變異知識與統計製程管制

Knowledge of Variation
&
Statistical Process Control

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The Global Voice of Quality™

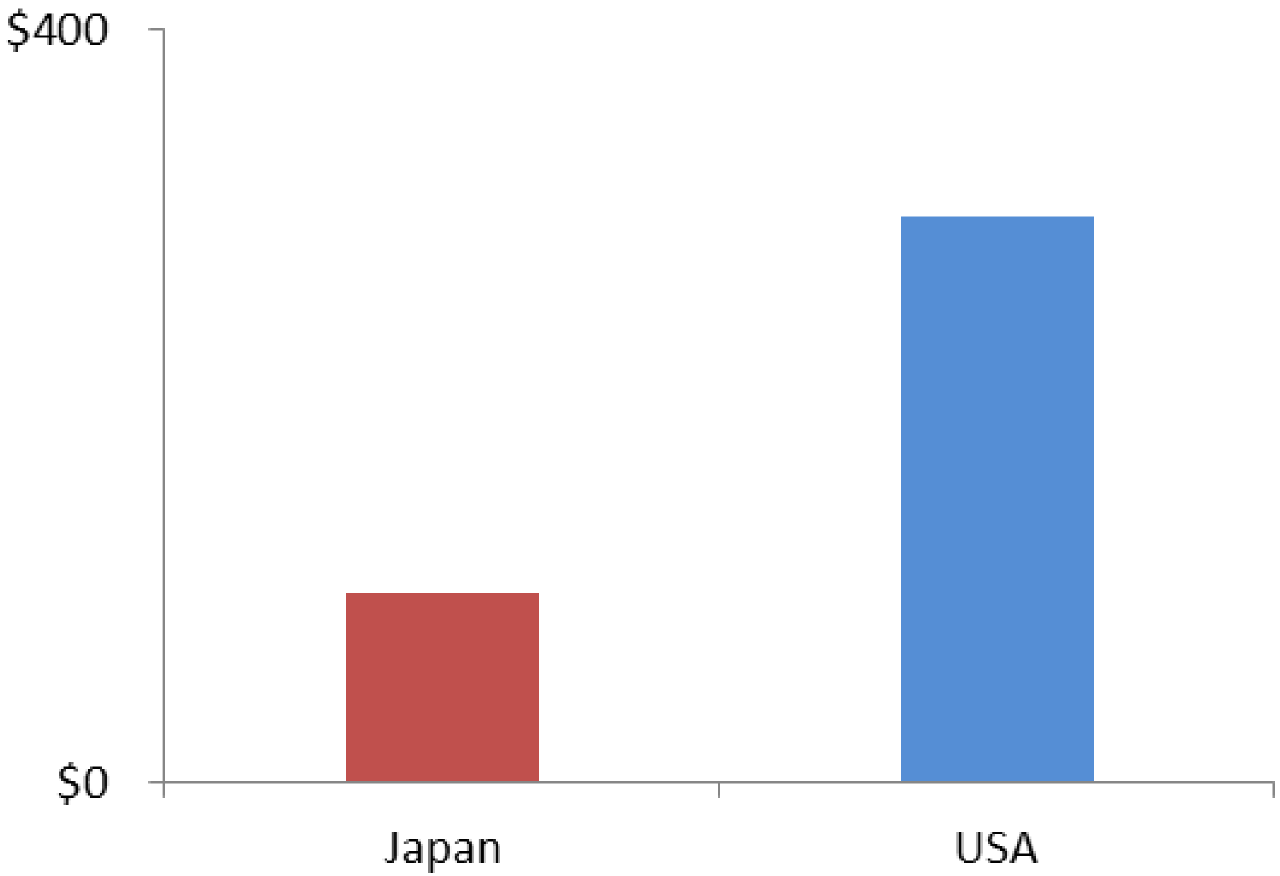
Teams課程注意事項

- 請隨自己的生活步調進出教室, **不需特別留言**說要離開或加入
- 若有聽不懂或者覺得太快時,**可使用舉手功能隨時打斷課程沒關係** 大家聽懂最重要
- 課程中請大家保持關閉麥克風、關閉視訊
- 課程約歷時2hrs, 沒能上到課或中途離開的人之後還有機會, 不用緊張

保持愉快的心情 課程正式開始

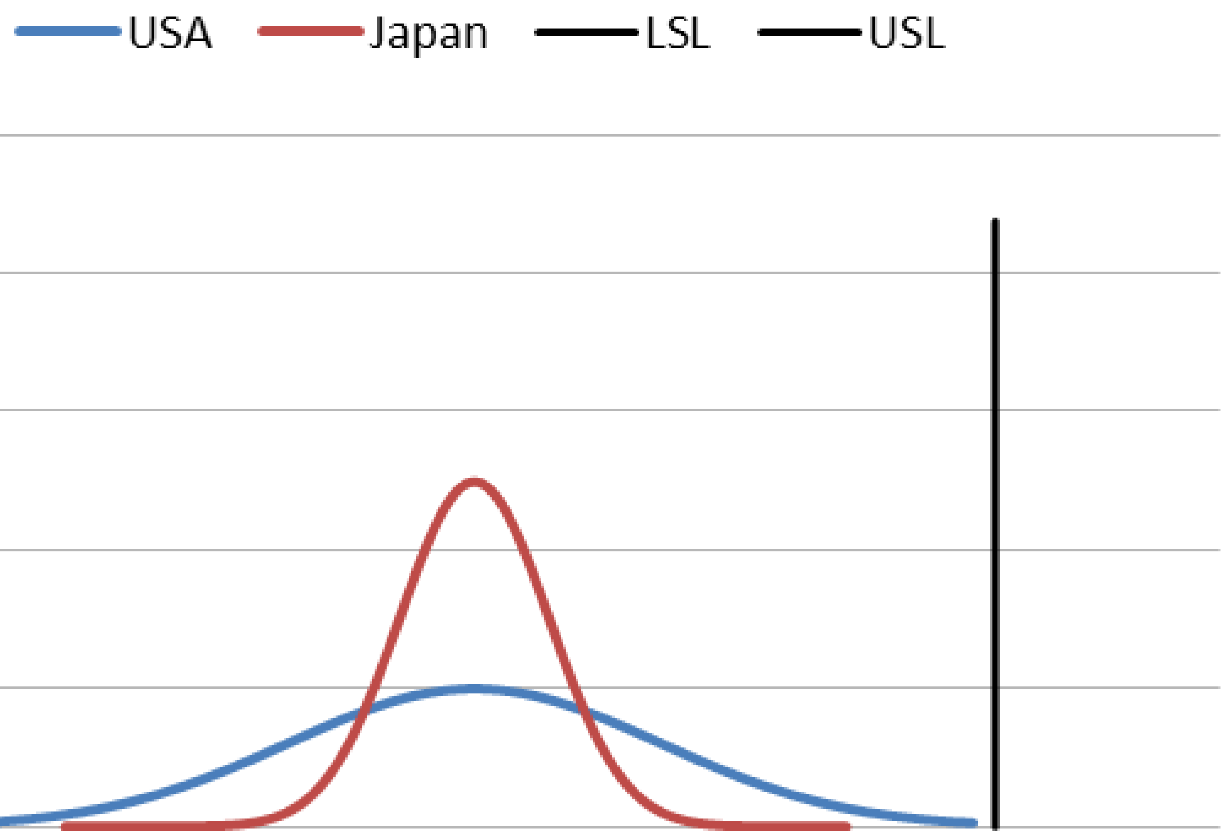
What is Quality ?

- 70年代日本與美國的競爭



What is Quality ?

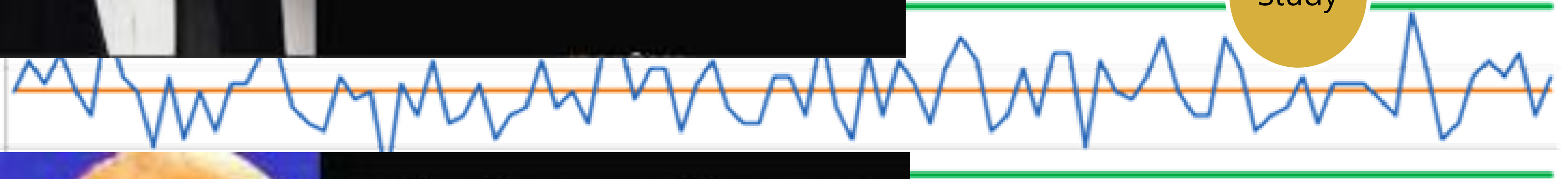
- 70年代日本與美國的競爭

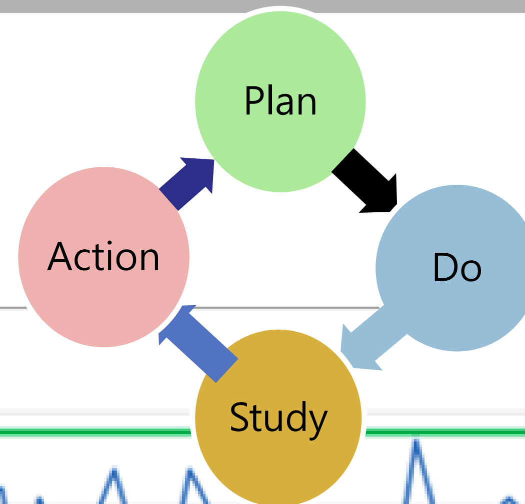


What is Quality ?

蕭華特Joseph.Shewart

1891~1967





戴明Edward.Deming

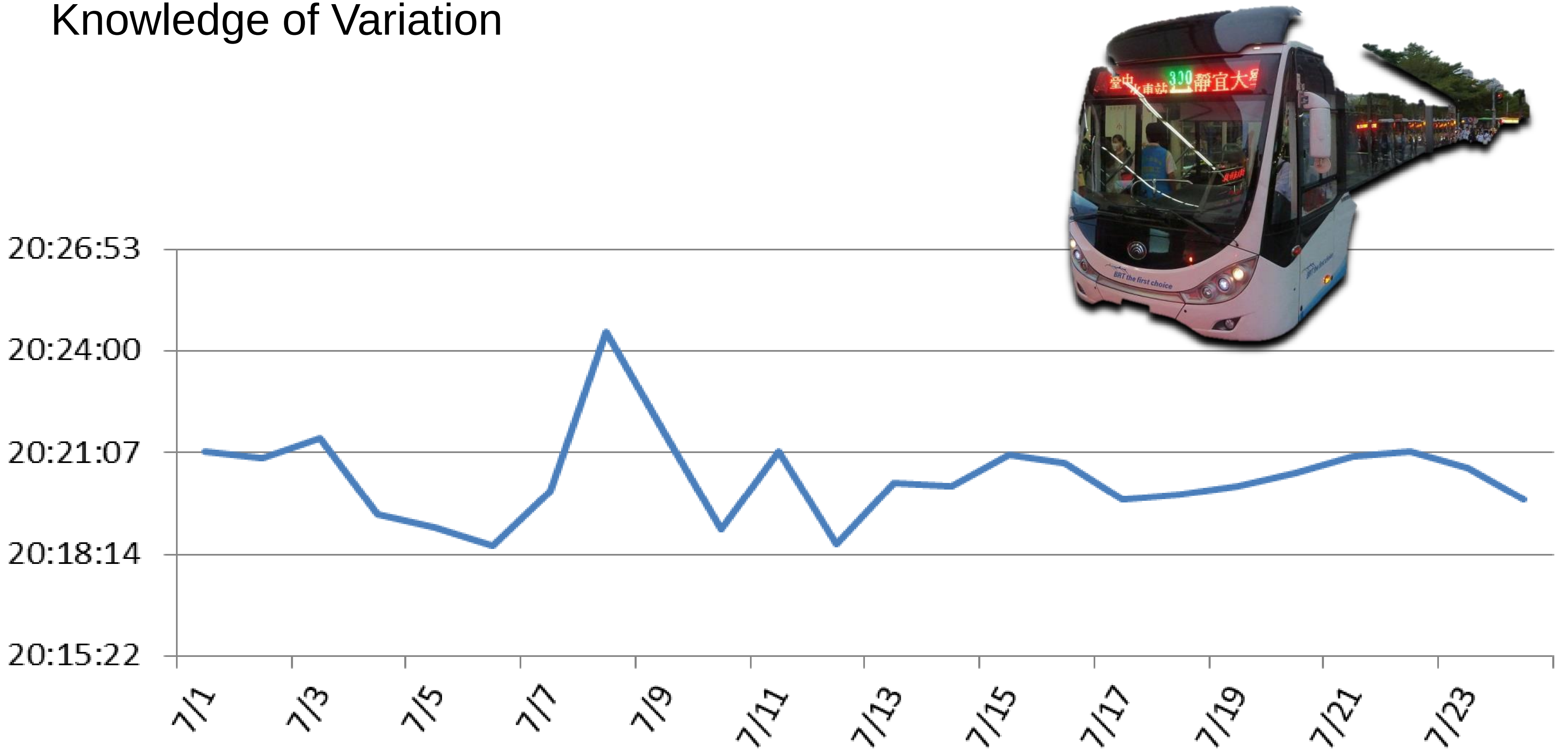
1900~1993

Profound Knowledge

- Appreciation of System
- Knowledge of Variation
- Theory of Knowledge
- Psychology

What is Quality ?

Knowledge of Variation



What is Quality ?

公司簡介：

Highest Quality Company創立於2008年，是一家擁有高品質、嚴謹的標準作業流程、員工恪遵標準作業的專業代工廠。敝司生產高品質的白珠並交送給客戶，過程中設立了嚴格的作業流程及100%品檢流程，我們保證公司的珠子均滿足客戶的高規格需求。

品質政策：

Highest Quality Company秉持：

- 零缺點品質 Zero Defect Quality
- 第一次就做對 Do it right at first time
- 客戶滿意 Customer Satisfaction
- 100%品質檢驗
- ISO 9001 / IATF16949/ ISO13485證書

標準作業程序：

1. Highest Quality Company員工一天使用一把勺子撈取50顆珠子
2. 撈取過程不得用手觸摸珠子、不得刻意抖落已撈取的珠子、不得與他人聊天、不得拋媚眼 並且須留意凹槽是否填滿 若違反上述規定則須取消當日工資
3. 撈取後須將勺子交由品檢員檢驗紅珠數量並登記紅珠數量於檢驗紀錄表
4. 登記完畢後即完成當日工作
5. 該員工的績效表現取決於紅珠的多寡
紅珠數量越少 績效獎金越高
紅珠數量過多 則進行「汰劣專案」

白珠3200顆
紅珠800顆
勺子 附有50個凹槽

What is Quality ?

姓名	Neal	Taco	Tim	Michael	Tony	Richart	Total	Avarage	累計平均
D1	3	6	13	11	9	12	54	9.0	9.0
D2	13	9	12	8	13	11	66	11.0	10.00
D3	8	8	7	10	8	7	48	8.0	9.333
D4	9	10	10	15	11	15	70	11.7	9.917
Total	33	33	42	44	41	45	238	39.7	9.917

Day1：

Day2：

Day3：

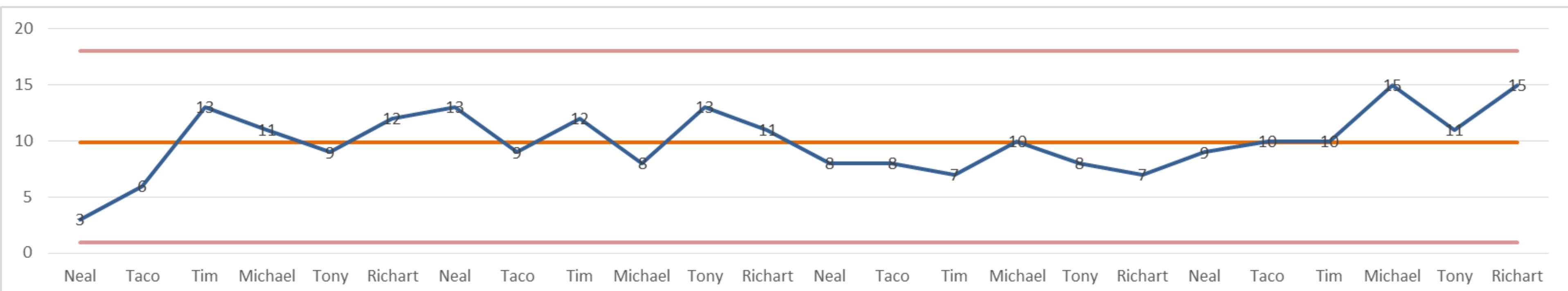
Day4：

公司決策：

白珠3200顆
紅珠800顆
勺子 附有50個凹槽

What is Quality ?

姓名	Neal	Taco	Tim	Michael	Tony	Richart	Neal	Taco	Tim	Michael	Tony	Richart	Neal	Taco	Tim	Michael	Tony	Richart	Neal	Taco	Tim	Michael	Tony	Richart
紅珠數	3	6	13	11	9	12	13	9	12	8	13	11	8	8	7	10	8	7	9	10	10	15	11	15
UCL	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
CL	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92
LCL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1



Red Beads Experiment

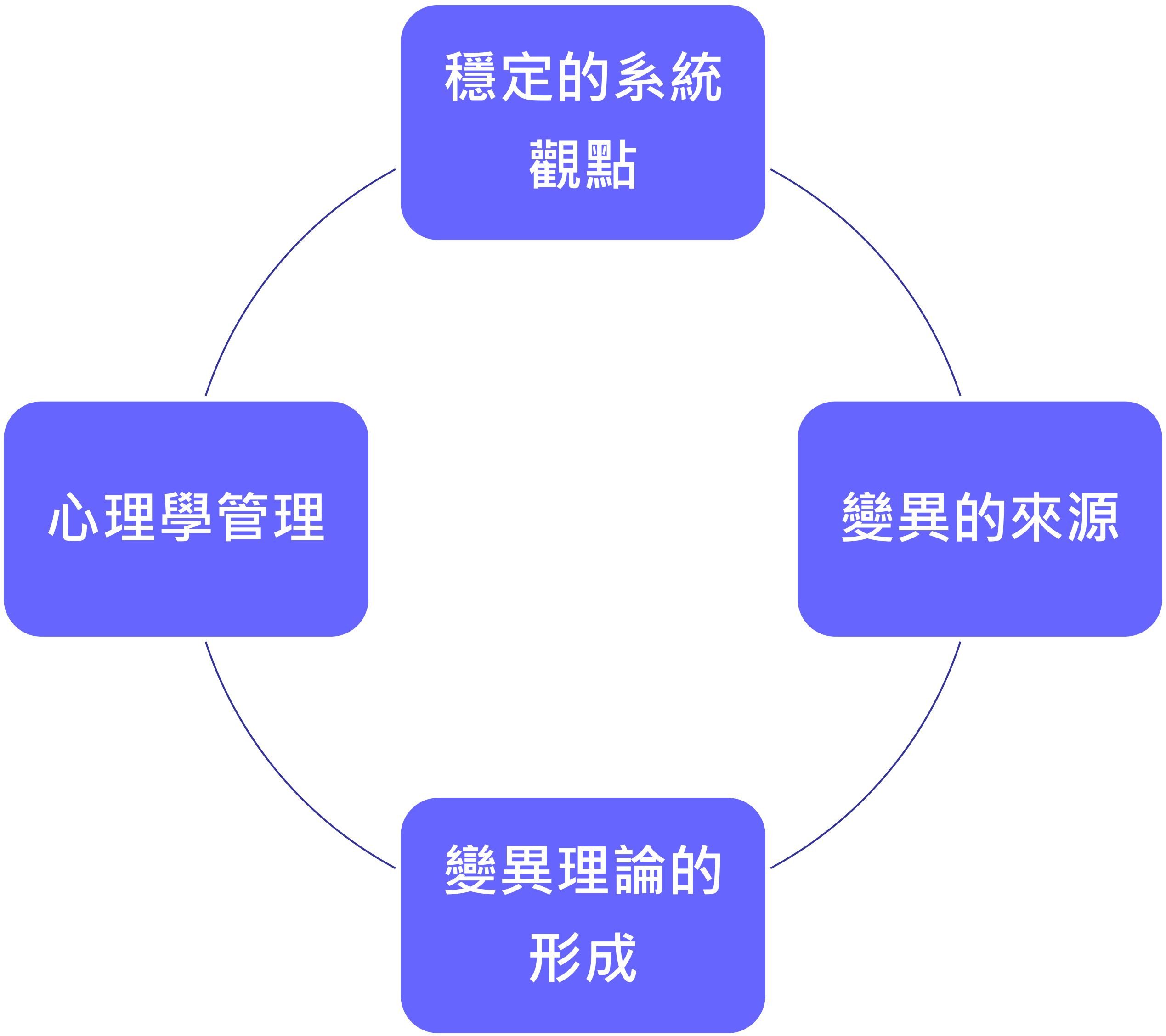
註：該圖表計算方式請參考骰子SPC_紅珠實驗sheet

What is Quality ?

