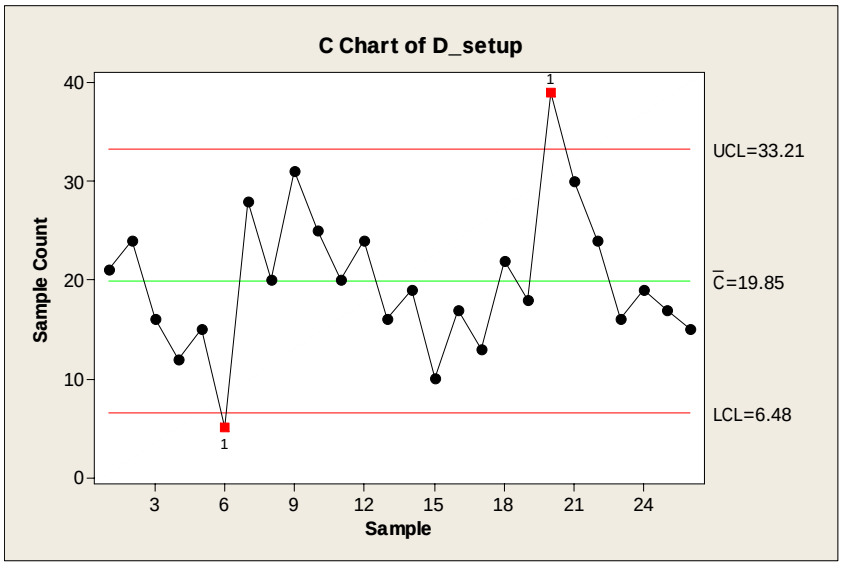


- Stat➔ Control Charts➔ Attributes Charts ➔ C...





