Lektion 5

2006-11-13
Kapitel 4
Statistisk processtyrning

http://www.varians.se/HSIDA/index.htm

Hög produktkvalitet

- Repeterbarhet och stabilitet
- Statistisk processtyrning
- Reglerteknik

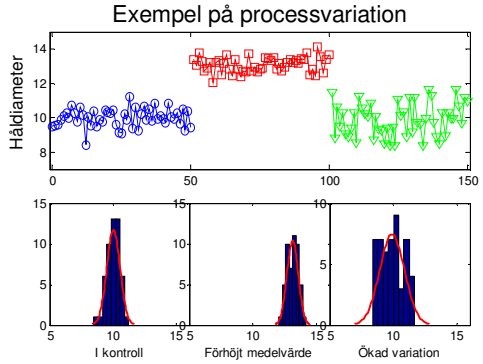
SPS
7 bra verktyg (*Bergman*)

1. Histogram
2. Check sheet (*datainsamling*)
3. Paretodiagram
4. Cause-and-effect diagram. (*fiskbensdiagram, Ishikawadiagram*)
5. Defect concentration diagram (*stratifiering??*)
6. Scatter diagram (*sambandsdiagram*)
7. Control chart (*styrdiagram*)

Statistisk processstyrning

- Kapitel 4: *Grunder och filosofi*
- Kapitel 5: *Styrdiagram för variabeldata*
- Kapitel 6: *Styrdiagram för attributdata*
- Kapitel 8: *CUMSUM och EWMA*
- Kapitel 9: *Autokorrelerade data*
- Kapitel 10: *Multivariat processstyrning*
- Kapitel 11: *Reglerteknik och SPS*

Exempel på processvariation

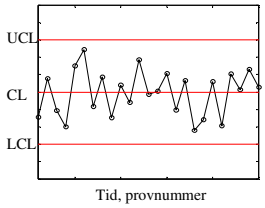


Kör matlabexemplet!

Variationskällor

- Slumpmässiga källor (*chance causes*)
  - Slumpmässig variation
  - Bakgrundsbrus
  - Statistisk kontroll, stabil
- Systematiska källor (*assignable causes*)
  - Orsak finns
  - Ej i statistisk kontroll (out of control)
  - Ej stabil.
- SPS är till för att upptäcka och eliminera systematiska källor!

Styrdiagramet



$$\begin{cases} H_0: & \mu = \mu_0 \\ H_1: & \mu \neq \mu_0 \end{cases}$$

Typ I fel: Falsklarm
Typ II fel: Ej larma.

OBS: styrgränser ≠ toleransgränser

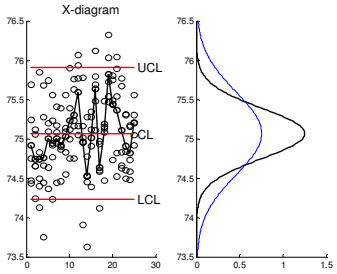
Shewhart styrdiagram

$$\begin{cases} UCL = \bar{x} + L\sigma_{\bar{x}} \\ CL = \bar{x} \\ LCL = \bar{x} - L\sigma_{\bar{x}} \end{cases}$$

Medelvärdet sprider mindre: ×

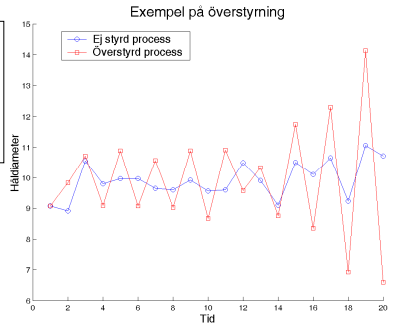
$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

L=3 eller 3.09 (ofta)



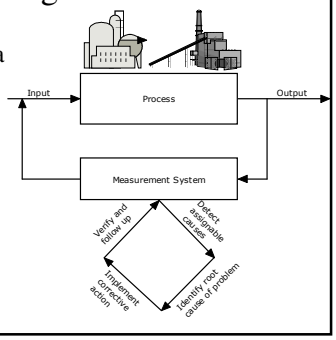
Styr ej på enskilda värden!

Adderar variation!



Styrdiagram

- Man kan ej övervaka fram hög kvalitet – agera!
- Out-of-Control Plan OCAP



OCAP – viktig!

Analysera systemet:
- S-FMEA
- Felträdsanalys
- Försöksplanering
- Fiskbensdiagram
- Et.c.