深厚知識/紅珠實驗帶給我們的啟發：

- 紅珠躲藏在系統層面而非個人層面，並形成了穩定的系統
  Appreciation of System.
- 紅珠造成的變異是隨機的，但這些變異卻形成了穩定的系統
  Knowledge of Variation.
- 統計理論可以說明/解釋紅珠的變異
  System Knowledge.
- 管理階層不恰當的績效制度造成員工對管理階層的不滿(人性心理)
  Psychology.

What is Quality ?



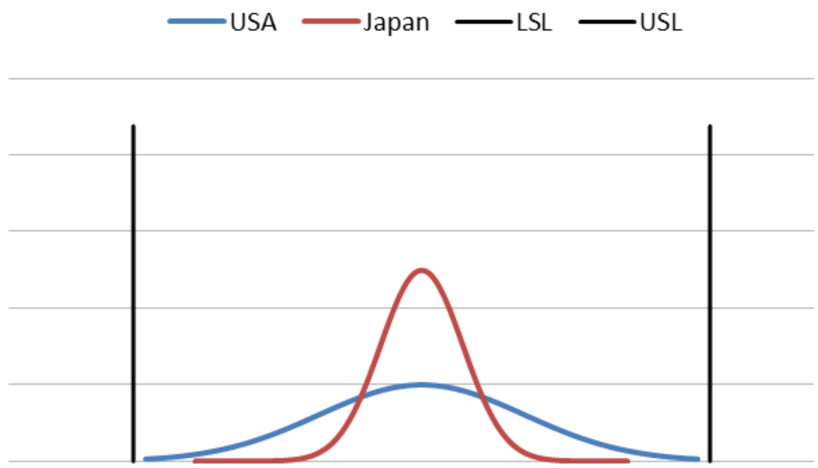
What is Quality ?

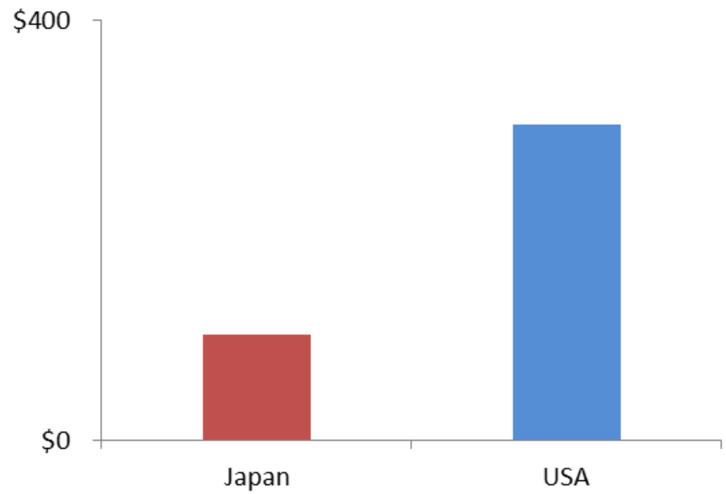
事實是70年代根本沒有競爭這回事 是**日本企業徹底打垮美國企業**
美國企業發現50年代日本企業就邀請Dr.Deming傳授統計品質管理並發揚光大
日本企業持續應用統計及田口品質工程工具提升品質水準
美國企業體會到顧客感受到的是產品的穩定性而回頭重視統計品質管理

符合規格是錯誤的觀點 降低變異才是真正的關鍵

Inversely proportional to variability

品質是變異的反比 $Q \propto \frac{1}{v}$





Quiz

What you should understand after the class.

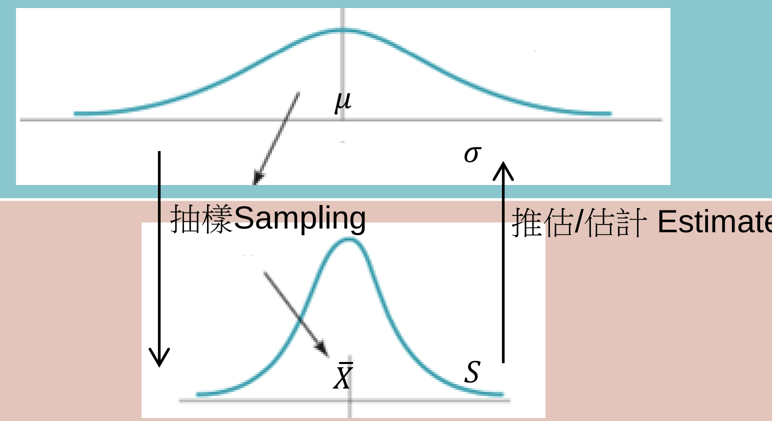
- 品質到底是什麼? 課堂上的定義與您自己之前所認知的差異為何?

- 您有聽過紅珠實驗嗎?您能簡單陳述一下紅珠實驗想表達的是什麼?

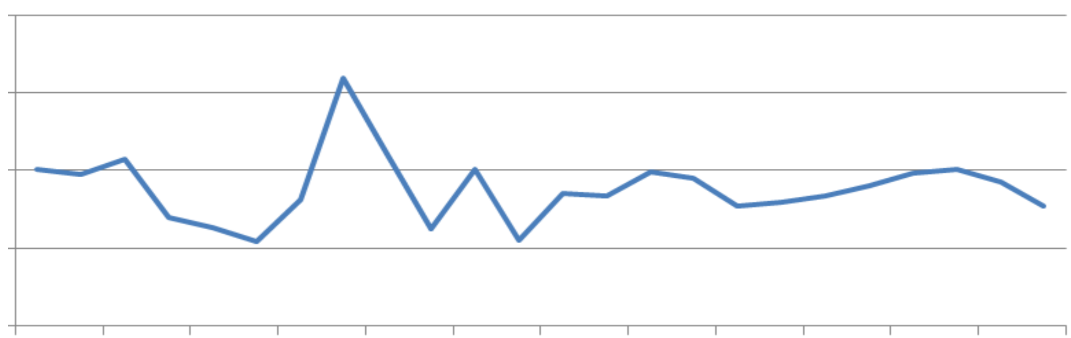
- PDSA / PDCA該如何理解? 您能用一個例子記住並實際應用嗎?
  - ✓ 評估把水杯裝滿水
  - ✓ 開水龍頭
  - ✓ 評估目前水位及水杯高度的差異
  - ✓ 確認水位, 若差異接近時則關水龍頭

  - ✓ 設立拉單槓的目標
  - ✓ 開始拉單槓
  - ✓ 評估現有單槓數量與目標數量的差異
  - ✓ 分析差異並更新單槓目標

如何描述變異?

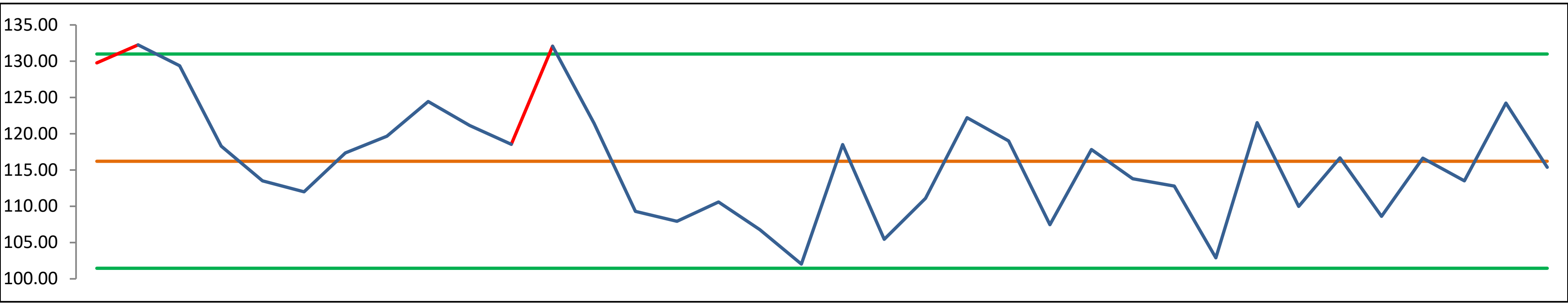
	位置 Location	寬度 Width	Distribution
母體 Population	μ	σ^2	
樣本 Sample	$\bar{X}$	S^2	

- $E(S^2) = \sigma^2$
- $E(\bar{X}) = \mu$

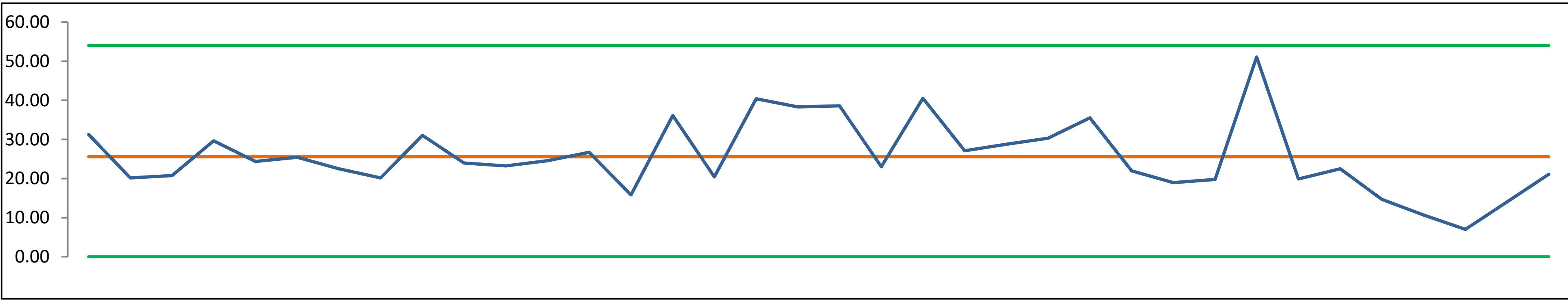


初窺管制圖

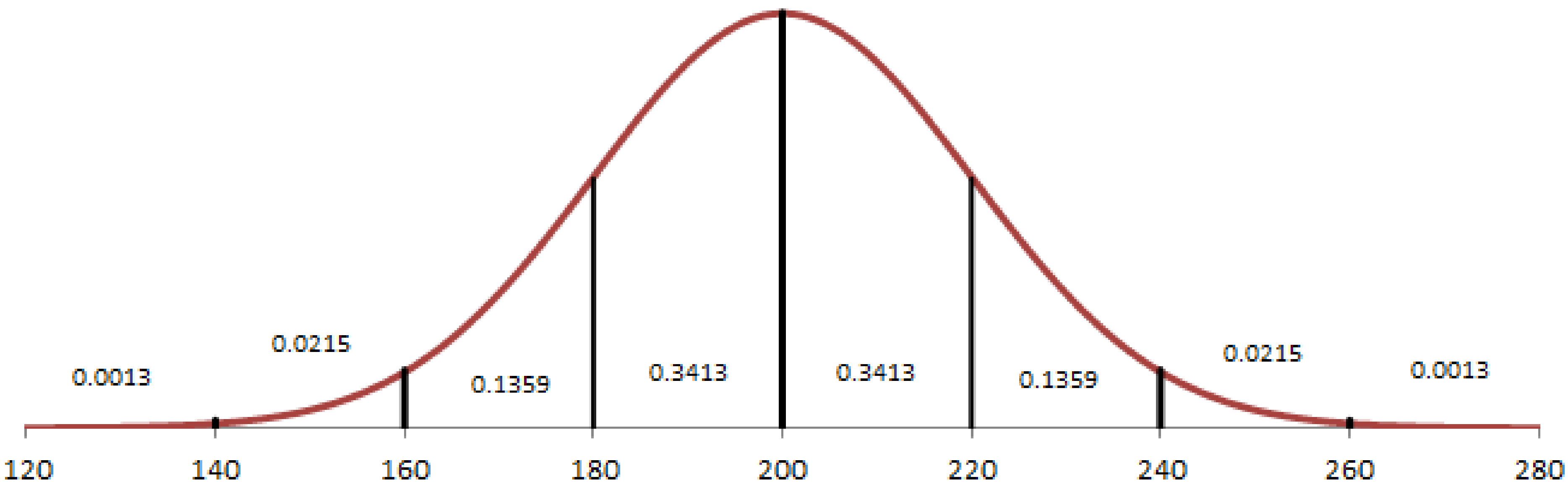
X-bar Chart



R Chart



原理1：常態分配
Principle 1st_ Normal Distribution



P(平均值 ± 3標準差) = 0.9974 = 99.74%
P(超出3標準差) = 1- 0.9974 = 0.0026 = 0.26%
ARL = 1 / P = 1 / 0.0026 = 384

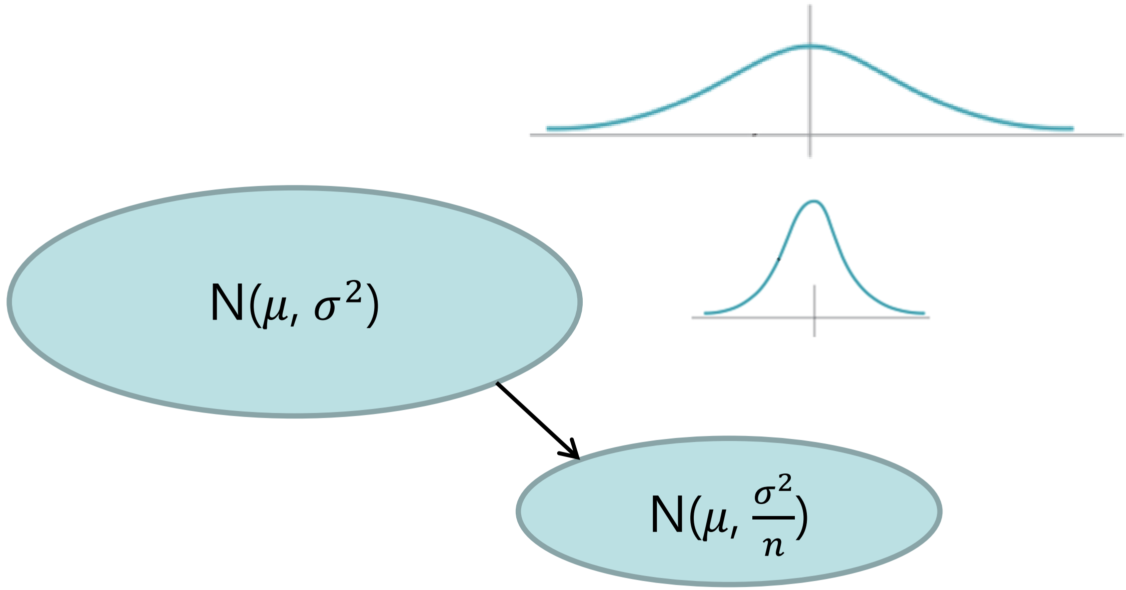
原理2_抽樣分配
Principle 2nd_ Sampling Distribution

- 若母體為常態分配~N(μ , σ^2)
  則抽樣樣本$\bar{X}$ ~ N(μ , $\frac{\sigma^2}{n}$)

E($\bar{X}$) = μ

Var($\bar{X}$) = $\frac{\sigma^2}{n}$

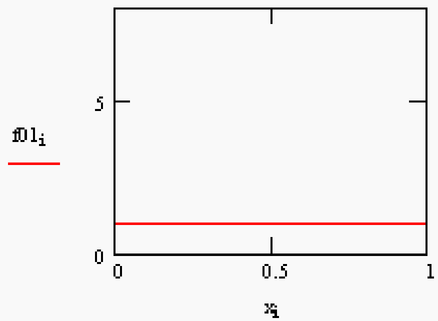
Proof:



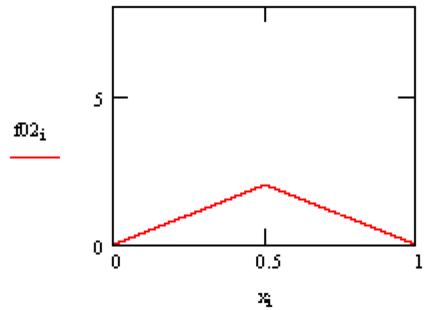
- 抽樣分配的樣本平均值會服從常態分配, 且樣本標準差為母體標準差$\frac{1}{\sqrt{n}}$
- 若母體非常態分配, 則在大樣本下應用中央極限定理可得到相同的結果

原理3：中央極限定理CLT
Principle 3rd_ Central Limit Theorem

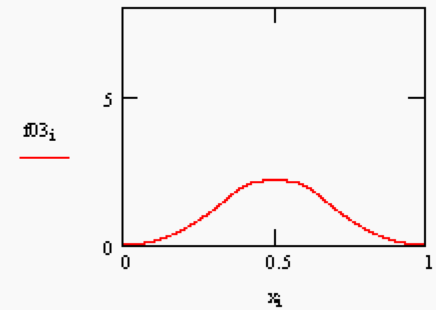
- 無論隨機變數的原始分配為何
  若樣本數n越大 則該隨機變數的樣本平均值 $\bar{x} \sim N(\mu, \frac{\sigma^2}{n})$



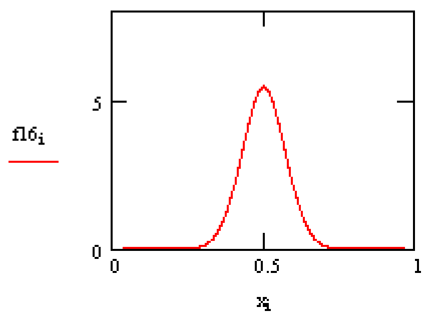
NonNormal Distribution of X



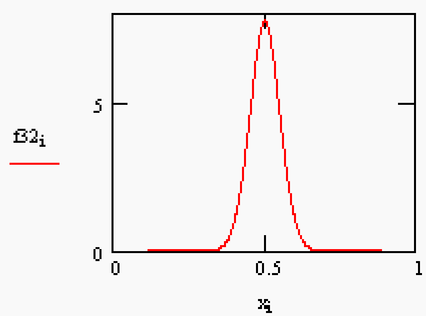
Distribution of Xbar when sample size is 2