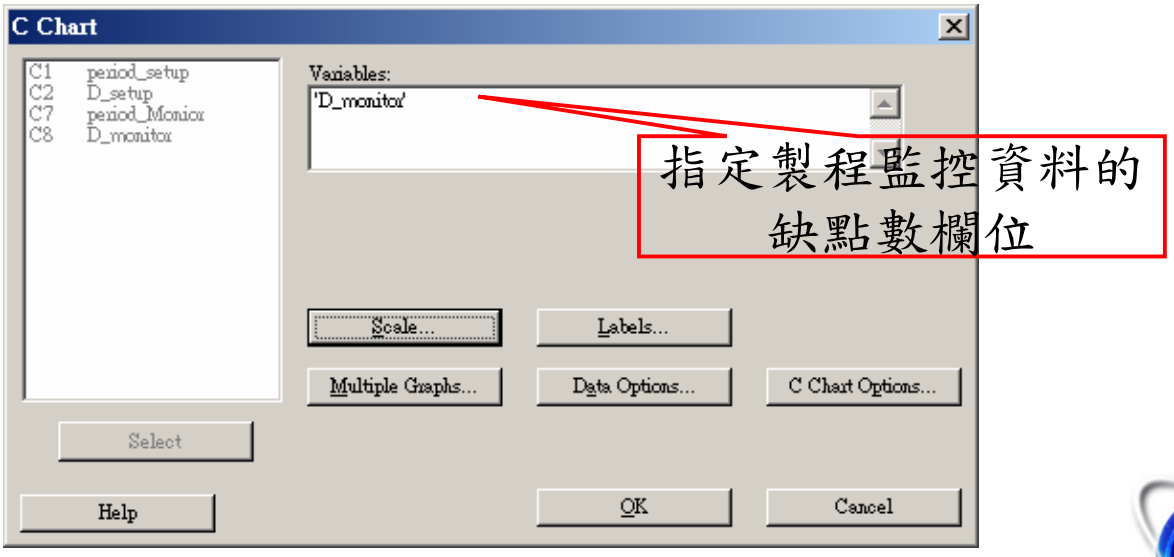


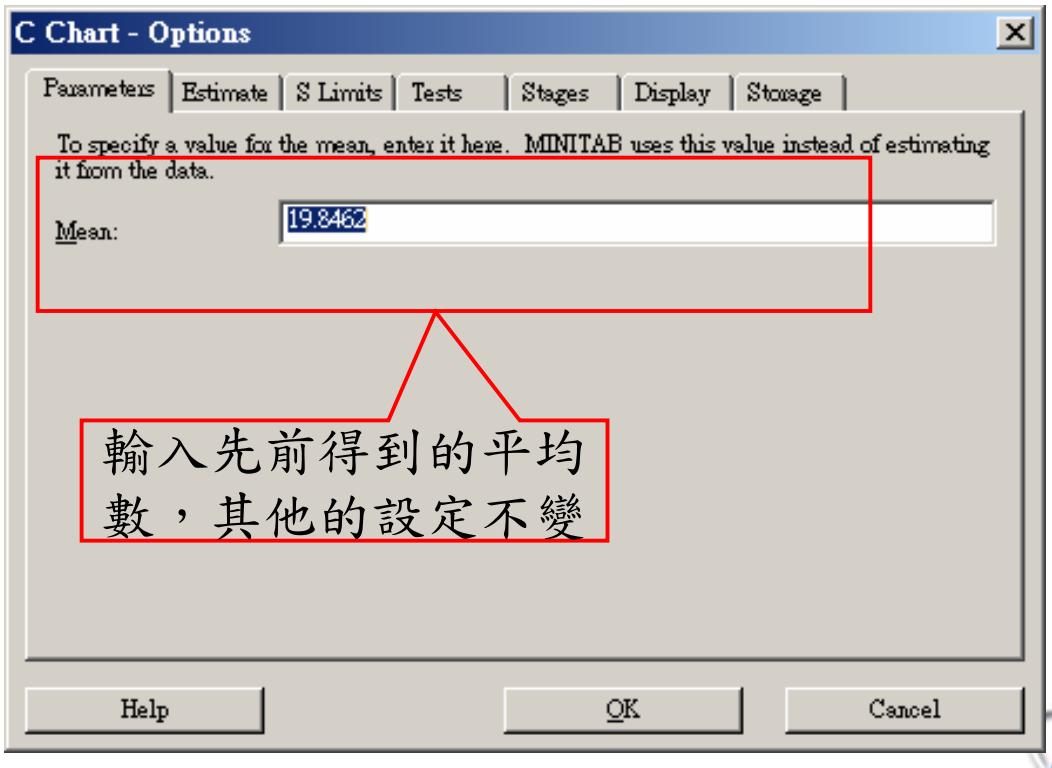


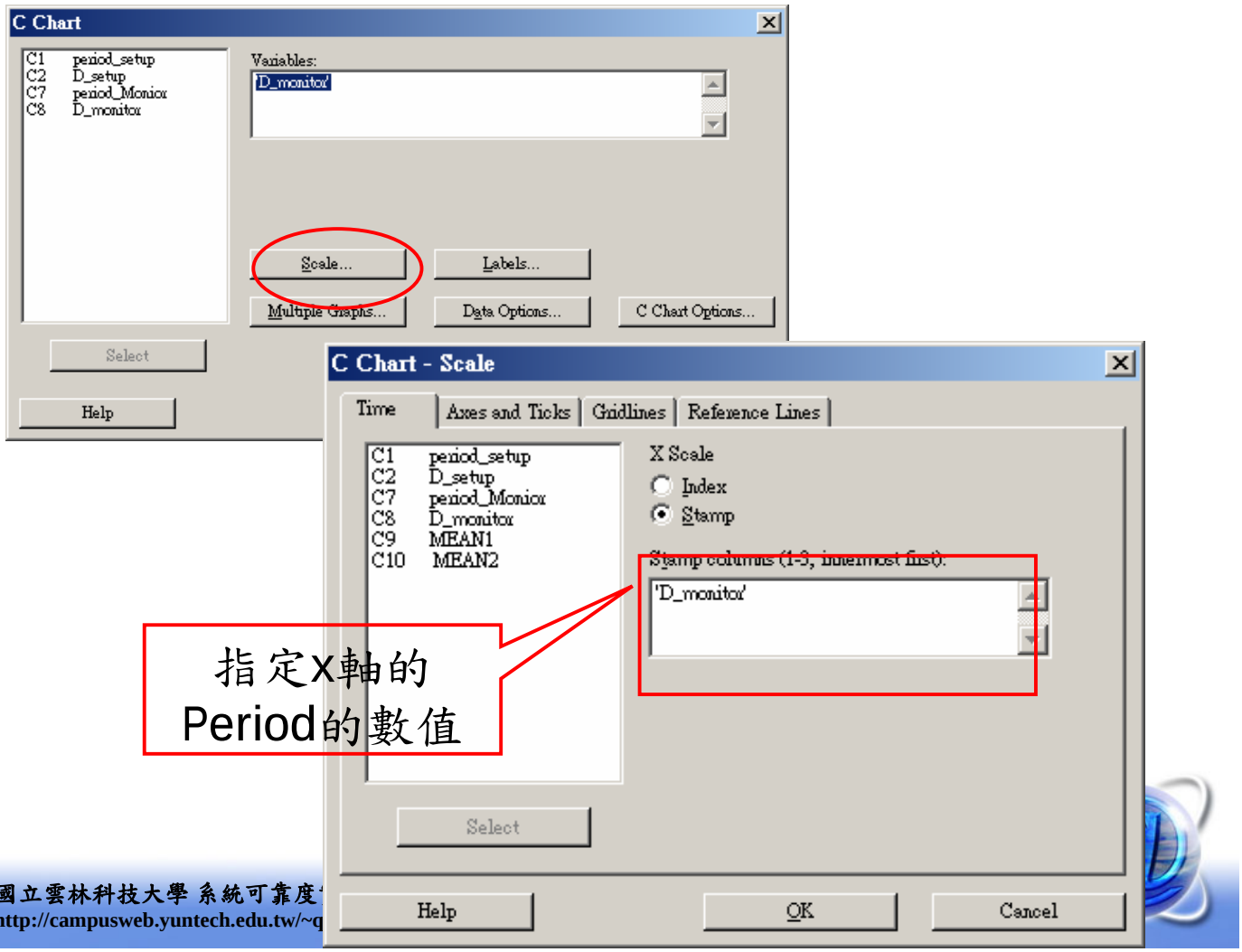
- 有兩個點落在管制界限外，追查原因後，發現是管制圖誤判，所以保留兩筆數據。