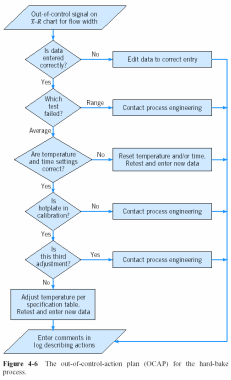


Figure 4-6 The out-of-control-action plan (OCAP) for the hard-bake process.

Mer principer

- Styrdiagram kan användas för analys av *processkapabilitet*.
- Två generella typer av planer
  - Variabelkontroll
  - Attributkontroll
- Konstruktion av SPS
  - Provstorlekar, frekvens, riskbedöming…

Olika typer av processvariation

- Stationära och okorrelerade processer
- Stationära och korrelerade processer
- Icke stationära processer

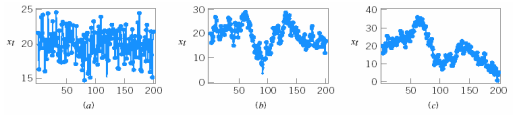


Figure 4-7 Data from three different processes. (*a*) Stationary and uncorrelated (white noise). (*b*) Stationary and autocorrelated. (*c*) Nonstationary.

Reasons for Popularity of Control Charts (enligt Montgomery)

1. Control charts are a proven technique for improving productivity.
2. Control charts are effective in defect prevention.
3. Control charts prevent unnecessary process adjustment.
4. Control charts provide diagnostic information.
5. Control charts provide information about process capability.

Styrgränser

- Påverkar både **typ I** och **typ II** fel.
- 3-σ styrgränser
  - P(Typ I) = 0.0027
- Sannolikhetsgränser
  - P(Typ I) väljes direkt.
  - Ex. 0.002 ger 3.09-σ gränser
- Varningsgränser vid 2-σ gränser
  - Ökand känslighet
  - Adaptiva provplaner

Storlek och frekvens på proven

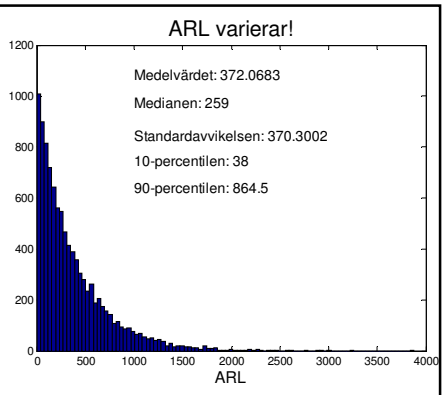
- Små ofta eller stora sällan?
- Stora stickprov upptäcker mindre skift.
- Average run length: $ARL = \frac{1}{p}$

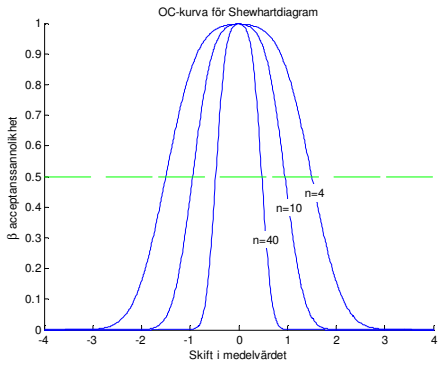
$$ARL_0 = \frac{1}{p} = \frac{1}{0.0027} = 370$$

- Average time to signal: $ARLS = ARL \cdot h$

ARL varierar!

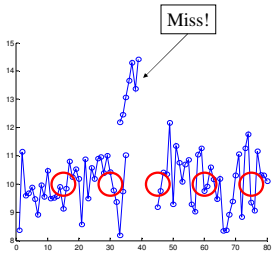
$ARL \sim geo(p)$





Frekvensen

- Beror på processen och potentiella systematiska källor.
- Fånga upp tillfälliga systematiska källor.



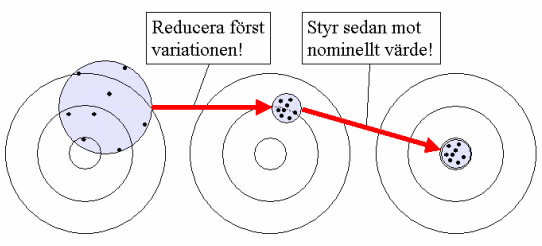
Rational subgroup

- Idéen bakom begreppet *rational subgroup* är att välja provgrupper på så sätt att
  - Chansen för systematisk variation maximeras mellan provgrupperna.
  - Chansen för systematisk variation minimeras inom provgrupperna.