Distribution of Xbar when sample size is 3



Distribution of Xbar when sample size is 16



Distribution of Xbar when sample size is 32

The Galton Board

骰子Excel VBA

CLT: Uniform Distribution

原理4：假設檢定
Principle 4th_ Hypothesis test

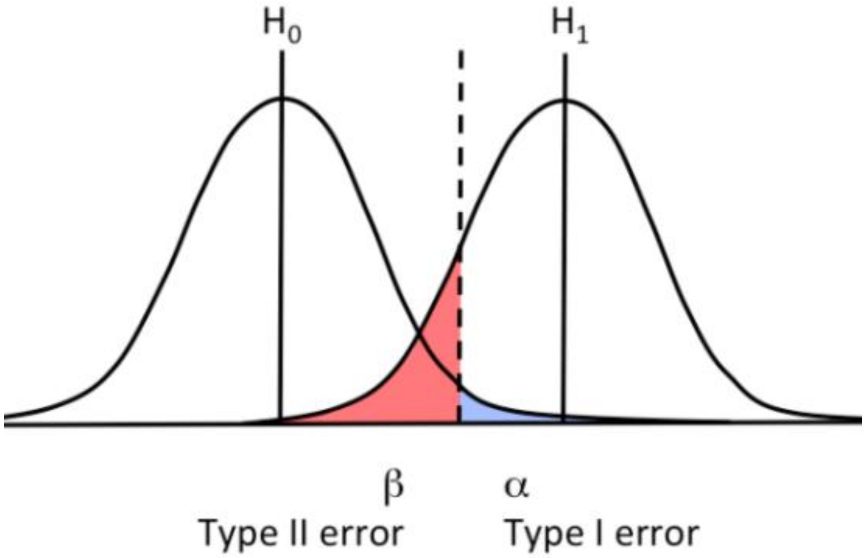
- 假設檢定是以樣本觀察值來推論母體參數的方式
  因為透過抽樣進行推論，因此有可能因為抽樣誤差而做出錯誤的判斷
  在統計上這樣的誤差必然存在, 因此不能夠宣稱統計的結果「一定」是正確的決定
- Ex：一個木箱裝有300kg的物品，請問你會認為裡面是頭豬還是一個人？

H_0：是人
H_1：是豬(不是人)

P($X \geq 300$ | H_0 = True) = 0.0000001
假設是人的前提下，體重超過300kg的機率

P($X \geq 300$ | H_1 = True) = 0.5
假設是豬的前提下，體重超過300kg的機率

	H_0 True	H_0 False
Reject H_0	Type I Error	Correct Rejection
Fail to Reject H_0	Correct Decision	Type II Error



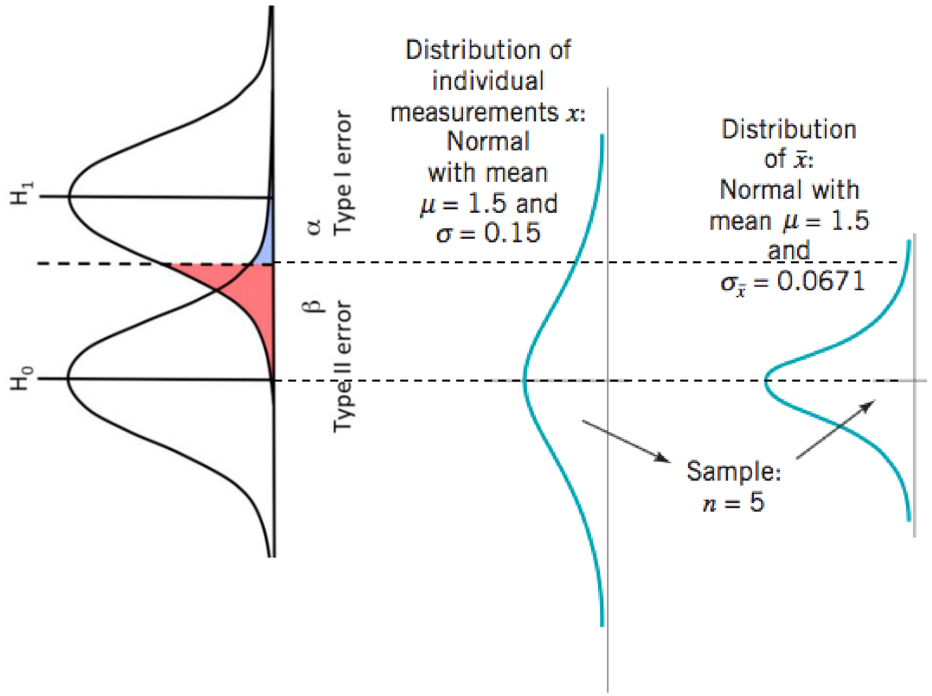
$\alpha = P\{\text{type I error}\} = P\{\text{reject } H_0 | H_0 \text{ is true}\}$

$\beta = P\{\text{type II error}\} = P\{\text{fail to reject } H_0 | H_0 \text{ is false}\}$

$\text{Power} = 1 - \beta = P\{\text{reject } H_0 | H_0 \text{ is false}\}$

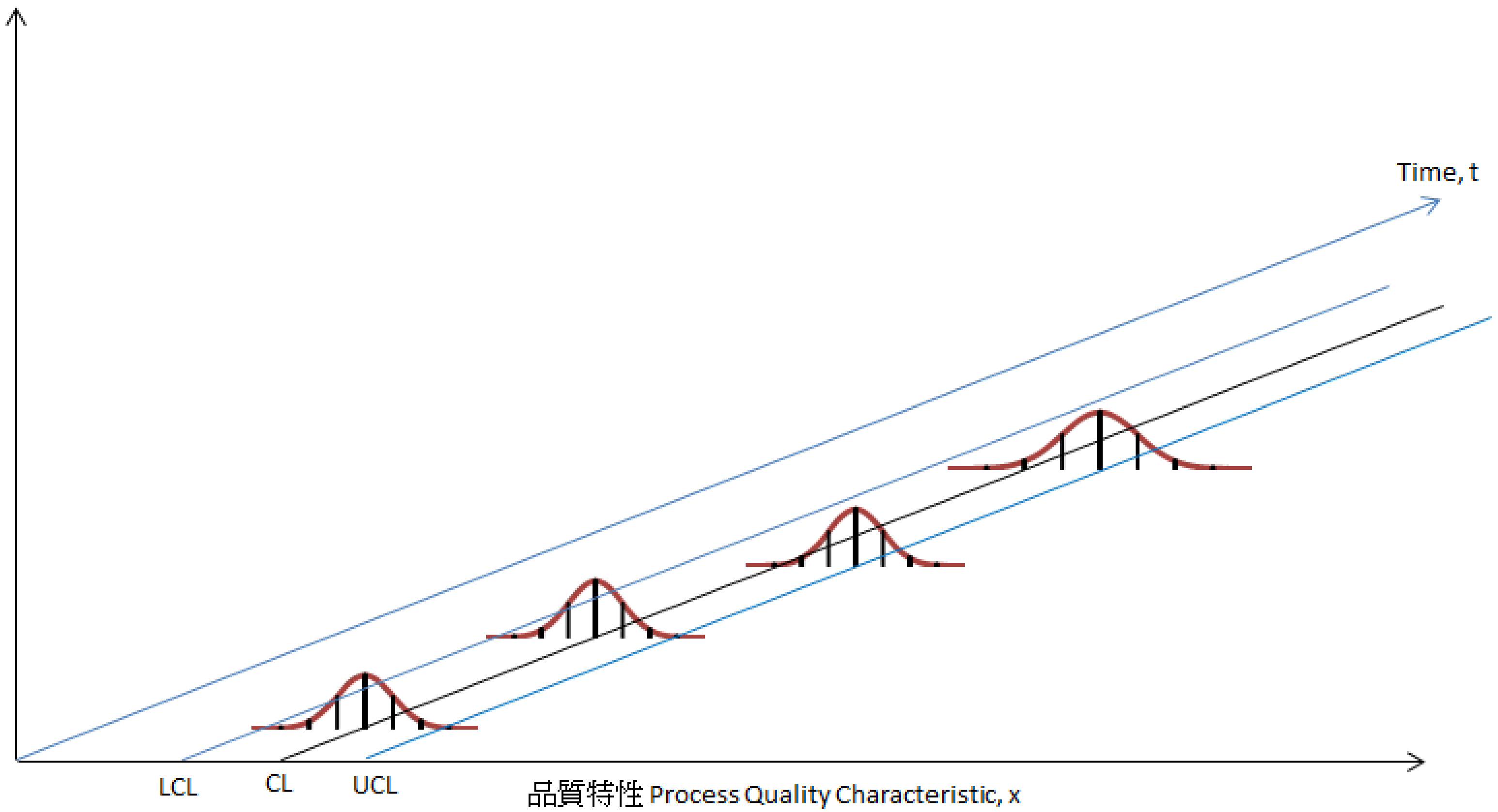
原理4：假設檢定
Principle 4^{th}_ Hypothesis test

- 假設檢定是以樣本觀察值來推論母體參數的方式
  因為透過抽樣進行推論，因此有可能因為抽樣誤差而做出錯誤的判斷
  在統計上這樣的誤差必然存在, 因此不能夠宣稱統計的結果「一定」是正確的決定
- 對於SPC而言, 每一點樣本平均值都等於執行一次假設檢定



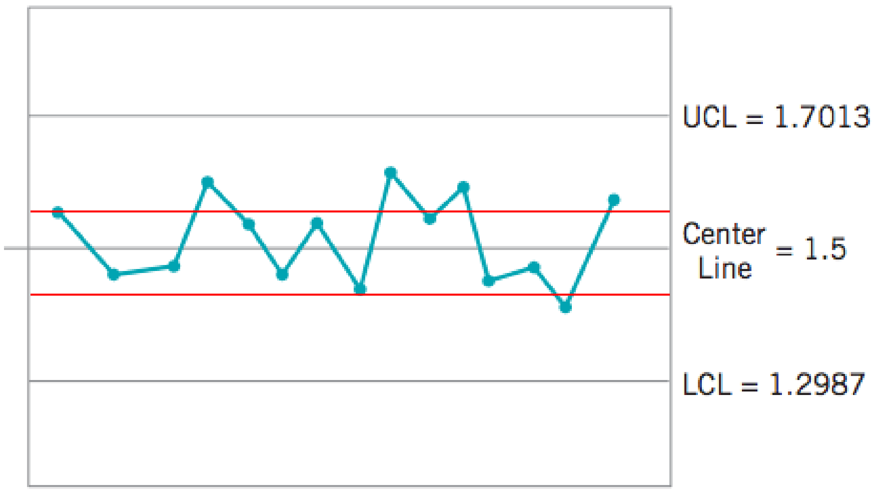
原理5_共同原因&特殊原因
Principle 5th_ Common Cause & Special Cause

- 共同原因 Common cause
- 特殊原因 Special cause



原理5_共同原因&特殊原因
Principle 5th_ Common Cause & Special Cause

- 共同原因 Common cause
- 特殊原因 Special cause

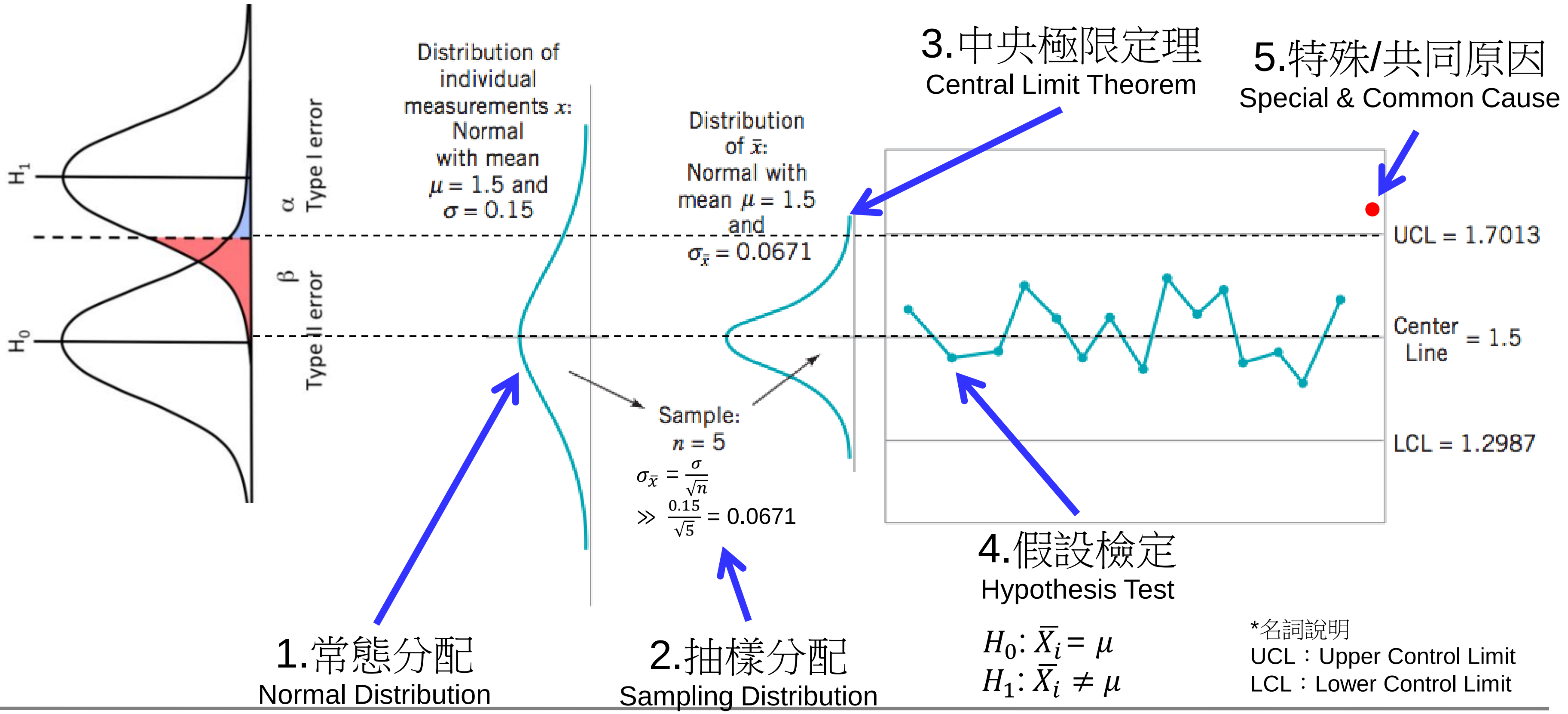


		Statistical Control	
		In control	Out of control
Spec	In spec	Case1	Case2
	Out of spec	Case3	Case4

- 錯誤1 Mistake one (Case 3)
  將共同原因錯認為特殊原因 → 產品超出規格, 但實際上製程卻很穩定
- 錯誤2 Mistake two (Case 2)
  將特殊原因錯認為共同原因 → 試量產SPC其實不穩定, 卻不追查原因直接導入量產

Control Chart

- 假設檢定的圖形側放就是SPC的原型
- 結合抽樣分配、中央極限定理、常態分配 & 假設檢定就是SPC的理論基礎
- 功能是建立監控機制觀察製程狀態
- 目的是「預防」、「監控」取代過時的品質觀念「檢驗」、「事後彌補」



$H_0: \overline{X}_i = \mu$

$H_1: \overline{X}_i \neq \mu$

*名詞說明
UCL：Upper Control Limit
LCL：Lower Control Limit

Quiz

What you should understand after the class.

- 品質是降低變異，那麼該如何描述變異呢?
- 常態分配的特性有哪些? 那些地方可以看到常態分配?
- 母體跟樣本之間有什麼聯繫? 你能記得最近一次選舉民調的相關資料嗎?
- 中央極限定理跟常態分配有什麼關係?
- 妳相信美國的將軍要跟妳結婚嗎? 為什麼幸運兒不會是妳?
- 在台灣沒事不要搭長途客運，你知道為什麼嗎?

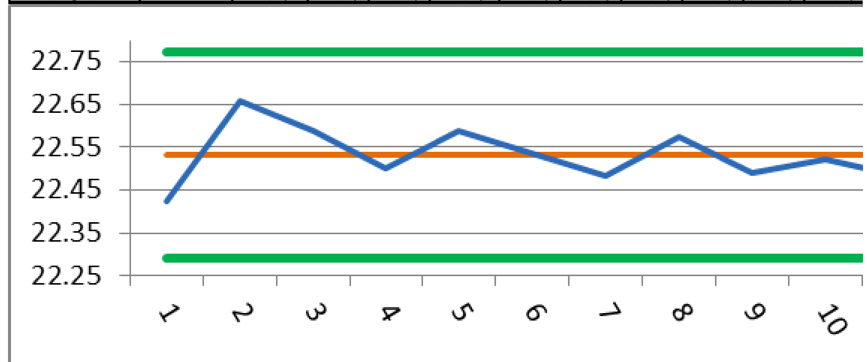
$\bar{X}-R\ Chart$ 計量型SPC

- 全名為平均值-全距統計製程管制圖
- 由於計算簡便, 在電腦不普及的年代是最好的SPC工具
- 目前仍是傳統產業推廣SPC的有效工具 諸如: 機械加工、塑膠射出及壓鑄產業
- 適合用於小樣本(n<10) 因為R全距在n>10的時候會逐漸失去對標準差的估計能力
  (R = Max-Min 忽略了樣本中間數值的表現, 當樣本數n增加時會損失越多數值的資訊)
- 3倍樣本標準差的資訊涵蓋在A_2、D_3、D_4 裡面

$\bar{X} - R$ Chart SPC

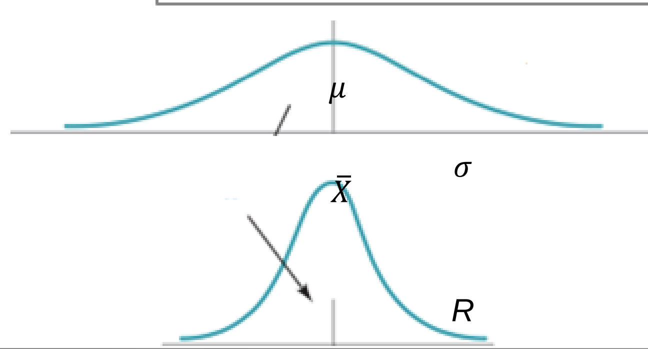
- **$\bar{X}$ chart**
  $\bar{X}$ chart監控平均值, 若母體標準差σ已知, 則
  $$UCL_{\bar{X}} = \mu_{\bar{X}} + 3\sigma_{\bar{X}} = \mu_{\bar{X}} + 3\frac{\sigma}{\sqrt{n}}$$
  $$CL_{\bar{X}} = \mu_{\bar{X}} = \mu$$
  $$LCL_{\bar{X}} = \mu_{\bar{X}} - 3\sigma_{\bar{X}} = \mu_{\bar{X}} - 3\frac{\sigma}{\sqrt{n}}$$