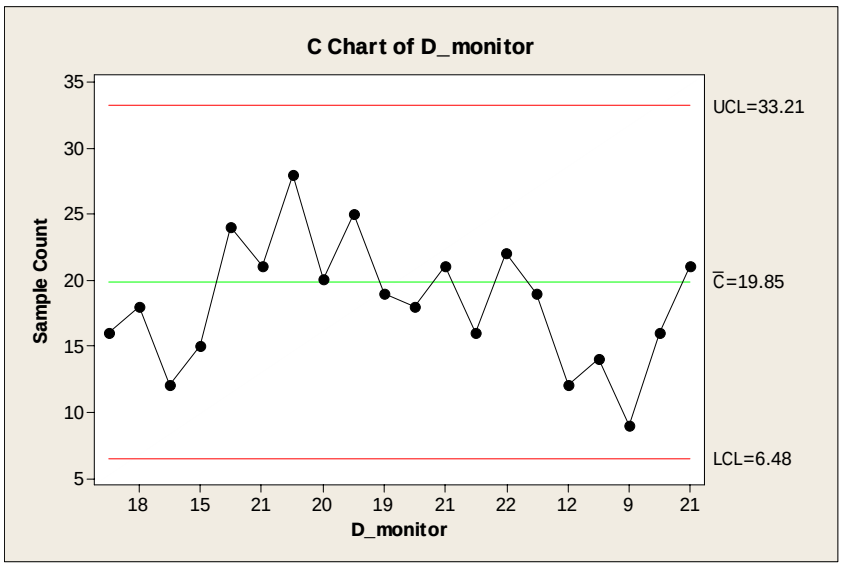
$$\overline{C} = 19.8462$$

- Stat➔ Control Charts➔ Attributes Charts ➔ C...









- 沒有點落在管制界限外，表示製程正常

繪製U Chart 實例 (Ex. 7)