Två typer av subgrupper

1. Enheterna i gruppen tillverkas samtidigt
   - ”Snapshot”
   - Upptäcka medelvärdesskift.
2. Enheterna i gruppen är ett slumpmässigt prov från hela perioden mellan provtillfällena.
   - Beslut om acceptans
   - Kan upptäcka snabba temporära skift i medel.
   - Observera att varje process verkar stabil om provfrekvensen blir tillräckligt lång.

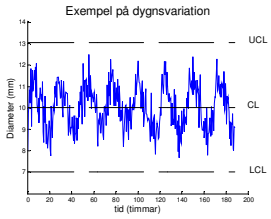
Alltid två diagram: medelvärde och spridning



Mönster i diagrammet

Western Electric handbook:

1. En punkt utanför 3-sigma gränserna.
2. Två av tre utanför varningsgränserna
3. Fyra av fem utanför 1-sigma gränsen.
4. Åtta på varandra punkter ovan eller under CL.



Varning: Ökad risk för falsklarm.

Två faser vid SPS

- **Fas 1:** Analysera processdata för att konstruera *provgränser*.
  - Ta bort systematiska felkällor.
  - Mätsystemsanalys, felaktig datahantering, mänskliga fel et.c.
- **Fas 2:** *Övervaka* processen
  - Processen är ganska stabil.
  - Tyngdpunkt på övervakning mer än stabilisering.

4-4 THE REST OF THE "MAGNIFICENT SEVEN" (resten av OH-mtrl är lånat från Montgomery)

1. Histogram or stem-and-leaf plot
2. Check sheet
3. Pareto chart
4. Cause-and-effect diagram
5. Defect concentration diagram
6. Scatter diagram
7. Control chart

Check Sheet

CHECK SHEET
DEFECT DATA FOR 2002–2003 YTD

Part No.: TAX-41
Location: Bellevue
Study Date: 6/5/03
Analyst: TCB

	2002												2003					
Defect	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	Total
Parts damaged		1		3	1	2		1		10	3		2	2	7	2		34
Machining problems			3	3				1	8		3		8	3				29
Supplied parts rusted			1	1		2	9											13
Masking insufficient		3	6	4	3	1												17
Misaligned weld	2																	2
Processing out of order	2															2		4
Wrong part issued		1					2											3
Unfinished fairing			3															3
Adhesive failure				1							1		2		1	1		6
Powdery alodine					1													1
Paint out of limits						1								1				2
Paint damaged by etching			1															1
Film on parts						3		1	1									5
Primer cans damaged								1										1
Voids in casting									1	1								2
Delaminated composite										2								2
Incorrect dimensions											13	7	13	1		1	1	36
Improper test procedure										1								1
Salt-spray failure													4			2		4
TOTAL	4	5	14	12	5	9	9	6	10	14	20	7	29	7	7	6	2	166

Figure 4-16 A check sheet to record defects on a tank used in an aerospace application.

Pareto Chart

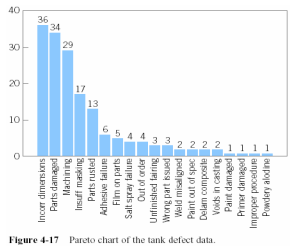


Figure 4-17 Pareto chart of the tank defect data.

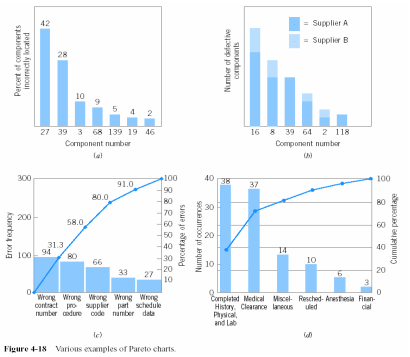


Figure 4-18 Various examples of Pareto charts.

Cause-and-Effect Diagram

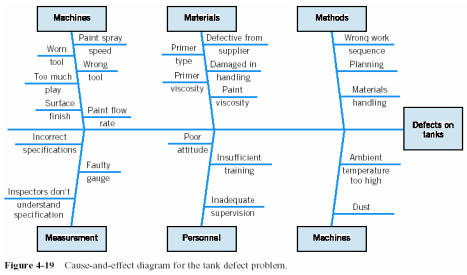


Figure 4-19 Cause-and-effect diagram for the tank defect problem.