25		1	2	3	4	5	6	7	8	9	10
X barbar	22.53	22.42	22.7	22.6	22.5	22.6	22.5	22.5	22.6	22.5	22.5
樣本值	1	22.3	22.9	22.9	22.4	22.6	22.4	22.2	22.6	22.6	22.4
	2	22.54	22.7	22.7	22.7	22.7	22.3	22.4	22.7	22.5	22.6
	3	22.01	22.4	22.5	22.5	22.8	22.8	22.9	22.4	22.5	22.5
	4	22.62	22.6	22.3	22.4	22.6	22.7	22.5	22.5	22.5	22.4
	5	22.65	22.7	22.6	22.6	22.3	22.5	22.5	22.7	22.3	22.6
R bar	0.418	0.64	0.43	0.58	0.29	0.45	0.41	0.67	0.37	0.3	0.24
S	0.189	0.269	0.16	0.22	0.11	0.16	0.19	0.25	0.15	0.11	0.11
UCL		22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77
CL		22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53
LCL		22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29



- 若母體標準差σ未知, 則須由樣本標準差估計母體標準差
  由於全距不是σ的不偏估計量 所以需要進行轉換 $W = \frac{R}{\sigma}$
  *詳見補充教材

$$UCL_{\bar{X}} = \bar{\bar{x}} + 3\frac{\bar{R}}{d_2\sqrt{n}} = \bar{\bar{x}} + A_2\bar{R}$$
$$CL_{\bar{X}} = \bar{\bar{x}}$$
$$LCL_{\bar{X}} = \bar{\bar{x}} - 3\frac{\bar{R}}{d_2\sqrt{n}} = \bar{\bar{x}} - A_2\bar{R}$$



X-bar管制圖		
A	A2	A3
2.121	1.88	2.659
1.732	1.023	1.954
1.5	0.729	1.628
1.342	0.577	1.427
1.225	0.483	1.287
1.134	0.419	1.182
1.061	0.373	1.099
1	0.337	1.032
0.949	0.308	0.975

$\bar{X} - R$ Chart SPC

- **R-chart**

  R-chart監控變異, 若母體標準差σ_R已知, 則

  $UCL_R = \mu_R + 3\sigma_R$

  $CL_R = \mu_R = \bar{R}$

  $LCL_R = \mu_R - 3\sigma_R$

- 若母體標準差σ_R未知, 則須由樣本標準差估計母體標準差

  由於全距**不是**σ_R的不偏估計量 所以需要進行變數變換 W = $\frac{R}{\sigma}$

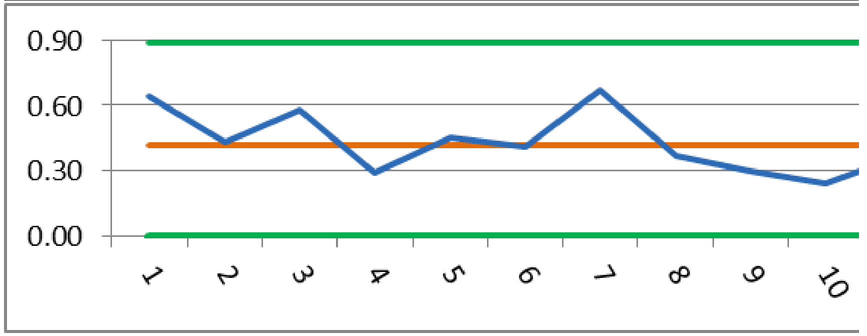
  *詳見補充教材

$$UCL_R = \bar{R} + 3\sigma_R = [1+\frac{3d_3}{d_2}]\bar{R} = D_4\bar{R}$$

$$CL_R = \bar{R}$$

$$LCL_R = \bar{R} - 3\sigma_R = [1-\frac{3d_3}{d_2}]\bar{R} = D_3\bar{R}$$

25		1	2	3	4	5	6	7	8	9	10
X barbar	22.53	22.42	22.7	22.6	22.5	22.6	22.5	22.5	22.6	22.5	22.5
樣本值	1	22.3	22.9	22.9	22.4	22.6	22.4	22.2	22.6	22.6	22.4
	2	22.54	22.7	22.7	22.7	22.7	22.3	22.4	22.7	22.5	22.6
	3	22.01	22.4	22.5	22.5	22.8	22.8	22.9	22.4	22.5	22.5
	4	22.62	22.6	22.3	22.4	22.6	22.7	22.5	22.5	22.5	22.4
	5	22.65	22.7	22.6	22.6	22.3	22.5	22.5	22.7	22.3	22.6
R bar	0.418	0.64	0.43	0.58	0.29	0.45	0.41	0.67	0.37	0.3	0.24
S	0.189	0.269	0.16	0.22	0.11	0.16	0.19	0.25	0.15	0.11	0.11
UCLr		0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
CLr		0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
LCLr		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



R管制圖					
d2	d3	D1	D2	D3	D4
1.128	0.853	0	3.686	0	3.267
1.693	0.888	0	4.358	0	2.574
2.059	0.88	0	4.698	0	2.282
2.326	0.864	0	4.918	0	2.114
2.534	0.848	0	5.078	0	2.004
2.704	0.833	0.204	5.204	0.076	1.924
2.847	0.82	0.388	5.306	0.136	1.864
2.97	0.808	0.547	5.393	0.184	1.816
3.078	0.797	0.687	5.469	0.223	1.777

補充教材_ R→σ

R→σ
W=R/σ

E(W) = E(R/σ)
E(W) $= \frac{E(R)}{E(\sigma)}$
E(W) = d_2
$\hat{\sigma} = \frac{\bar{R}}{d_2}$

R= Wσ
Var(R) = Var(Wσ) = σ^2Var(W)
$\sigma_R = \sigma\ \sigma_W$
$\sigma_W = d_3$
$\sigma_R = d_3\sigma$
$\sigma_R = d_3\ \frac{\bar{R}}{d_2}$

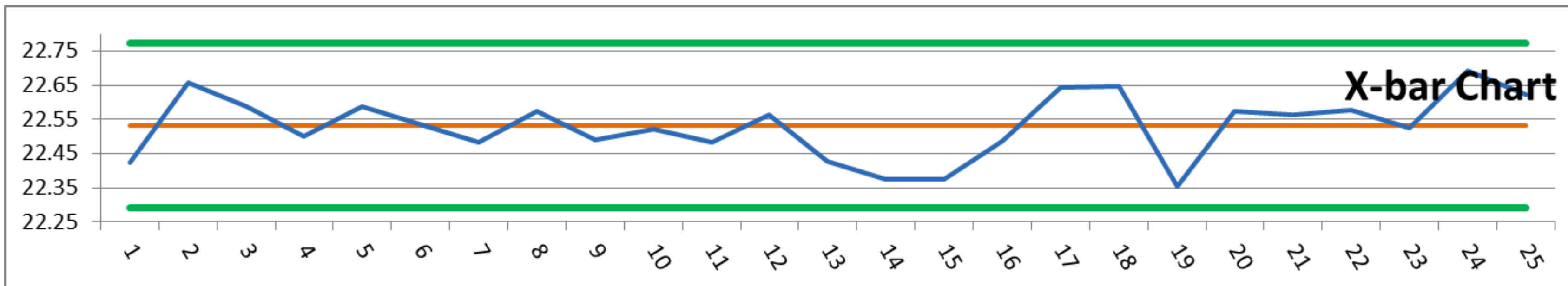
補充教材_估計量

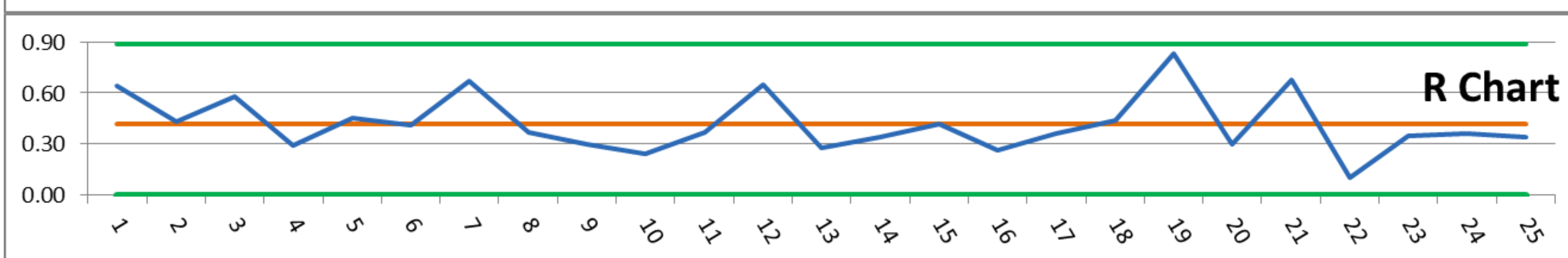
良好的估計量

1) 不偏：E($\hat{\theta}$-θ) = 0
2) 有效：MSE($\hat{\theta}$) = E($\hat{\theta}-\theta)^2$ 相對較小者
3) 一致：P($\lim_{n\to\infty} \hat{\theta}_n$=$\theta$) = 1
4) 充分：樣本資料均被使用

$\bar{X} - R$ Chart SPC

25		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
X barbar	22.53	22.42	22.7	22.6	22.5	22.6	22.5	22.5	22.6	22.5	22.5	22.5	22.6	22.4	22.4	22.4	22.5	22.6	22.6	22.4	22.6	22.6	22.6	22.5	22.7	22.6
樣本值	1	22.3	22.9	22.9	22.4	22.6	22.4	22.2	22.6	22.6	22.4	22.3	22.5	22.3	22.4	22.3	22.7	22.5	22.8	22.7	22.5	22.5	22.5	22.5	22.8	22.8
	2	22.54	22.7	22.7	22.7	22.7	22.3	22.4	22.7	22.5	22.6	22.6	22.3	22.6	22.2	22.4	22.5	22.9	22.6	22.8	22.6	22.4	22.5	22.6	22.5	22.7
	3	22.01	22.4	22.5	22.5	22.8	22.8	22.9	22.4	22.5	22.5	22.4	22.4	22.4	22.5	22.3	22.4	22.6	22.8	21.9	22.5	22.3	22.6	22.4	22.9	22.5
	4	22.62	22.6	22.3	22.4	22.6	22.7	22.5	22.5	22.5	22.4	22.7	22.7	22.6	22.2	22.3	22.4	22.6	22.7	22	22.8	22.7	22.6	22.5	22.7	22.8
	5	22.65	22.7	22.6	22.6	22.3	22.5	22.5	22.7	22.3	22.6	22.6	22.9	22.3	22.6	22.7	22.5	22.7	22.4	22.5	22.6	23	22.6	22.7	22.5	22.4
R bar	0.418	0.64	0.43	0.58	0.29	0.45	0.41	0.67	0.37	0.3	0.24	0.37	0.65	0.28	0.34	0.42	0.26	0.36	0.44	0.83	0.3	0.68	0.1	0.35	0.36	0.34
S	0.189	0.269	0.16	0.22	0.11	0.16	0.19	0.25	0.15	0.11	0.11	0.15	0.26	0.14	0.14	0.17	0.1	0.13	0.18	0.38	0.11	0.28	0.05	0.13	0.17	0.15
UCL		22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77
CL		22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53
LCL		22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29
UCLr		0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
CLr		0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
LCLr		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00





$\overline{X} - S\ Chart$ 計量型SPC

- 全名為平均值-樣本標準差統計製程管制圖
- 由於計算繁複, 在電腦不普及的年代很難計算, 但在今日已經沒有此困擾
- 但在傳統產業推廣SPC時 諸如: 機械加工、塑膠射出及壓鑄產業等現場無電腦設備的行業仍不方便
- 適合用於各種樣本數量, 常用於大樣本的情境

  (R = Max-Min 忽略了樣本中間數值的表現, 當樣本數n增加時會損失越多數值的資訊)
- 3倍樣本標準差的資訊涵蓋在A_3、B_3、B_4 裡面

$\bar{X} - S$ Chart SPC

- **$\bar{X}$ chart**

  $\bar{X}$ chart監控平均值, 若母體標準差已知, 則

  $UCL_{\bar{x}}$: $\bar{\bar{x}} + 3\frac{\sigma}{\sqrt{n}}$

  $CL_{\bar{x}}$: $\bar{\bar{x}}$

  $LCL_{\bar{x}}$: $\bar{\bar{x}} - 3\frac{\sigma}{\sqrt{n}}$

- 若母體標準差**未知**, 則須由樣本標準差估計母體標準差

  由於樣本標準差**不是**母體標準差σ的不偏估計量 *詳見補充教材

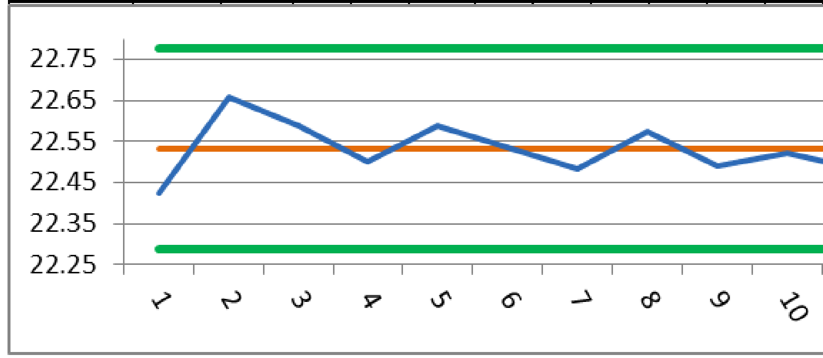
  則

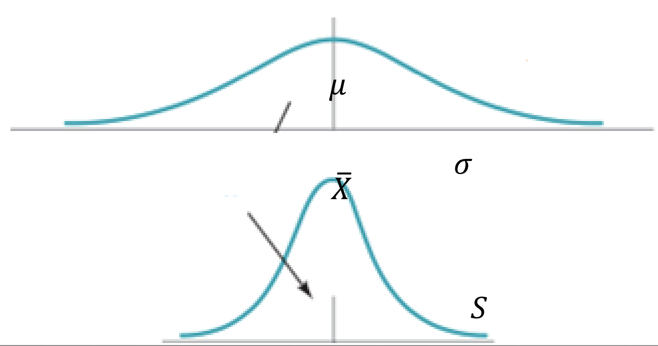
  $UCL_{\bar{x}}$: $\bar{\bar{x}} + 3\frac{\bar{S}}{C_4\sqrt{n}} = \bar{\bar{x}} + A_3\bar{S}$

  $CL_{\bar{x}}$: $\bar{\bar{x}}$

  $LCL_{\bar{x}}$: $\bar{\bar{x}} - 3\frac{\bar{S}}{C_4\sqrt{n}} = \bar{\bar{x}} - A_3\bar{S}$

25		1	2	3	4	5	6	7	8	9	10
X barbar	22.53	22.42	22.7	22.6	22.5	22.6	22.5	22.5	22.6	22.5	22.5
樣本值	1	22.3	22.9	22.9	22.4	22.6	22.4	22.2	22.6	22.6	22.4
	2	22.54	22.7	22.7	22.7	22.7	22.3	22.4	22.7	22.5	22.6
	3	22.01	22.4	22.5	22.5	22.8	22.8	22.9	22.4	22.5	22.5
	4	22.62	22.6	22.3	22.4	22.6	22.7	22.5	22.5	22.5	22.4
	5	22.65	22.7	22.6	22.6	22.3	22.5	22.5	22.7	22.3	22.6
R bar	0.418	0.64	0.43	0.58	0.29	0.45	0.41	0.67	0.37	0.3	0.24
S	0.189	0.269	0.16	0.22	0.11	0.16	0.19	0.25	0.15	0.11	0.11
UCL		22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77
CL		22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53
LCL		22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29





X-bar管制圖		
A	A2	A3
2.121	1.88	2.659
1.732	1.023	1.954
1.5	0.729	1.628
1.342	0.577	1.427
1.225	0.483	1.287
1.134	0.419	1.182
1.061	0.373	1.099
1	0.337	1.032
0.949	0.308	0.975

$\bar{X} - S$ *Chart* SPC

- **S-chart**

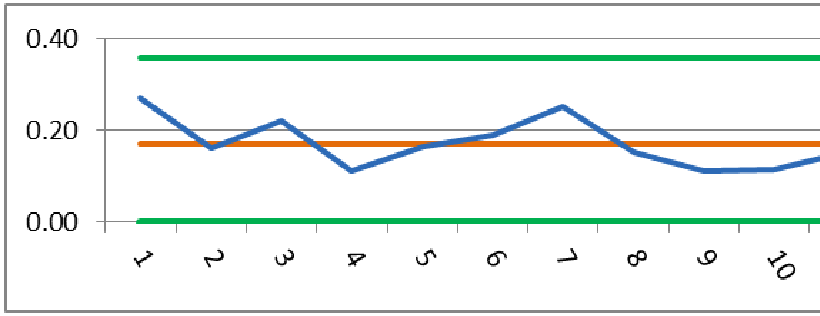
  S-chart監控變異, 若母體標準差已知, 則

  UCL_S : $\bar{S}$ + 3σ_S

  CL_S : $\bar{S}$

  LCL_S : $\bar{S}$ - 3σ_S

25		1	2	3	4	5	6	7	8	9	10
X barbar	22.53	22.42	22.7	22.6	22.5	22.6	22.5	22.5	22.6	22.5	22.5
樣本值	1	22.3	22.9	22.9	22.4	22.6	22.4	22.2	22.6	22.6	22.4
	2	22.54	22.7	22.7	22.7	22.7	22.3	22.4	22.7	22.5	22.6
	3	22.01	22.4	22.5	22.5	22.8	22.8	22.9	22.4	22.5	22.5
	4	22.62	22.6	22.3	22.4	22.6	22.7	22.5	22.5	22.5	22.4
	5	22.65	22.7	22.6	22.6	22.3	22.5	22.5	22.7	22.3	22.6
R bar	0.418	0.64	0.43	0.58	0.29	0.45	0.41	0.67	0.37	0.3	0.24
S	0.189	0.269	0.16	0.22	0.11	0.16	0.19	0.25	0.15	0.11	0.11
UCLs		0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
CLs		0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
LCLs		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



- 若母體標準差**未知**, 則須由樣本標準差估計母體標準差

  由於樣本標準差**不是**母體標準差σ_S的不偏估計量 *詳見補充教材

  則

  UCL_S : $\bar{S} + 3\sigma\sqrt{1 - C_4{}^2} = \bar{S} + 3\frac{\bar{S}}{C_4}\sqrt{1 - C_4{}^2} = B_4\bar{S}$