- 以Period 1~10數據設置

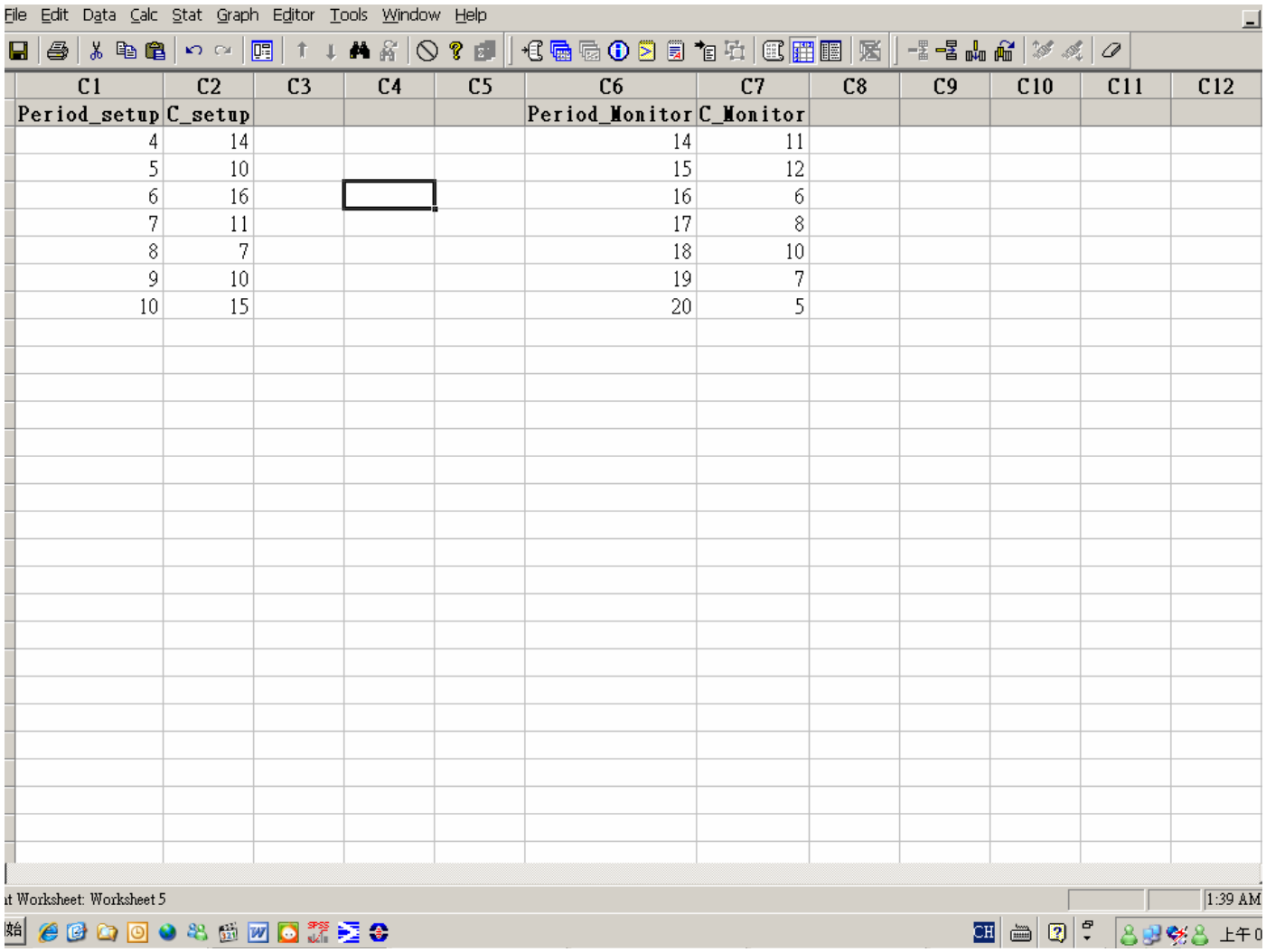
U Chart，以Period 11~20

數據監控製程。

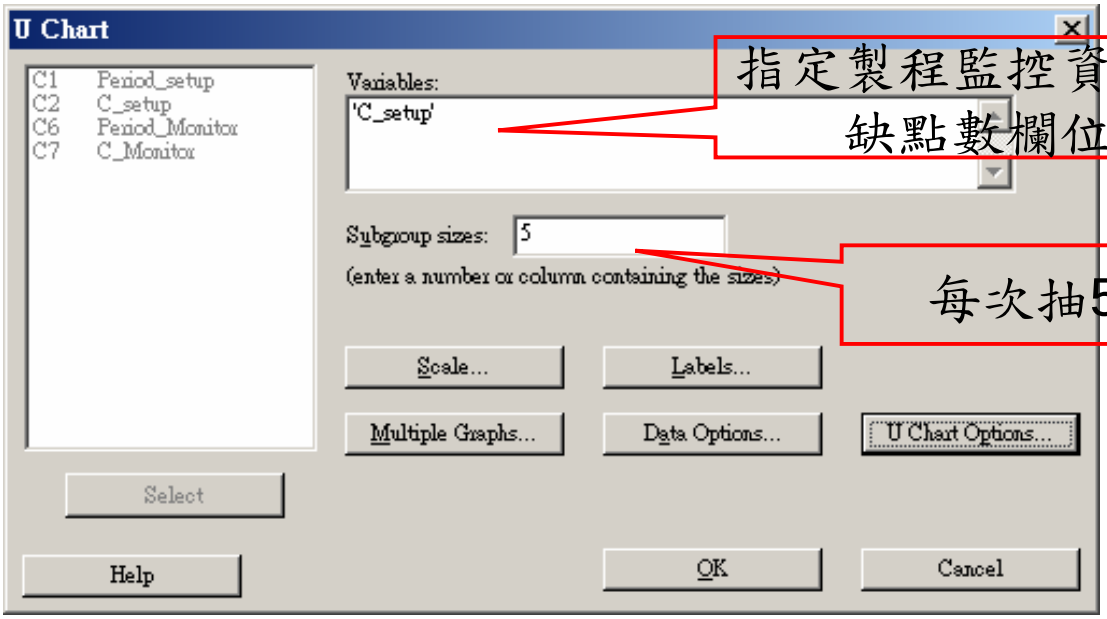
PS：每次抽樣數為5

Period_setup	C_setup
1	10
2	12
3	8
4	14
5	10
6	16