How to Construct a Cause-and-Effect Diagram

1. Define the problem or effect to be analyzed.
2. Form the team to perform the analysis. Often the team will uncover potential causes through brainstorming.
3. Draw the effect box and the center line.
4. Specify the major potential cause categories and join them as boxes connected to the center line.
5. Identify the possible causes and classify them into the categories in step 4. Create new categories, if necessary.
6. Rank order the causes to identify those that seem most likely to impact the problem.
7. Take corrective action.

Defect Concentration Diagram

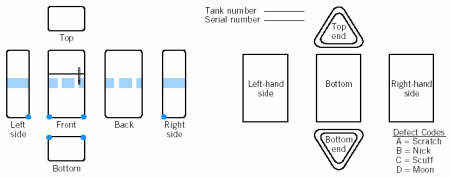


Figure 4-20 Surface-finish defects on a refrigerator.

Figure 4-21 Defect concentration diagram for the tank.

Scatter Diagram

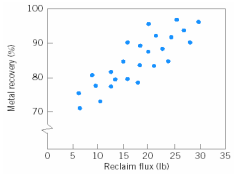


Figure 4-22 A scatter diagram.

4-5 IMPLEMENTING SPC

Elements of a Successful SPC Program

1. Management leadership
2. A team approach
3. Education of employees at all levels
4. Emphasis on reducing variability
5. Measuring success in quantitative (economic) terms
6. A mechanism for communicating successful results throughout the organization

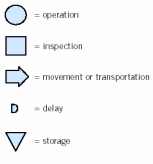
4-7 NONMANUFACTURING APPLICATIONS OF STATISTICAL PROCESS CONTROL

- Nonmanufacturing applications do not differ substantially from industrial applications, but sometimes require ingenuity
  1. Most nonmanufacturing operations do not have a natural measurement system
  2. The observability of the process may be fairly low
- **Flow charts** and **operation process charts** are particularly useful in developing process definition and process understanding. This is sometimes called **process mapping**.
  - Used to identify **value-added** versus **nonvalue-added** activity

Ways to Eliminate Nonvalue-Add Activities

1. Rearranging the sequence of worksteps
2. Rearranging the physical location of the operator in the system
3. Changing work methods
4. Changing the type of equipment used in the process
5. Redesigning forms and documents for more efficient use
6. Improving operator training
7. Improving supervision
8. Identifying more clearly the function of the process to all employees
9. Trying to eliminate unnecessary steps
10. Trying to consolidate process steps

Operation Process Chart Symbols



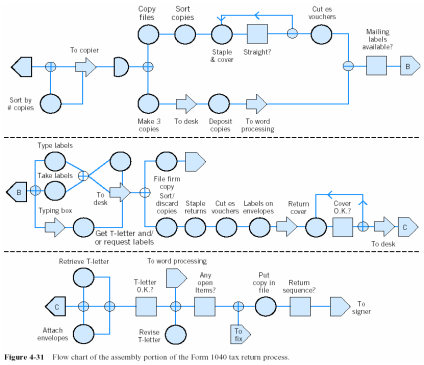


Figure 4-31 Flow chart of the assembly portion of the Form 1040 tax return process.

IMPORTANT TERMS AND CONCEPTS

Assignable causes of variation
Average run length (ARL)
Average time to signal
Cause-and-effect diagram
Chance causes of variation
Control chart
Control limits
Defect concentration diagram
Designed experiments
Flow charts and operations process charts
Histogram
In-control process
"Magnificent seven"
Out-of-control-action plan (OCAP)
Out-of-control process
Pareto chart
Patterns on control charts
Phase I and phase II application of control charts
Rational subgroups
Sample size for control charts
Sampling frequency for control charts
Scatter diagram
Sensitizing rules for control charts
Shewhart control charts
Statistical control of a process
Statistical process control (SPC)
Stem-and-leaf plot
Three-sigma control limits
Warning limits

LEARNING OBJECTIVES

1. Understand chance and assignable causes of variability in a process
2. Explain the statistical basis of the Shewhart control chart, including choice of sample size, control limits, and sampling interval
3. Explain the rational subgroup concept
4. Understand the basic tools of SPC; the histogram or stem-and-leaf plot, the check sheet, the Pareto chart, the cause-and-effect diagram, the defect concentration diagram, the scatter diagram, and the control chart
5. Explain phase I and phase II use of control charts
6. Explain how average run length is used as a performance measure for a control chart
7. Explain how sensitizing rules and pattern recognition are used in conjunction with control charts