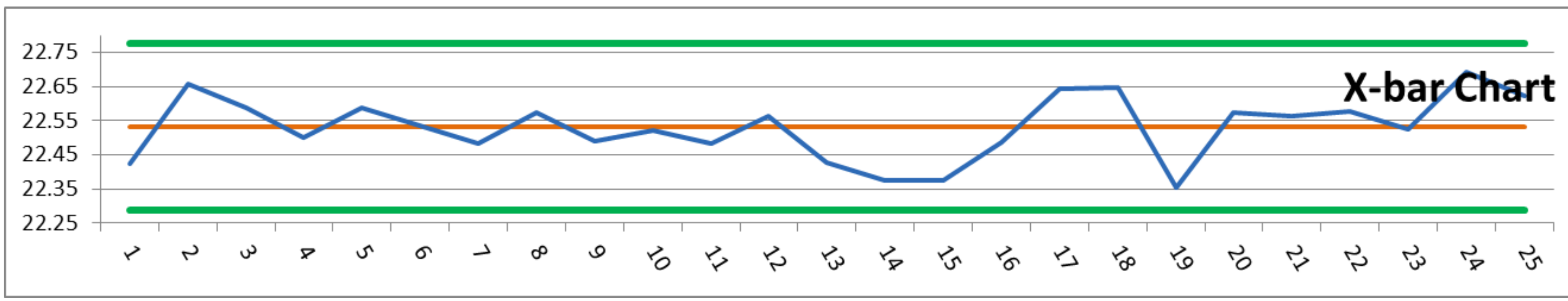
  CL_S : $\bar{S}$

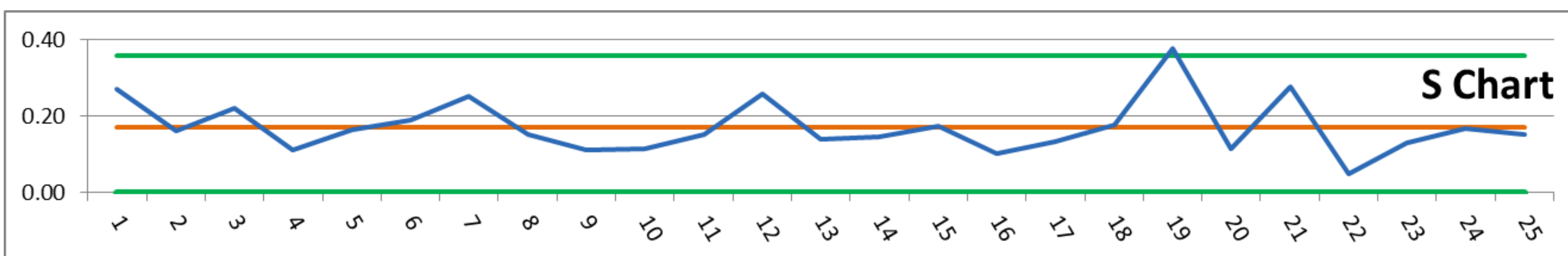
  LCL_S : $\bar{S} - 3\sigma\sqrt{1 - C_4{}^2} = \bar{S} - 3\frac{\bar{S}}{C_4}\sqrt{1 - C_4{}^2} = B_3\bar{S}$

S管制圖	
B3	B4
0	3.267
0	2.568
0	2.266
0	2.089
0.03	1.97
0.118	1.882
0.185	1.815
0.239	1.761
0.284	1.716

$\overline{X} - S\ Chart$ SPC

25		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
X barbar	22.53	22.42	22.7	22.6	22.5	22.6	22.5	22.5	22.6	22.5	22.5	22.5	22.6	22.4	22.4	22.4	22.5	22.6	22.6	22.4	22.6	22.6	22.6	22.5	22.7	22.6
樣本值	1	22.3	22.9	22.9	22.4	22.6	22.4	22.2	22.6	22.6	22.4	22.3	22.5	22.3	22.4	22.3	22.7	22.5	22.8	22.7	22.5	22.5	22.5	22.5	22.8	22.8
	2	22.54	22.7	22.7	22.7	22.7	22.3	22.4	22.7	22.5	22.6	22.6	22.3	22.6	22.2	22.4	22.5	22.9	22.6	22.8	22.6	22.4	22.5	22.6	22.5	22.7
	3	22.01	22.4	22.5	22.5	22.8	22.8	22.9	22.4	22.5	22.5	22.4	22.4	22.4	22.5	22.3	22.4	22.6	22.8	21.9	22.5	22.3	22.6	22.4	22.9	22.5
	4	22.62	22.6	22.3	22.4	22.6	22.7	22.5	22.5	22.5	22.4	22.7	22.7	22.6	22.2	22.3	22.4	22.6	22.7	22	22.8	22.7	22.6	22.5	22.7	22.8
	5	22.65	22.7	22.6	22.6	22.3	22.5	22.5	22.7	22.3	22.6	22.6	22.9	22.3	22.6	22.7	22.5	22.7	22.4	22.5	22.6	23	22.6	22.7	22.5	22.4
R bar	0.418	0.64	0.43	0.58	0.29	0.45	0.41	0.67	0.37	0.3	0.24	0.37	0.65	0.28	0.34	0.42	0.26	0.36	0.44	0.83	0.3	0.68	0.1	0.35	0.36	0.34
S	0.189	0.269	0.16	0.22	0.11	0.16	0.19	0.25	0.15	0.11	0.11	0.15	0.26	0.14	0.14	0.17	0.1	0.13	0.18	0.38	0.11	0.28	0.05	0.13	0.17	0.15
UCL		22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77
CL		22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53
LCL		22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29
UCLs		0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
CLs		0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
LCLs		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00





補充教材_ S→σ

S $\rightarrow \sigma$

- E(S^2) = σ^2
- 但 E(S) $\neq \sigma$

E(S) = $\left[\frac{2}{(n-1)}\right]^{\frac{1}{2}} \frac{\left[\frac{(n-2)}{2}\right]!}{\left[\frac{(n-3)}{2}\right]!}$ σ = C_4 σ

則 $\hat{\sigma}$ = $\frac{\bar{S}}{C_4}$

Var(S) = (1- ${C_4}^2$) σ^2

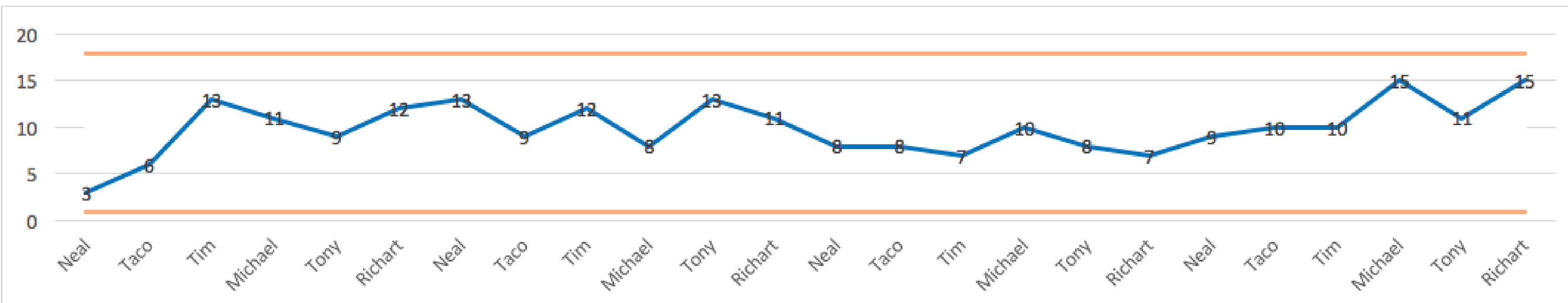
則 σ_s = $\sqrt{1-{C_4}^2}$ σ

np / p *Chart* 計數型SPC

姓名	Neal	Taco	Tim	Michael	Tony	Richart	Total	Avarage	累計平均
D1	3	6	13	11	9	12	54	9.0	9.00
D2	13	9	12	8	13	11	66	11.0	10.00
D3	8	8	7	10	8	7	48	8.0	9.33
D4	9	10	10	15	11	15	70	11.7	9.92
Total	33	33	42	44	41	45	238	39.7	9.92

SPC也能使用於管理層面
例如：紅珠實驗

姓名	Neal	Taco	Tim	Michael	Tony	Richart	Neal	Taco	Tim	Michael	Tony	Richart	Neal	Taco	Tim	Michael	Tony	Richart	Neal	Taco	Tim	Michael	Tony	Richart
紅珠數	3	6	13	11	9	12	13	9	12	8	13	11	8	8	7	10	8	7	9	10	10	15	11	15
UCL	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
CL	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92
LCL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1



不合格率管制圖 p

UCL$_p$ ： $\bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

C L$_p$ ： $\bar{p}$

LCL$_p$ ： $\bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

不合格品數管制圖 np

UCL$_{np}$ ： n$\bar{p}$ + $3\sqrt{n\hat{p}(1-\hat{p})}$

C L$_{np}$ ： n$\bar{p}$

LCL$_{np}$ ： n$\bar{p}$ - $3\sqrt{n\hat{p}(1-\hat{p})}$

補充教材_ $\hat{p} = \frac{X}{n}$

二項分配機率密度函數 $f(x;n,p) = \binom{n}{x} p^x q^{n-x}$

隨機變數X表示成功x次的次數

Ex : 硬幣骰10次出現4次正面的機率 = $\binom{10}{4} 0.5^4 0.5^6$ = 210*$\frac{1}{1024}$ = 0.205 = 20.5%

If

X~Bin(n, p)

E(X) = np

Var(X) = npq

then

$\hat{p} = \frac{X}{n}$

E($\hat{p}$) = $\hat{p}$

Var($\hat{p}$) = $\frac{\hat{p} * \hat{q}}{n}$

SPC建構範例
Calculation Example

Phase 1

- 基礎期

將製程參數調整到管制界限內

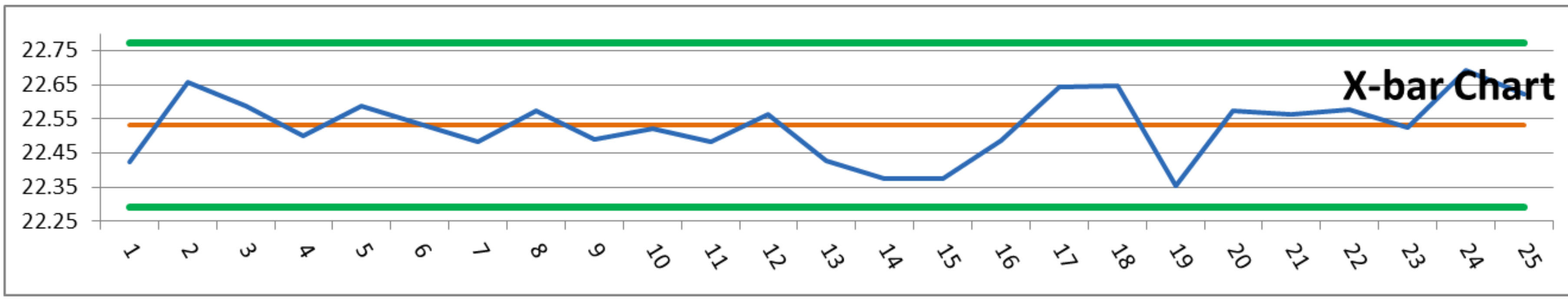
Phase 2

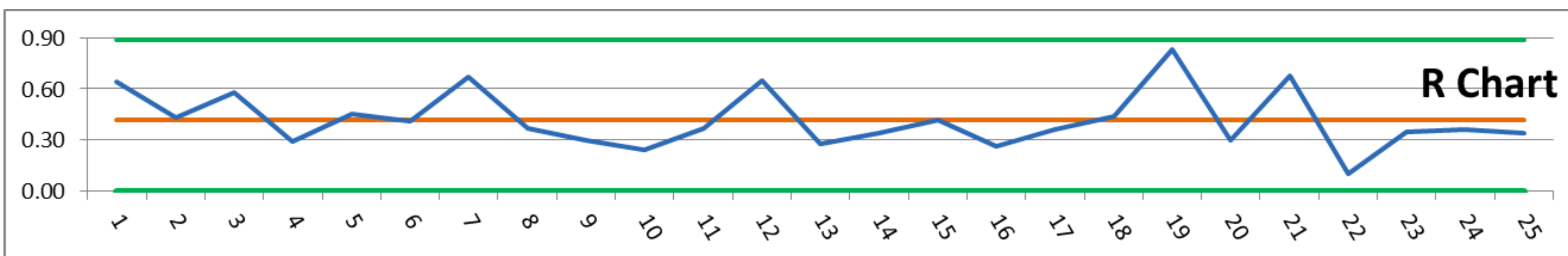
- 監控期：

持續監控製程參數，並針對不隨機的型態進行OCAP(Out of Control Action)

SPC建構範例
Calculation Example

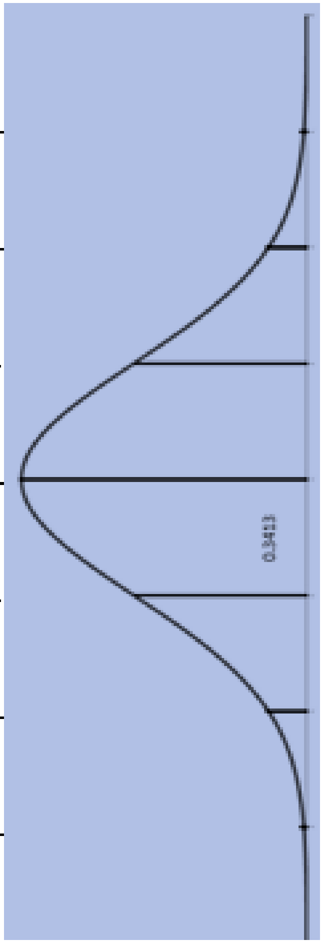
25		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
X barbar	22.53	22.42	22.7	22.6	22.5	22.6	22.5	22.5	22.6	22.5	22.5	22.5	22.6	22.4	22.4	22.4	22.5	22.6	22.6	22.4	22.6	22.6	22.6	22.5	22.7	22.6
樣本值	1	22.3	22.9	22.9	22.4	22.6	22.4	22.2	22.6	22.6	22.4	22.3	22.5	22.3	22.4	22.3	22.7	22.5	22.8	22.7	22.5	22.5	22.5	22.5	22.8	22.8
	2	22.54	22.7	22.7	22.7	22.7	22.3	22.4	22.7	22.5	22.6	22.6	22.3	22.6	22.2	22.4	22.5	22.9	22.6	22.8	22.6	22.4	22.5	22.6	22.5	22.7
	3	22.01	22.4	22.5	22.5	22.8	22.8	22.9	22.4	22.5	22.5	22.4	22.4	22.4	22.5	22.3	22.4	22.6	22.8	21.9	22.5	22.3	22.6	22.4	22.9	22.5
	4	22.62	22.6	22.3	22.4	22.6	22.7	22.5	22.5	22.5	22.4	22.7	22.7	22.6	22.2	22.3	22.4	22.6	22.7	22	22.8	22.7	22.6	22.5	22.7	22.8
	5	22.65	22.7	22.6	22.6	22.3	22.5	22.5	22.7	22.3	22.6	22.6	22.9	22.3	22.6	22.7	22.5	22.7	22.4	22.5	22.6	23	22.6	22.7	22.5	22.4
R bar	0.418	0.64	0.43	0.58	0.29	0.45	0.41	0.67	0.37	0.3	0.24	0.37	0.65	0.28	0.34	0.42	0.26	0.36	0.44	0.83	0.3	0.68	0.1	0.35	0.36	0.34
S	0.189	0.269	0.16	0.22	0.11	0.16	0.19	0.25	0.15	0.11	0.11	0.15	0.26	0.14	0.14	0.17	0.1	0.13	0.18	0.38	0.11	0.28	0.05	0.13	0.17	0.15





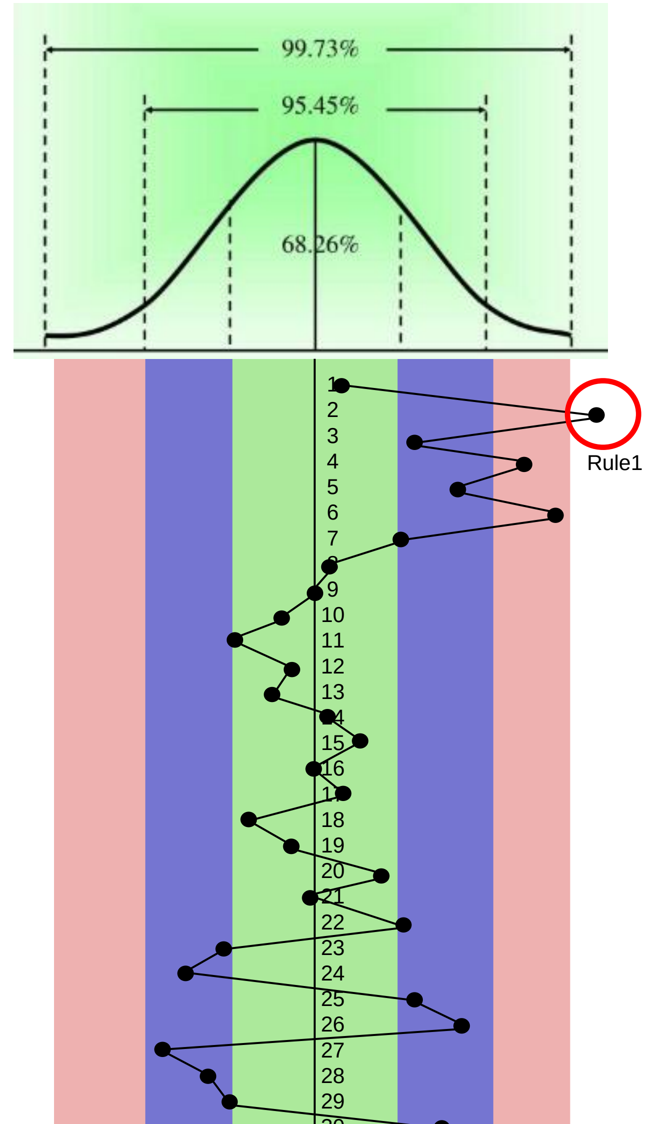
SPC異常型態
Nonrandom patterns

	Zone D1	$P\{D1\} = 0.00135$
UCL		
	Zone A1	$P\{A1\} = 0.02140$
	Zone B1	$P\{B1\} = 0.13591$
	Zone C1	$P\{C1\} = 0.34134$
CL		
	Zone C2	$P\{C2\} = 0.34134$
	Zone B2	$P\{B2\} = 0.13591$
	Zone A2	$P\{A2\} = 0.02140$
LCL		
	Zone D2	$P\{D2\} = 0.00135$



SPC異常型態
Nonrandom patterns

	Summary of Typical Special Cause Criteria
1	1 point more than 3 standard deviations[21] from centerline
2	7 points in a row on same side of centerline
3	6 points in a row, all increasing or all decreasing
4	14 points in a row, alternating up and down
5	2 out of 3 points > 2 standard deviations from centerline (same side)
6	4 out of 5 points > 1 standard deviation from centerline (same side)
7	15 points in a row within 1 standard deviation of centerline (either side)
8	8 points in a row > 1 standard deviation from centerline (either side)



- Practice to find nonrandom patterns in the picture.
- Nonrandom patterns are invented according to probability, one may find the calculation of probability through the link below
  http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1060&context=cssmwp

- P1 = (1-0.9973) = 0.0027
- P2 = 2*(0.5)^7 = 0.0156
- P3 = (1 +1) / 6! = 2/720 = 0.00278
- P4 = 398721962/14! = 0.00457
- P5 = 2*3*(0.02275)^2*0.97725 + 2*(0.02275)^3 = 0.00306
- P6 = 2*5*(0.15865)^4*0.84135 + 2*(0.15865)^5 = 0.00553
- P7 = (0.68268)^15 = 0.00326
- P8 = (0.31732)^8 = 0.0001