7	11
8	7
9	10
10	15

Period_Monitor	C_Monitor
11	9
12	5
13	7
14	11
15	12
16	6
17	8
18	10
19	7
20	5

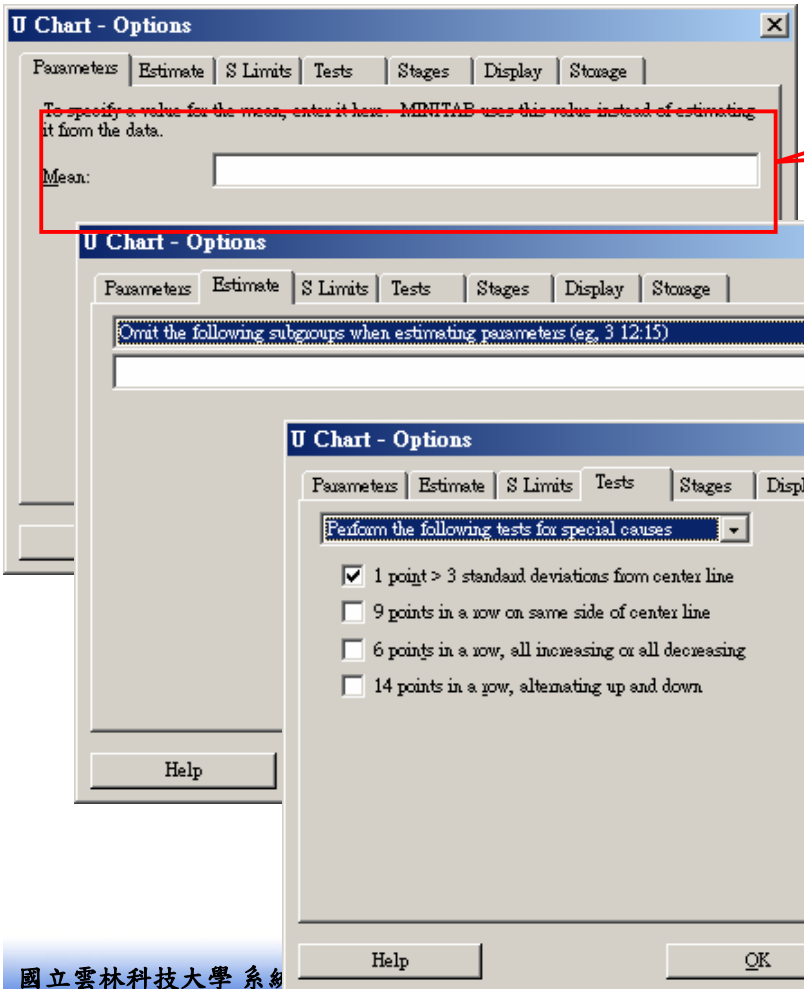


- Stat➔ Control Charts➔ Attributes Charts ➔ U...

