# Chapter 20: Statistical Process Control

## Introduction to control charts

2 types of variability in a process:

* Common cause variability: inherent variation in an in-control process.
* Assignable cause variability: extra variation for any number of reasons.

In-control process is predictable, out-of-control process is unpredictable.

Control charts:

* measure variability
* reduce amount of variability without guidance from management
* improve productivity & lower costs
* prevent unnecessary process adjustments
* provide diagnostic information about the process

## Control charts for variables

2 basic types:

* Control charts for variables
* Control charts for attributes

Chart: plots averages of small subsamples through time => process change  
R Chart: plots the changes of small subsamples through time => variability change

In-control behaviour: no point on X chart is outside of the control limits.

### 4.a. Control Charts and Hypothesis testing

H0: In control  
H1: Out of control  
p < 0.05: reject H0, accept H1.  
Type 1 error: eact to out of control, when actually still in control: false alarm.  
Type 2 error: process out of control, but text does not indicate so.

### 4.b. Other out-of-control indications

These are programmed into Stattools as options:

1. 8 upward or downward consecutive changes
2. 8 consecutive points above or below the centreline
3. 2-3 points above or below 2σ on the same side of the centreline
4. 4-5 points beyond 1σ on same side of the centreline

### 4.c. Rational subsamples

Don’t mix samples from different production nits: extreme values can cancel eachother out.

## Control charts for attributes

Simply check whether products are conform to specifications.  
p chart: chart of proportions that are **non**-conforming during consecutive periods of time  
c & u charts: chart the number or rate of defective items.

### 5.a. The p chart

Same as X & R charts but with proportions of defective items.

## Process capability

Predict how capable a process is in producing output that meets specifications.  
 - requirement: process in control  
 - estimate the proportion of products that meets specs: probability model.  
Check normality of distribution: histogram  
Normdist & 1-normdist to calculate probability of falling outside the specification limits.

### 6.a. Process capability indexes

Compare length of USL & LSL with a process capability index.  
Cp: process capability index = USL – LSL / 6  
 P(beyond specification limits) = 2P(Z<-3Cp)

Cpk: Capability Index used when mean is off target  
Cpk =

A k-sigma process is one in which the distance from the process to the nearest specification limit is kσ, where σ is the standard deviation of the process.

### 6.b. More on Motorola & 6σ

Motorola 6-sigma analysis: the goal of Motorola to produce no more than 3,4 non-conforming parts per million.