製程能力/製程績效指標
Process Capability / Process Performance Indices

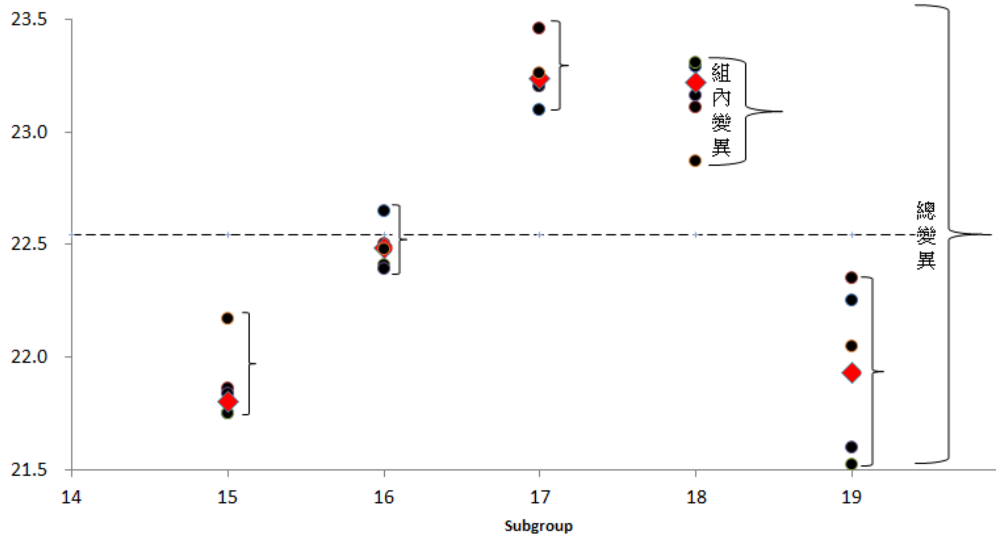
- 製程能力指標 → 數值觀察製程符合客戶規格的能力
- Control Chart → 圖形及3σ的標準判定製程是否穩定

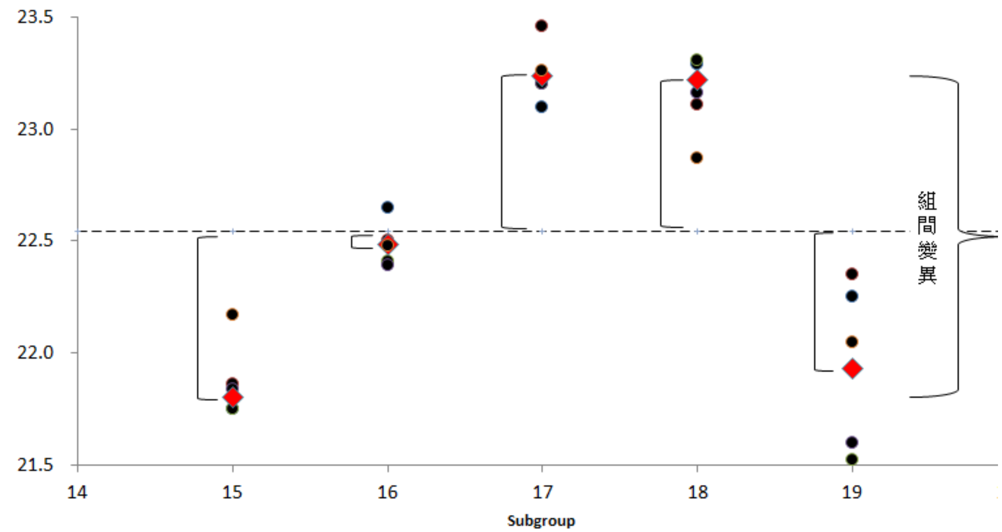
- 使用製程能力指標的先決條件
  1. 製程須穩定、在統計管制內
  2. 取得的資料須趨近常態分配
  3. 產品規格建立於客戶需求之上
  4. 不應以單獨指標觀察製程能力

- Cpk、Ppk、Cp、Pp的公式涵義及計算

- Cpk與Ppk的差異
  Cpk：For determining whether or not a process **is capable of meeting customer requirements.**
  Ppk：Shows whether the process performance **is actually meeting the customer requirements.**

製程能力/製程績效指標
Process Capability / Process Performance Indices





組內變異 Within Subgroup Variation

- 用$\frac{\bar{R}}{d_2}$估計 or 用$\frac{\bar{S}}{C_4}$估計

組間變異 Between Subgroup Variation

- Should be very small when process is under statistical control

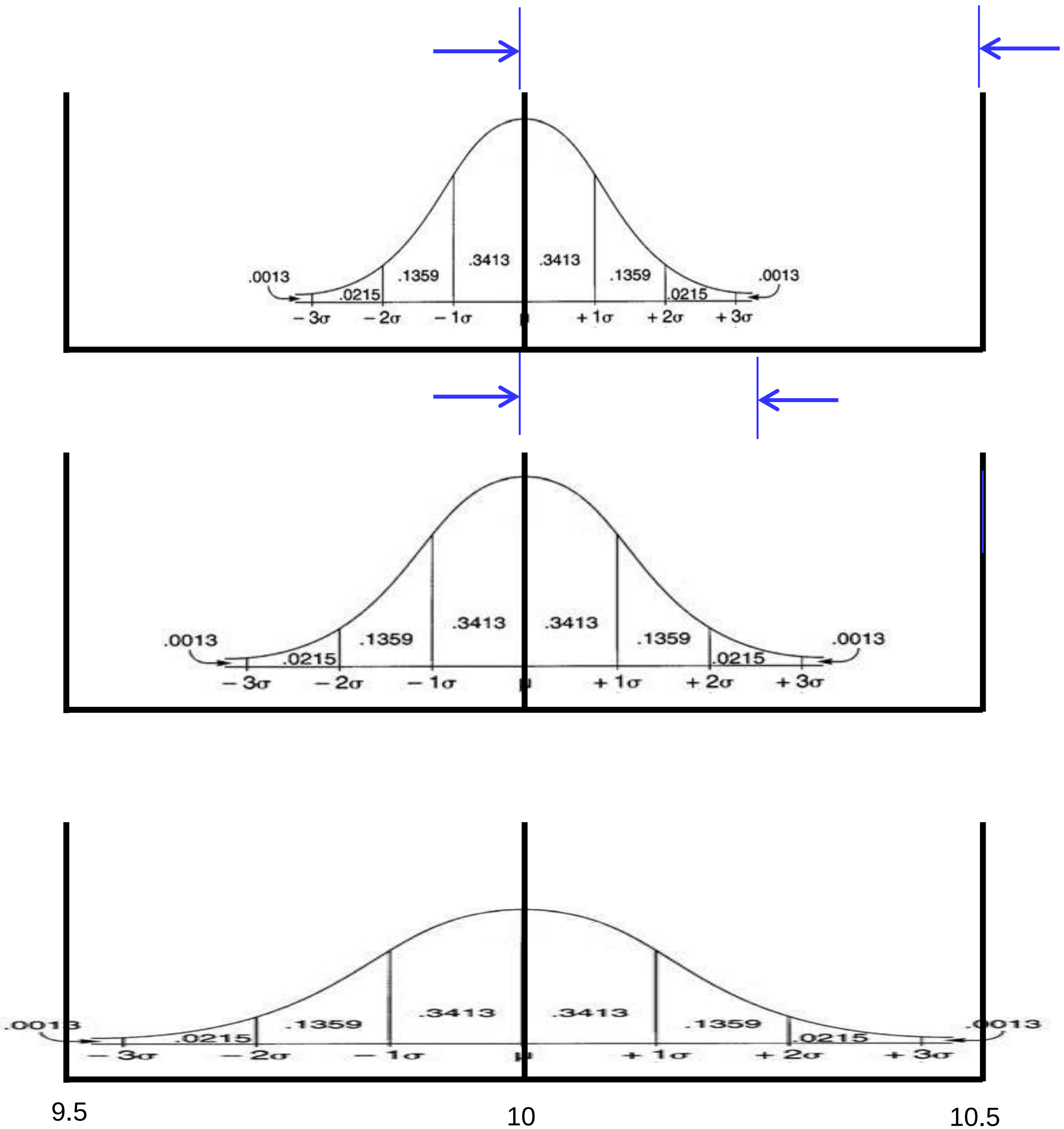
總變異 Total Variation

- $S = \sigma_P = \sqrt{\sum_i^n \frac{(x_i - \bar{x})^2}{n-1}}$

Indices

- C_{pk}= min $\left\{\frac{USL-\bar{\bar{X}}}{3\left(\bar{\bar{R}}/d_2\right)}, \frac{\bar{\bar{X}}-LSL}{3\left(\bar{\bar{R}}/d_2\right)}\right\}$
- P_{pk}= min $\left\{\frac{USL-\bar{\bar{X}}}{3S}, \frac{\bar{\bar{X}}-LSL}{3S}\right\}$
- $C_p = \frac{USL-LSL}{6\left(\bar{\bar{R}}/d_2\right)}$
- $P_p = \frac{USL-LSL}{6S}$

製程能力/製程績效指標
Process Capability / Process Performance Indices



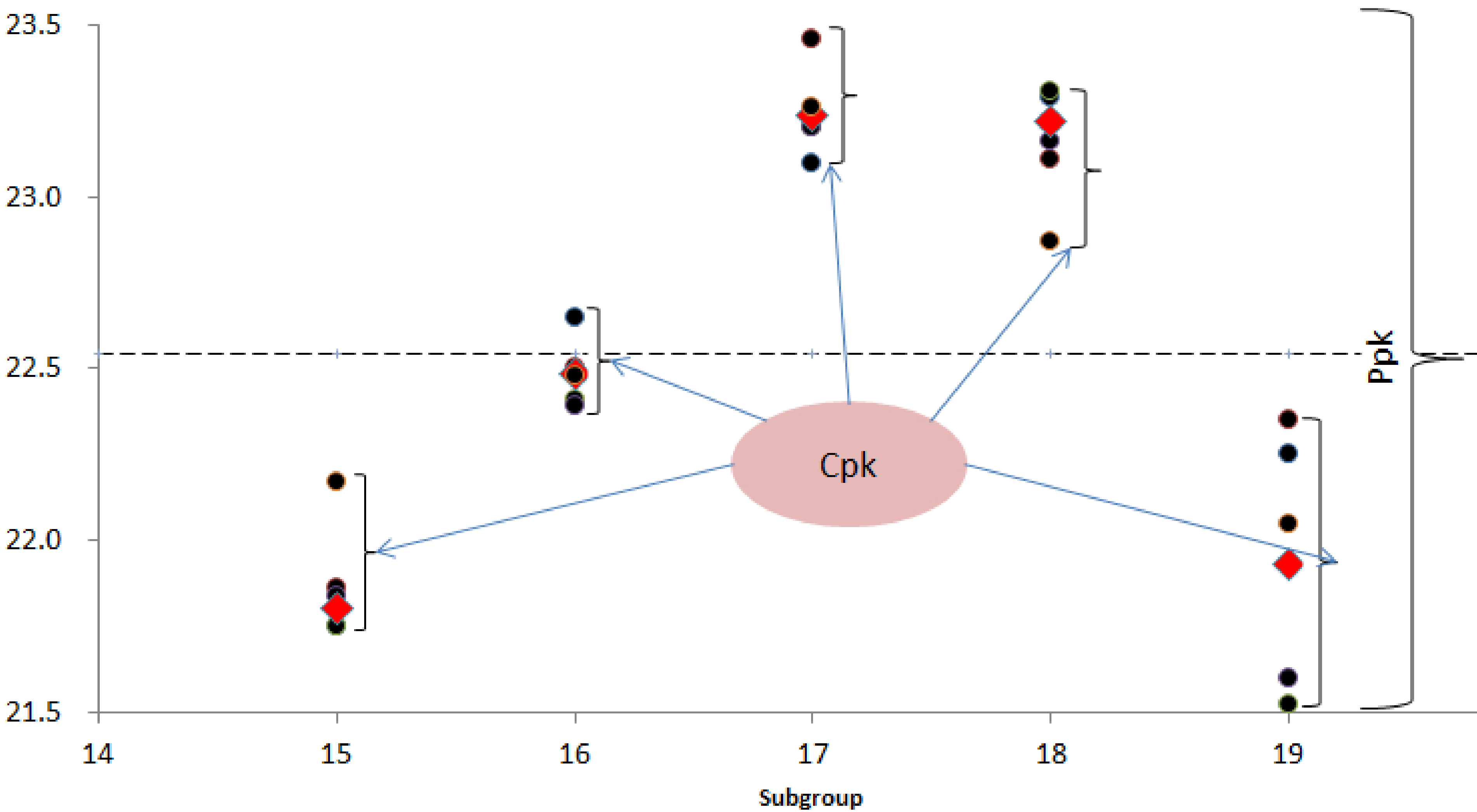
組內變異 Within Subgroup Variation
- 用$\frac{\bar{R}}{d_2}$估計 or 用$\frac{\bar{S}}{C_4}$估計

組間變異 Between Subgroup Variation
- Should be very small when process is under statistical control

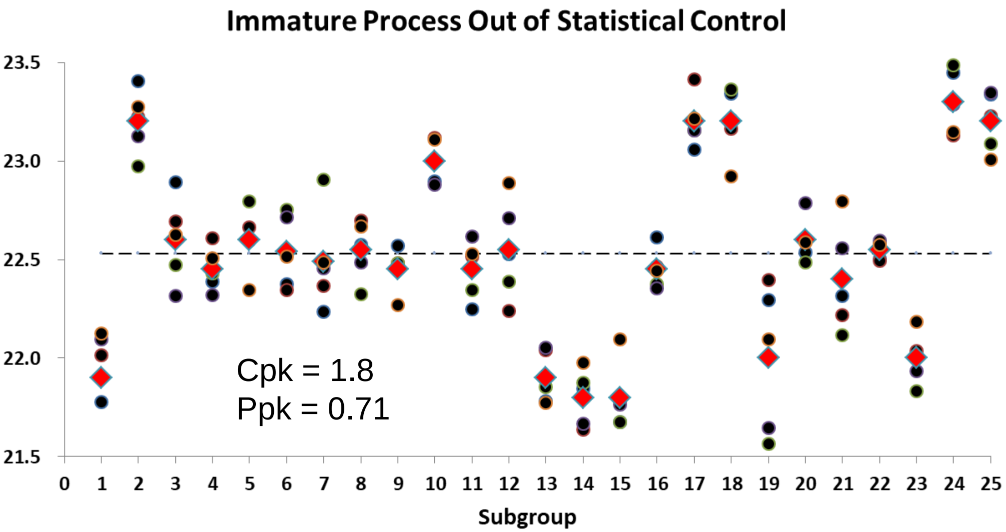
總變異 Total Variation
- $S = \sigma_P = \sqrt{\sum_i^n \frac{(x_i - \bar{x})^2}{n-1}}$

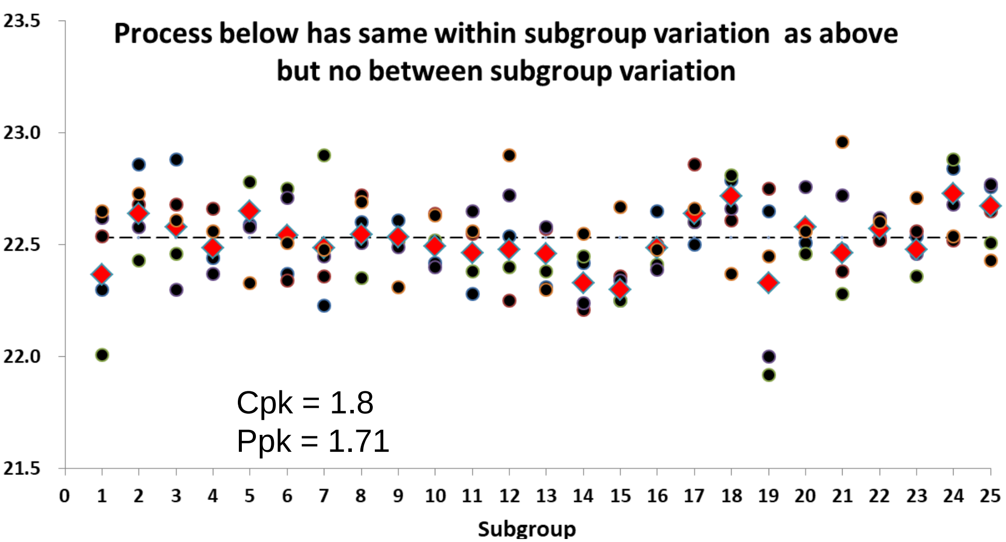
Indices
- C_{pk}= min $\left\{\frac{USL-\bar{\bar{X}}}{3\left(\bar{\bar{R}}/d_2\right)}, \frac{\bar{\bar{X}}-LSL}{3\left(\bar{\bar{R}}/d_2\right)}\right\}$
- P_{pk}= min $\left\{\frac{USL-\bar{\bar{X}}}{3S}, \frac{\bar{\bar{X}}-LSL}{3S}\right\}$
- $C_p = \frac{USL-LSL}{6\left(\bar{\bar{R}}/d_2\right)}$
- $P_p = \frac{USL-LSL}{6S}$

製程能力/製程績效指標
Process Capability / Process Performance Indices



製程能力/製程績效指標
Process Capability / Process Performance Indices





組內變異 Within Subgroup Variation

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組間變異 Between Subgroup Variation

- Should be very small when process is under statistical control

總變異 Total Variation

- $S = \sigma_P = \sqrt{\sum_i^n \frac{(x_i - \bar{x})^2}{n-1}}$

Indices

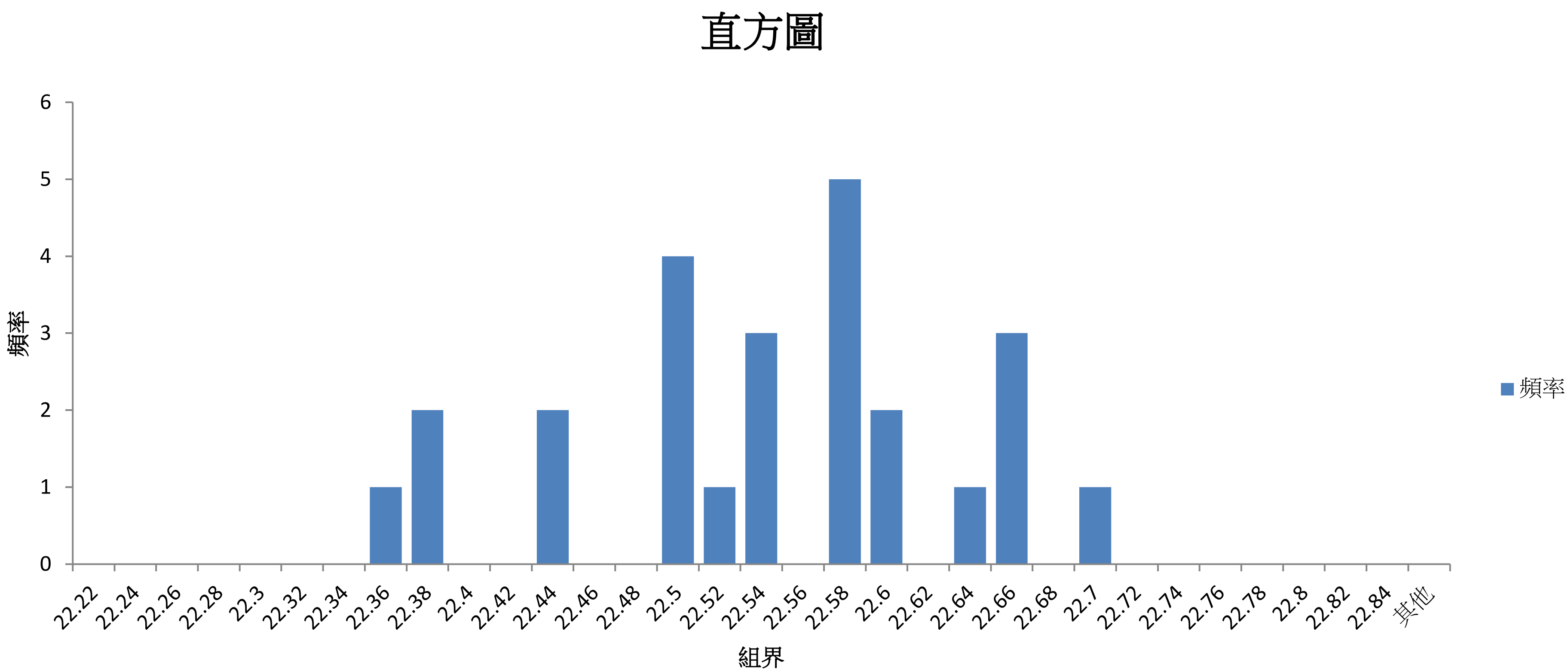
- $C_{pk} = \min\left\{\frac{USL-\bar{\bar{X}}}{3\left(\bar{\bar{R}}/d_2\right)}, \frac{\bar{\bar{X}}-LSL}{3\left(\bar{\bar{R}}/d_2\right)}\right\}$
- $P_{pk} = \min\left\{\frac{USL-\bar{\bar{X}}}{3S}, \frac{\bar{\bar{X}}-LSL}{3S}\right\}$
- $C_p = \frac{USL-LSL}{6\left(\bar{\bar{R}}/d_2\right)}$
- $P_p = \frac{USL-LSL}{6S}$