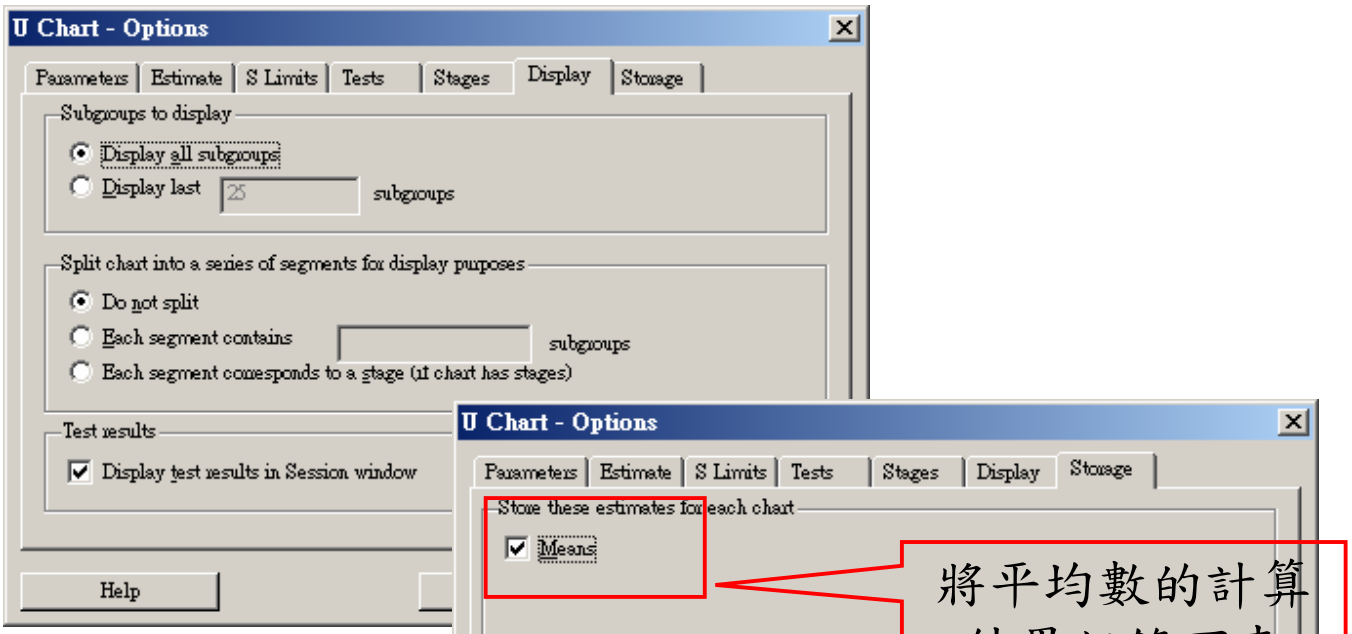


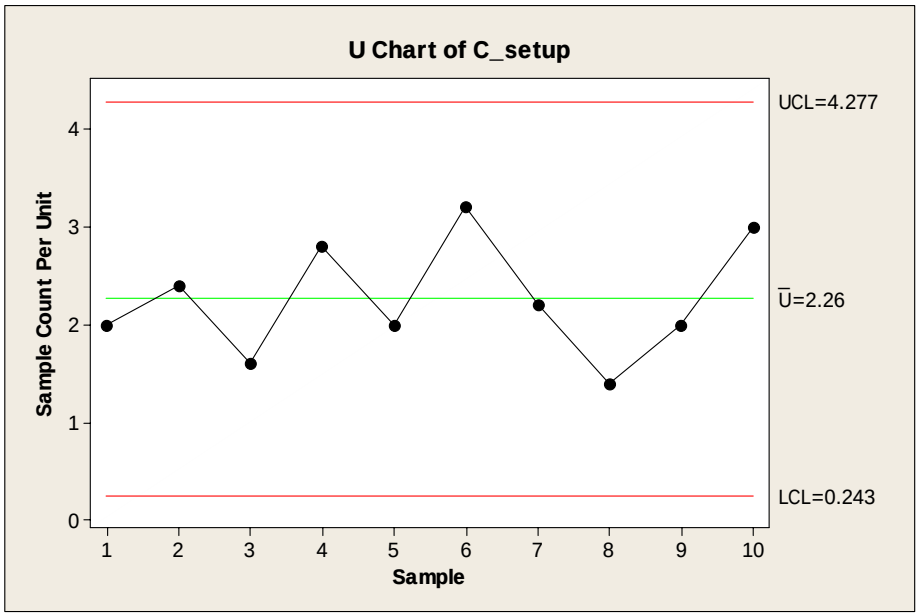
指定製程監控資料的缺點數欄位

每次抽5個樣本



平均數未知，所以不用填寫

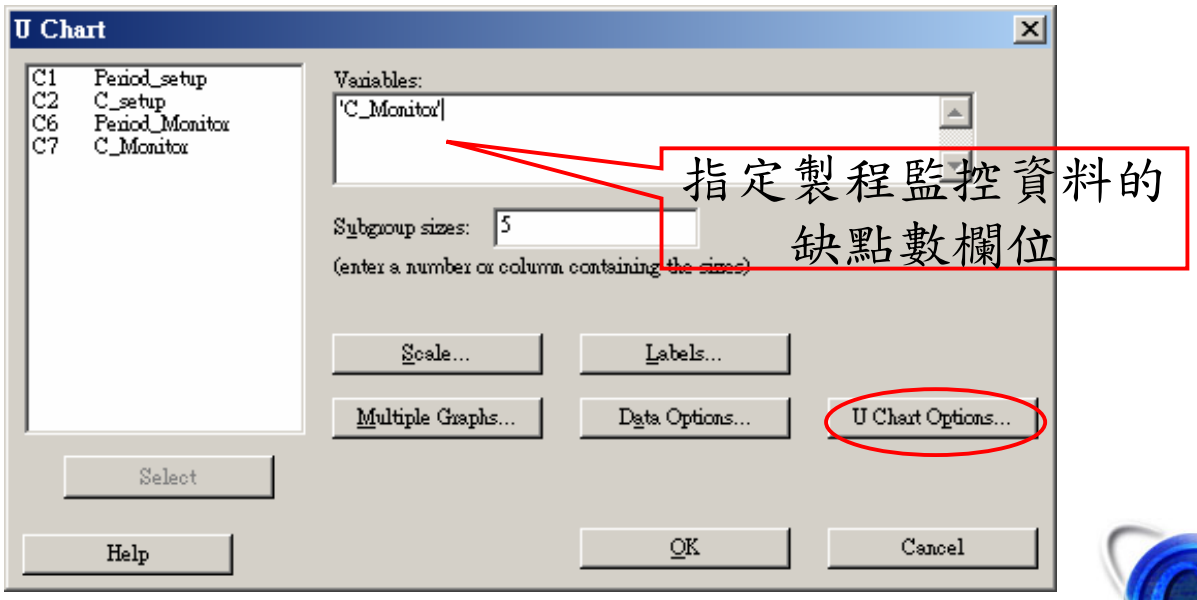