製程能力計算範例
Capability Index Calculation Example

25		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
X barbar	22.53	22.42	22.66	22.59	22.50	22.59	22.54	22.48	22.57	22.49	22.52	22.48	22.56	22.43	22.37	22.37	22.49	22.64	22.65	22.35	22.57	22.56	22.58	22.53	22.69	22.62
	1	22.30	22.86	22.88	22.44	22.59	22.37	22.23	22.60	22.61	22.42	22.28	22.54	22.31	22.42	22.25	22.65	22.50	22.79	22.65	22.51	22.48	22.53	22.54	22.84	22.76
	2	22.54	22.68	22.68	22.66	22.65	22.34	22.36	22.72	22.52	22.64	22.55	22.25	22.57	22.21	22.36	22.50	22.86	22.61	22.75	22.58	22.38	22.52	22.56	22.52	22.65
樣本值	3	22.01	22.43	22.46	22.48	22.78	22.75	22.90	22.35	22.52	22.52	22.38	22.40	22.38	22.45	22.25	22.41	22.60	22.81	21.92	22.46	22.28	22.61	22.36	22.88	22.51
	4	22.62	22.58	22.30	22.37	22.58	22.71	22.45	22.51	22.49	22.40	22.65	22.72	22.58	22.24	22.34	22.39	22.60	22.66	22.00	22.76	22.72	22.62	22.46	22.68	22.77
	5	22.65	22.73	22.61	22.56	22.33	22.51	22.48	22.69	22.31	22.63	22.56	22.90	22.30	22.55	22.67	22.48	22.66	22.37	22.45	22.56	22.96	22.60	22.71	22.54	22.43
R bar	0.418	0.64	0.43	0.58	0.29	0.45	0.41	0.67	0.37	0.3	0.24	0.37	0.65	0.28	0.34	0.42	0.26	0.36	0.44	0.83	0.3	0.68	0.1	0.35	0.36	0.34
S	0.189	0.27	0.16	0.22	0.11	0.16	0.19	0.25	0.15	0.11	0.11	0.15	0.26	0.14	0.14	0.17	0.1	0.13	0.18	0.38	0.11	0.28	0.05	0.13	0.17	0.15
UCL		22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77	22.77
CL		22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53
LCL		22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29	22.29
UCLr		0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
CLr		0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
LCLr		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

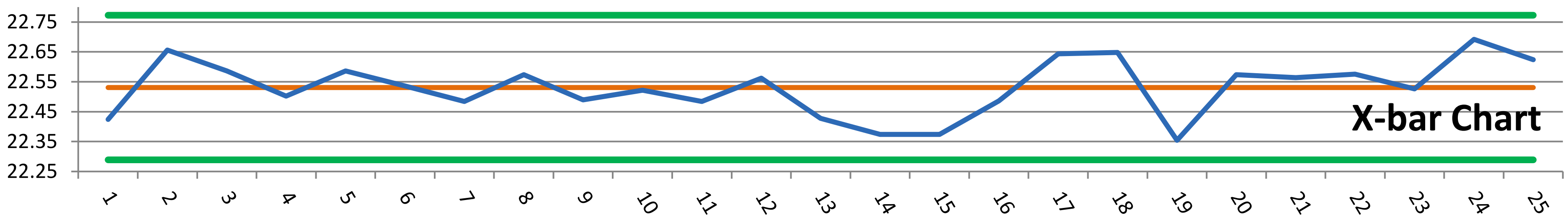
製程能力計算範例
Capability Index Calculation Example

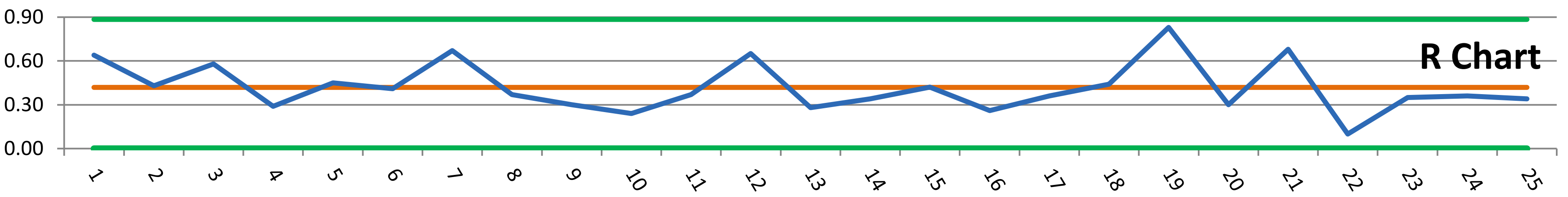
1. 確認資料的常態性



製程能力計算範例
Capability Index Calculation Example

2. 確認Control chart是否在統計管制內





製程能力計算範例
Capability Index Calculation Example

3. 計算Cpk, Cp, Ppk, Pp

Cpk	1.796	Cp	1.853
Ppk	1.712	Pp	1.767
USL	23.5		
LSL	21.5		
d2	2.326		
R-bar	0.418		
R-bar/d2	0.1799		

製程能力計算範例
Capability Index Calculation Example

4. 作出結論

Cpk	1.796	Cp	1.853
Ppk	1.712	Pp	1.767
USL	23.5		
LSL	21.5		
d2	2.326		
R-bar	0.418		
R-bar/d2	0.1799		

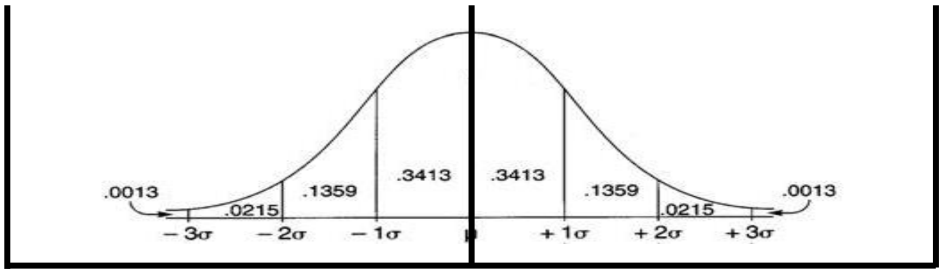
Cpk	1.796	Cp	1.853
Ppk	1.712	Pp	1.767
USL	23.5		
LSL	21.5		
d2	2.326	C4	0.94
R-bar	0.418	S-bar	0.171
R-bar/d2	0.1799	S-bar/C4	0.182

- Cp與Cpk相近 & Pp與Ppk相近：
- Cp與Pp相近 & Cpk與Ppk相近：

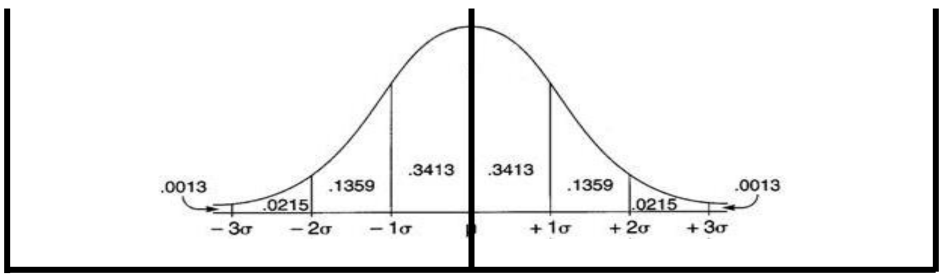
製程能力/製程績效指標
Process Capability / Process Performance Indices

- 為什麼Cpk > 1.33 or 1.66才叫好?

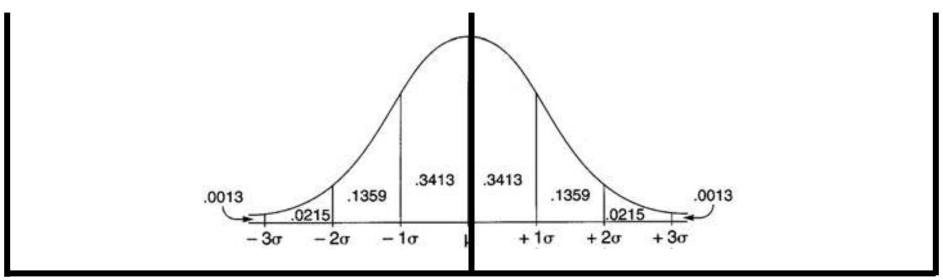
為說明方便 設$\bar{\bar{x}} = \frac{T}{2}$



$C_{pk} = \frac{T/2}{3\sigma}$ = 1.33
⇒ T/2 = 4σ
⇒ T = 8σ

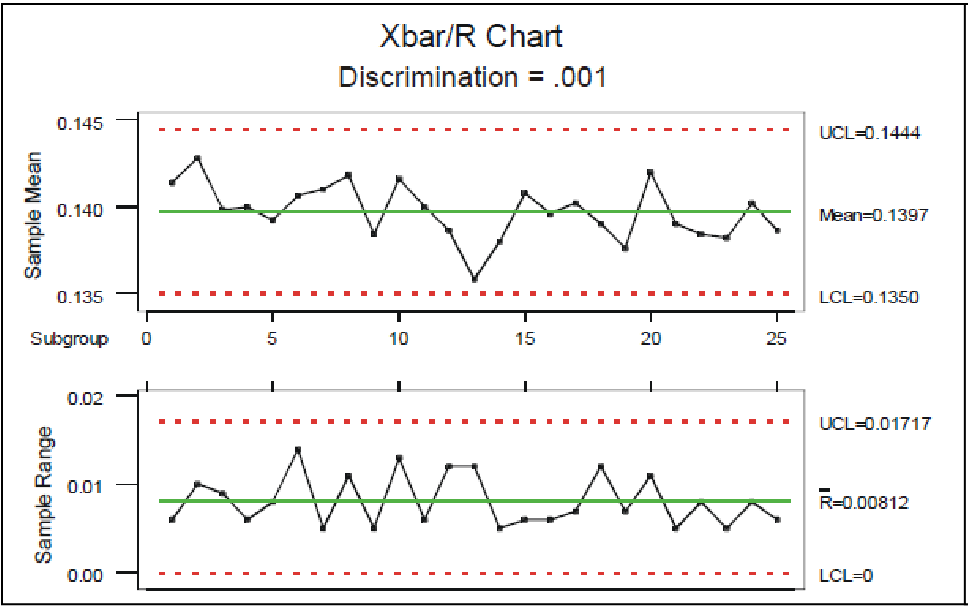


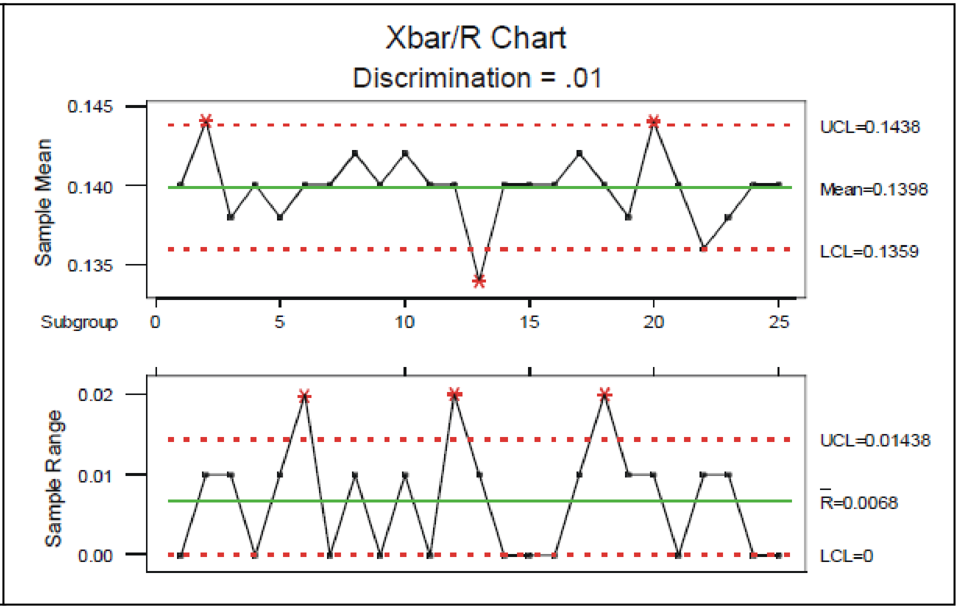
$C_{pk} = \frac{T/2}{3\sigma}$ = 1.66
⇒ T/2 = 5σ
⇒ T = 10σ



$C_{pk} = \frac{T/2}{3\sigma}$ = 2.00
⇒ T/2 = 6σ
⇒ T = 12σ

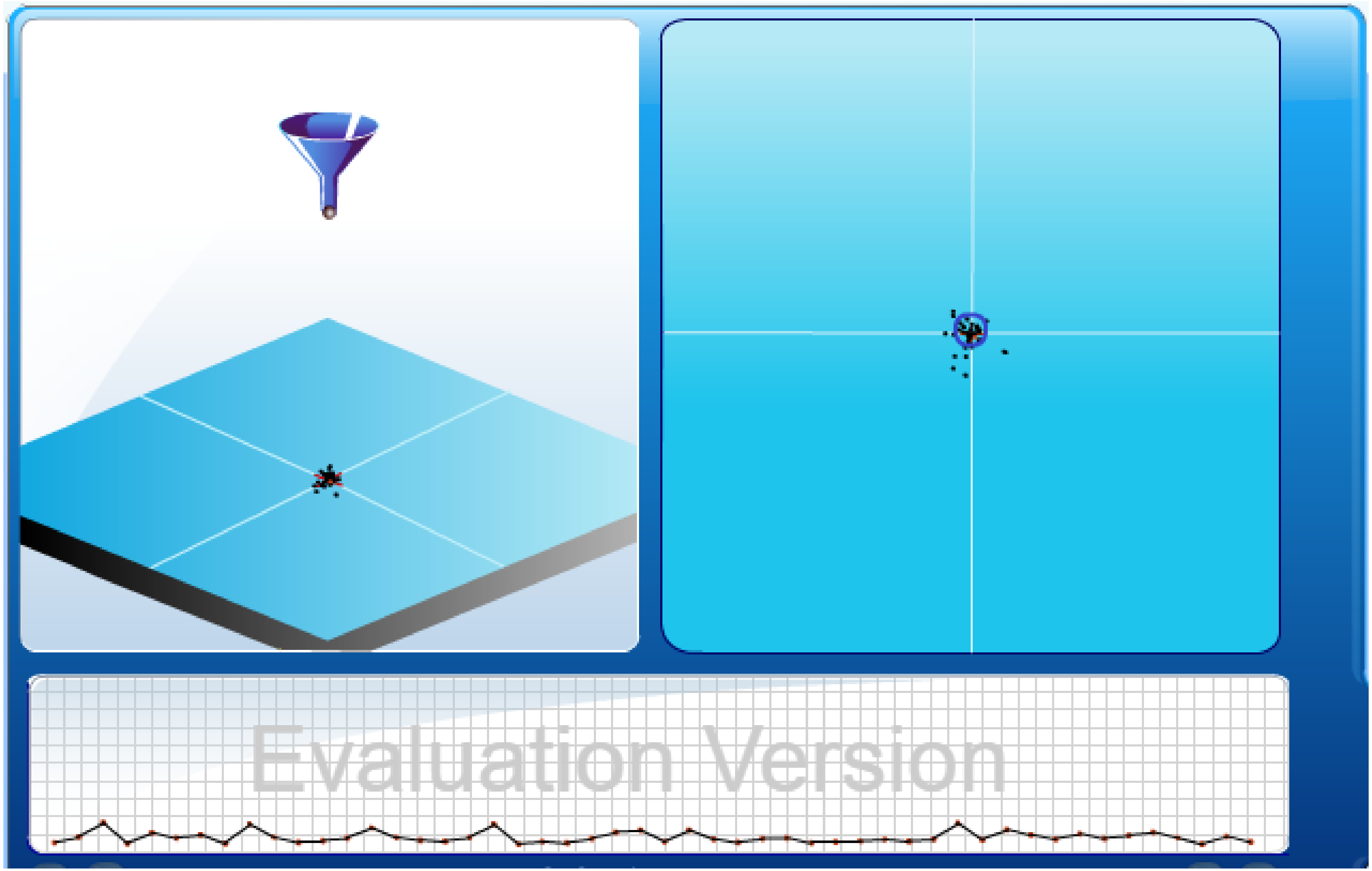
量測解析度對管制圖R chart的影響
Effects of Measurement Discrimination on Control Chart





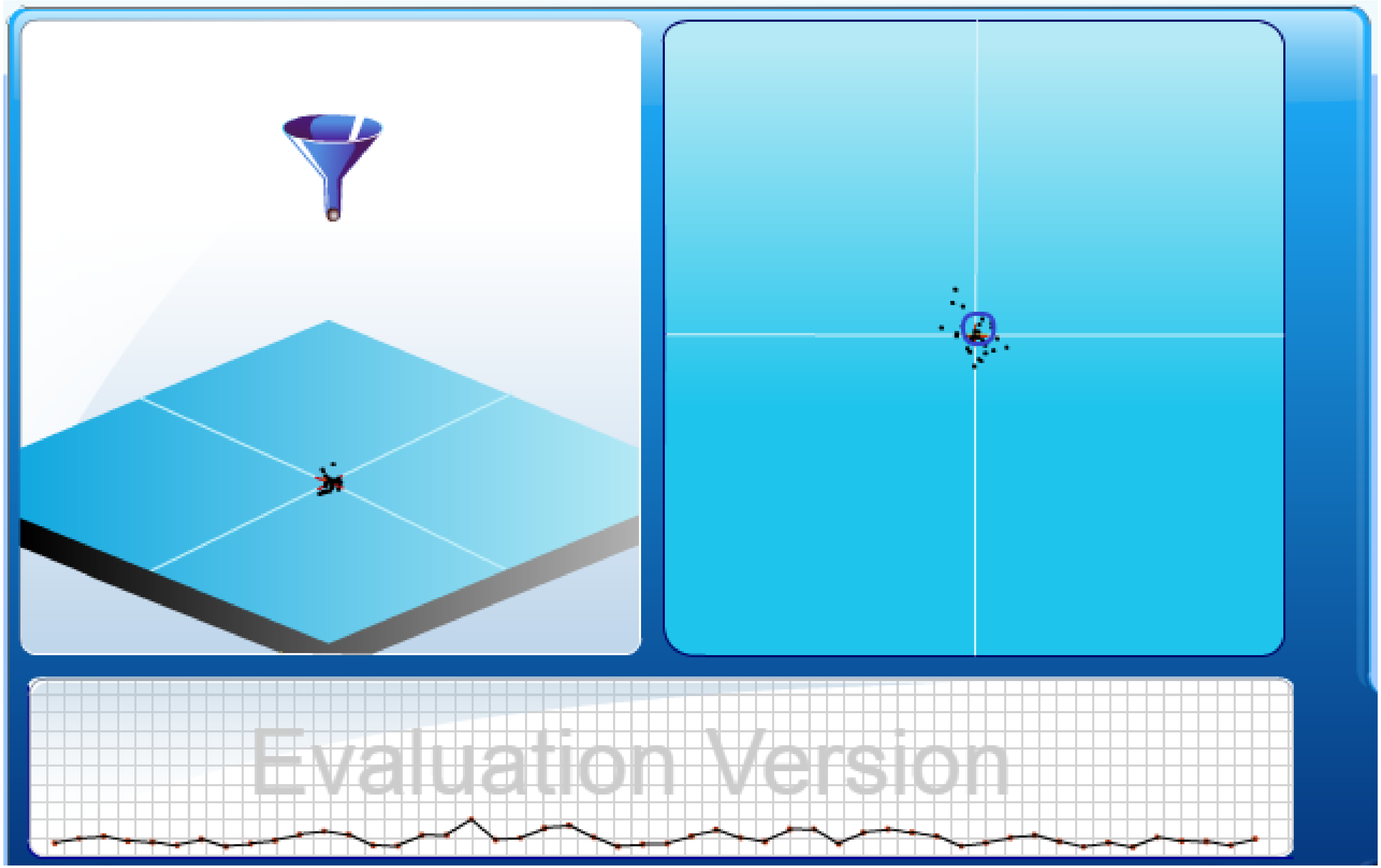
Over-adjustment

Funnel Experiment Rule1 The process is not adjusted.