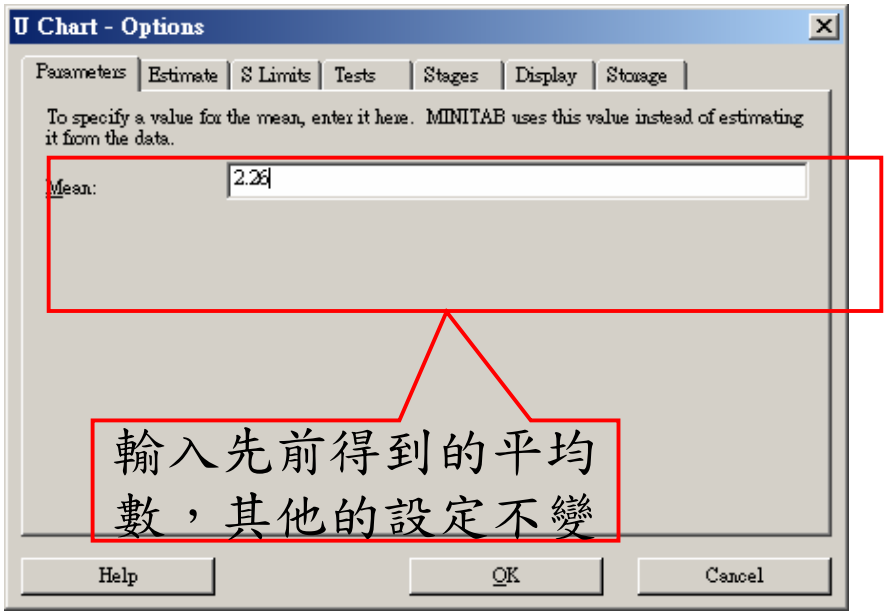


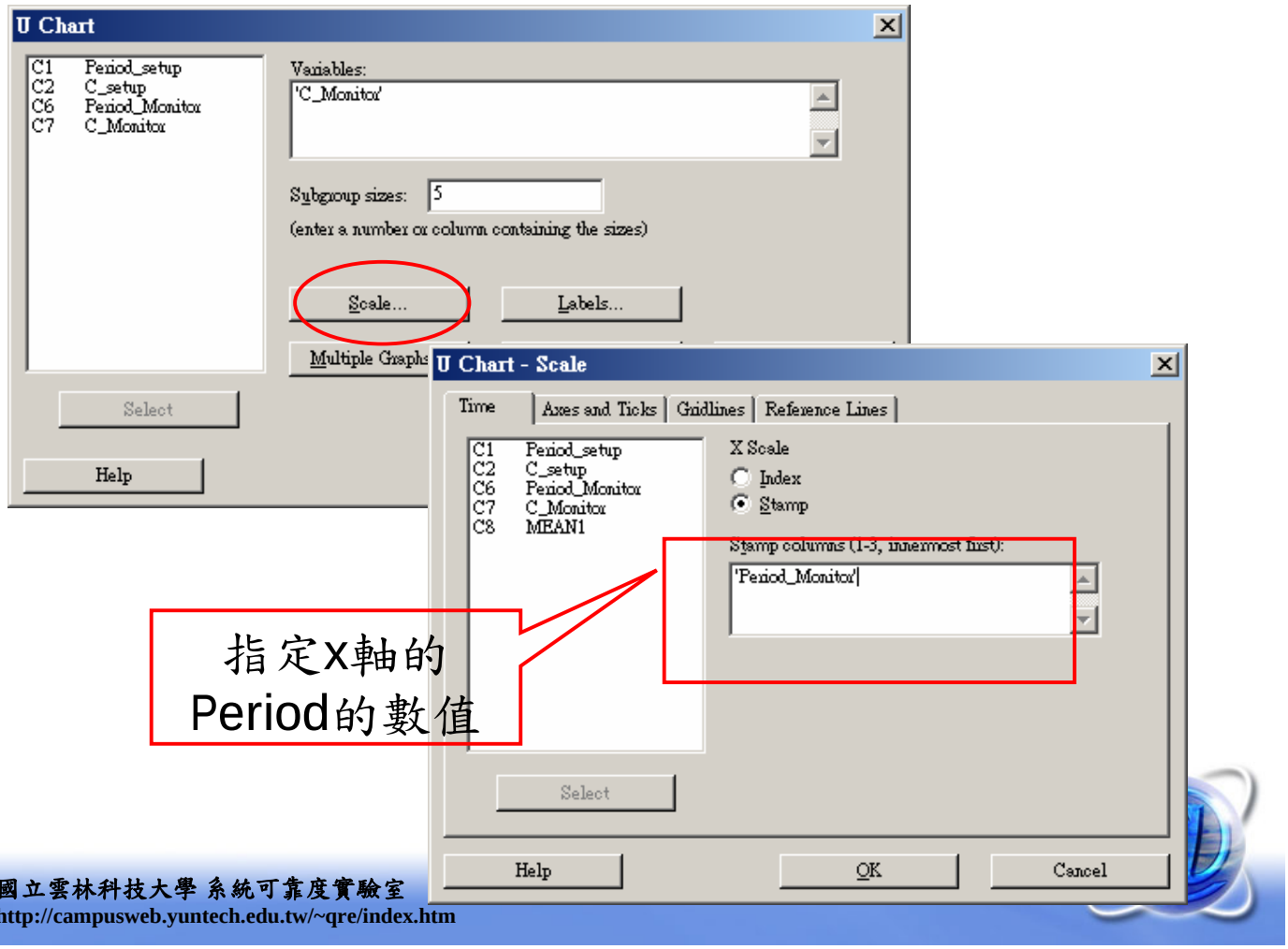
沒有點落在管制界限外

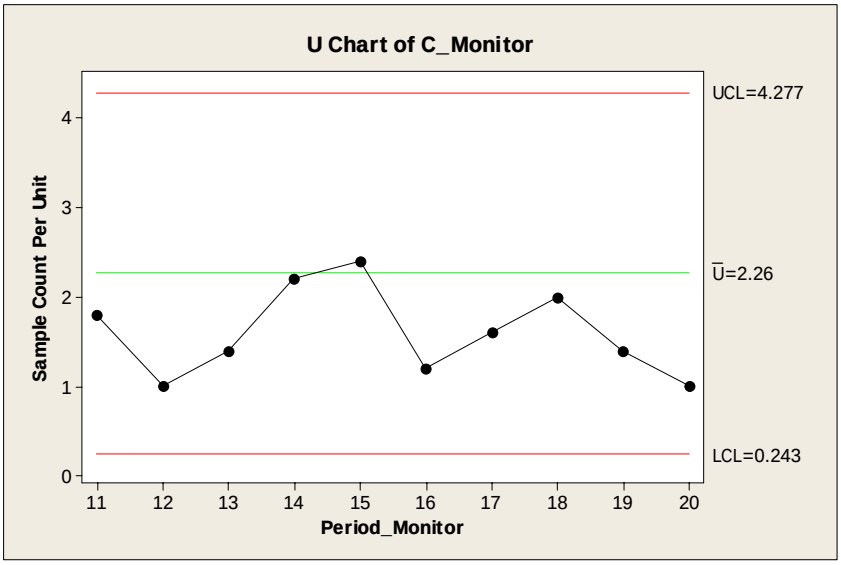
$$\overline{U} = 2.26$$

- Stat➔ Control Charts➔ Attributes Charts ➔ U...









- 沒有點落在管制界限外，表示製程正常

系統可靠度實驗室

國立雲林科技大學 工業工程與管理所

The End

Thank you

http://campusweb.yuntech.edu.tw/~qre/index.htm