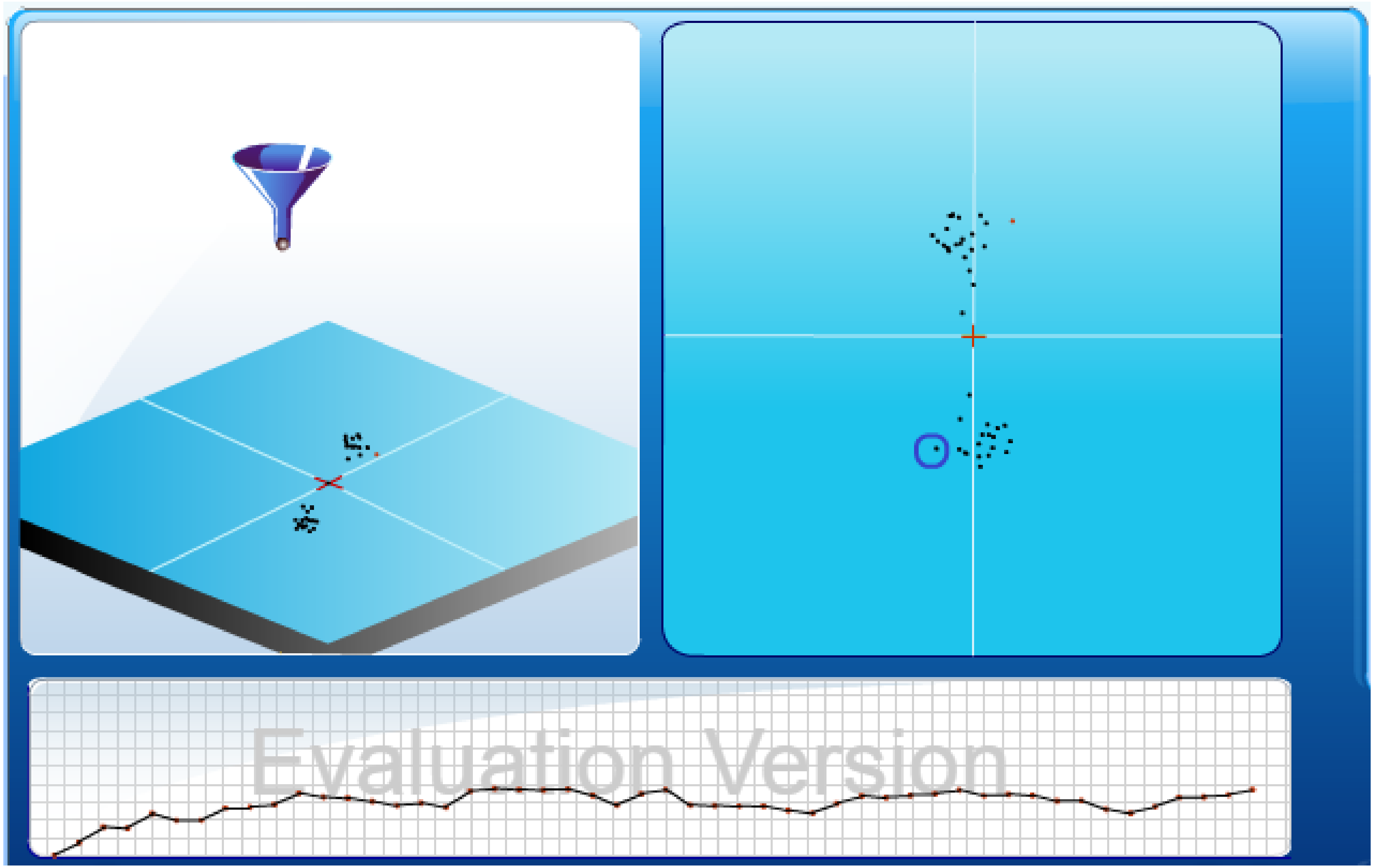
Over-adjustment

Funnel Experiment Rule2 The process is adjusted at every observation.



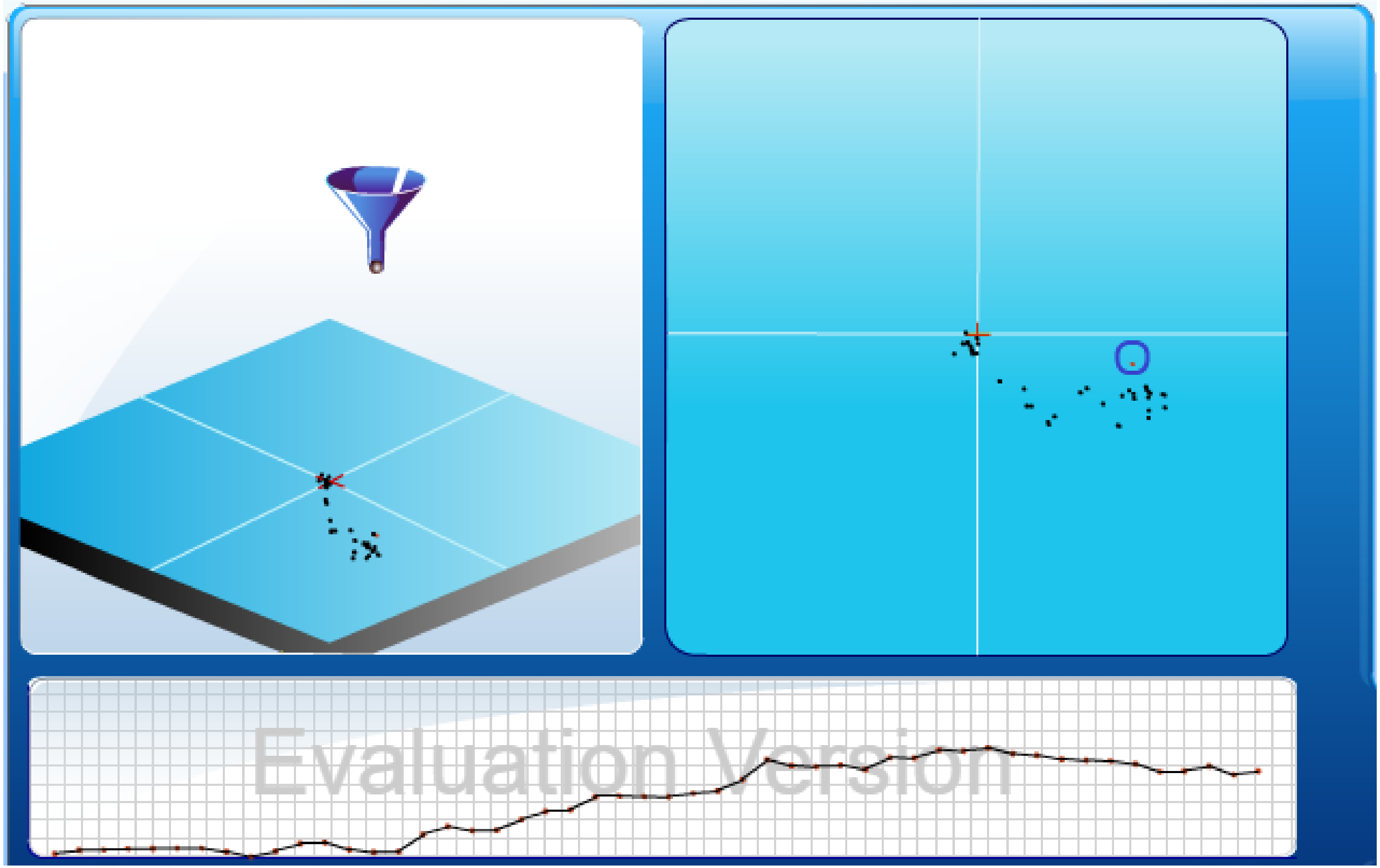
Over-adjustment

Funnel Experiment Rule3 The process is adjusted at every observation.



Over-adjustment

Funnel Experiment Rule4 The process is adjusted at every observation.



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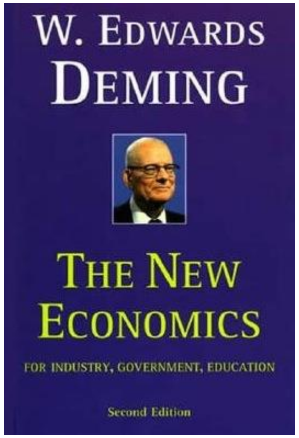
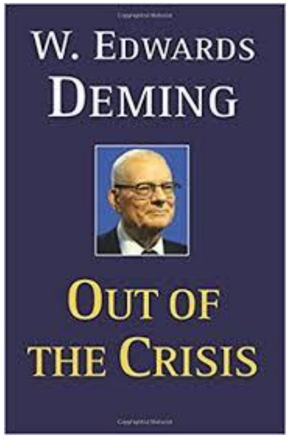
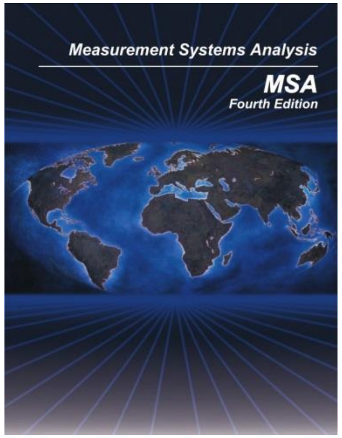
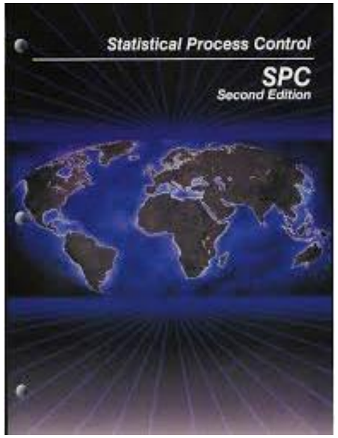
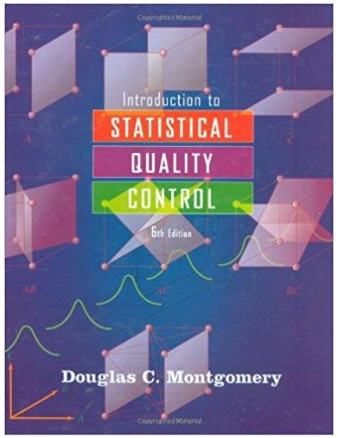
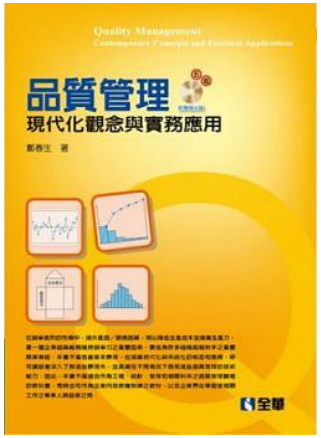












Outline

什麼是品質? What is Quality?

管制圖原理 Control Chart Principles

管制圖計算 Calculations of Control Charts

管制圖建構範例 An Example of Constructing Control Charts

管制圖的非隨機樣式 Non-random Patterns

製程能力/績效指標 Process Capability/Performance Indices

製程能力/績效指標計算範例 An Example of Calculation of Cpk and Ppk

參考資料 / Q&A Reference / Q&A

SPC in Mobile Quality System

IATF 16949:2016 & ISO 9001:2015

品質管理系統要求

9.1.1.1 製程監控與量測

組織應對所有新的製程(包括裝配和排序)進行過程研究，以驗證過程能力並提供額外的過程管制輸入，包括對特殊特性的管制。

備註：有某些製程，無法用過程能力來展現產品符合性，對此，其他的替代方案可以被使用，例如對於規格的批合格率。

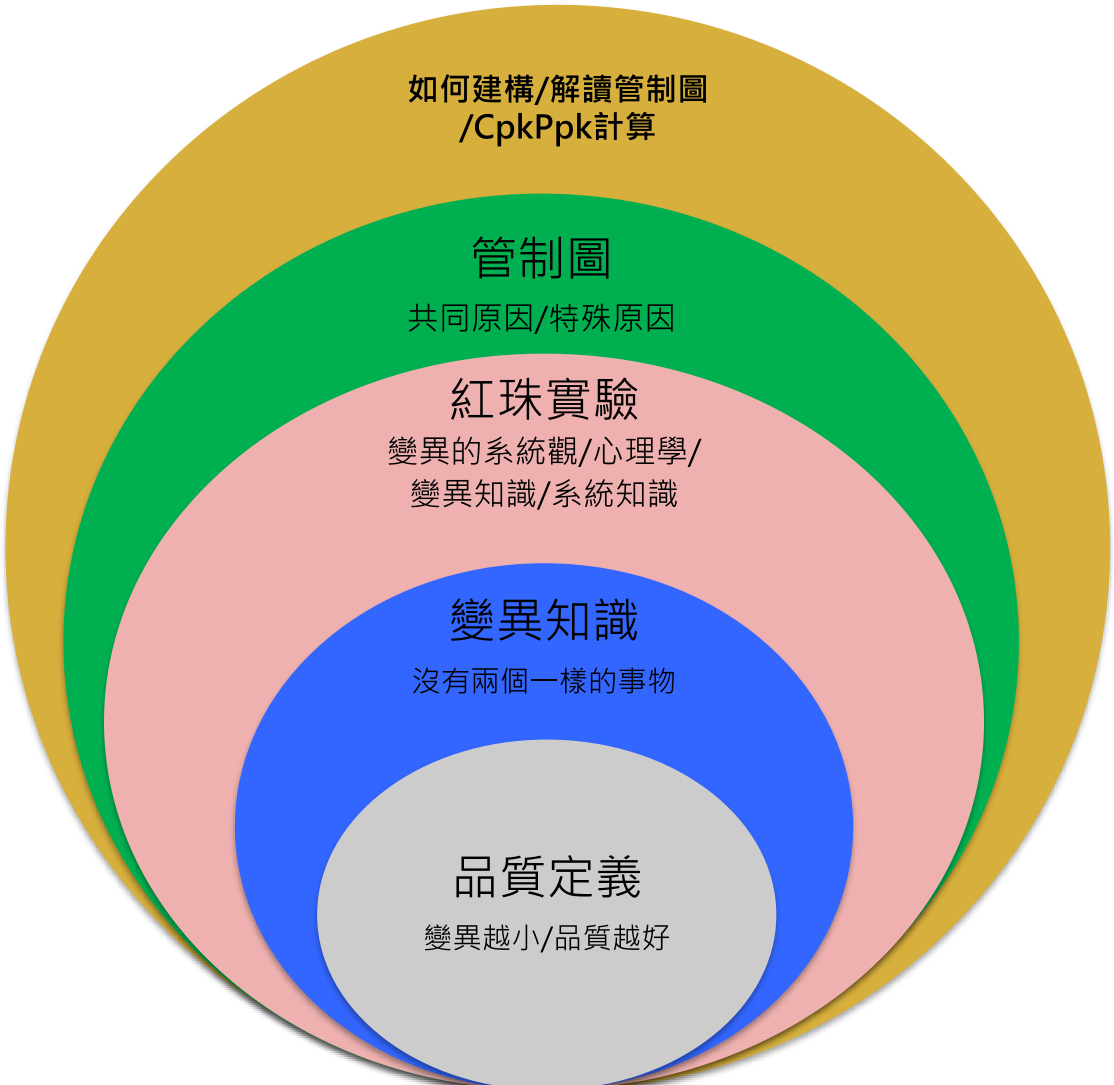
9.1.1.2 統計工具的界定

組織應決定適當的統計工具使用。組織應驗證適當的統計工具有被包含在先期產品品質規劃(或等同的)流程中，並包括在設計風險分析(例如 DFMEA)、過程風險分析(例如 PFMEA)及管制計畫中。

9.1.1.3 統計概念的應用

統計概念，如變異、控制(穩定)、過程能力、過度調整的後果，應被參與收集、分析、和管理統計資料的員工所理解及使用。

變異知識體系



如何建構/解讀管制圖
/CpkPpk計算
管制圖
共同原因/特殊原因
紅珠實驗
變異的系統觀/心理學/
變異知識/系統知識
變異知識
沒有兩個一樣的事物
品質定義
變異越小/品質越好

IATF16949 SPC Manual

- **Chapter1**
  Continual improvement and Statistical Process Control
  Prevention V.S. Detection
  A Process Control System
  Common Cause and Special Cause
  Local Actions and Actions on the system
  Process Control and Process Capability
  Control V.S. Capability
  Process Indices
  The process improvement cycle and process control
  Control charts: Tools for process control and improvement
  Effective use and benefits of control charts
- **Chapter2**
  Control charts
  Control charts process
  Defining "Out of control" signals
  Control chart formulas
- **Chapter3**
  Other types of control charts
- **Chapter4**
  Understanding process capability and process performance for variables data
  Definitions of process terms
  Process measures for predictable processes
  Description of conditions
  Handling non-normal and multivariate distributions
  Suggested use of process measures
- **Appendix**
  Some comments on sampling
  Some comments on special cause(Over-adjustment, time-dependent processes, repeating patterns)
  Selection procedure for the use of the control charts described in this manual
  Relationship between Cpm and other indices
  Tables of constants and formulas for control charts
  Capability index calculation example
  Glossary of terms and symbols
  References and suggested readings
  Standard normal tables

Q & A

Thank You