The ASPC - Statistical Process Control Charting Software

ABSTRACT----------

Of the arsenal of tools for analyzing data, Dr. Shewhart's control charting system is one of the most powerful because it captures best the voice of the process. Control charts are used to determine whether processes are operating in statistical control and may be used for predictability based on previous experience.

Dr. Shewhart designed seven different types of charts to fulfill specific purposes. Most users use Microsoft Excel or Minitab for their work. However, this semi-manual process is slow and prone to errors. In addition, time constraints may preclude users from experimentation.

The ASPC Software is a sophisticated piece of software with which the user can type in the data or import CSV files to generate any type of chart at the touch of a button. The only limitation, as of the size of the file, is the memory of the computer.

BIOGRAPHY----------

Marilou Haines
President and Founder
Alamo Software, Inc.

Marilou Haines is the President and founder of Alamo Software, Inc. a company dedicated to custom software development and management consulting to small and medium size enterprises including franchises. Ms. Haines is currently a PhD student at the University of Arkansas in Little Rock and holds an M.B.A. and a M.S. in Information Quality. Her research interests are information quality, quantitative analysis, management, and data mining.

Automated Statistical Process Control Utility ASPC

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Overview

- Shewhart's Control Charts and underlying methodology
  - The concept of variation, empirical rule, and the running record.
  - Controlled and Uncontrolled Variation
- ASPC Software Utility Overview
- Analyzing and Interpreting data with the Charts using four examples from the Healthcare Industry.

According to empirical evidence

- No two things are exactly alike.

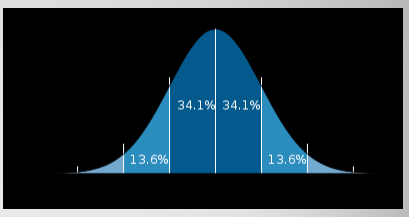
This became prevalent after the Industrial Revolution, when, because of the division of labor, individually manufactured parts had to fit interchangeably in an assembly.

- The challenge became how to produce parts within specifications.

The Concept of Variation

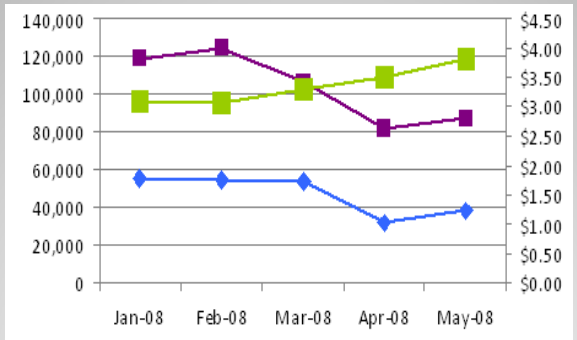
The Three Sigma rule states that for a normal distribution, almost all values lie within 3 standard deviations of the mean. Whereby

1. Roughly 60% - 75% of the data is located within one sigma unit on either side of the average.
2. Generally 90% - 98% of the data will be found at a distance of two sigma units from the average.
3. Nearly 99% - 100% of the data will be located within three sigma units from the average.



The Three Sigma Rule or Empirical Rule

The time order sequence in which an even occurs is preserved in the Running Record.



The Running Record

- Based on a combination of Three Sigma Limits and the Running Record, Control Charts seek to determine if a certain sequence of events may be used for predictions.
- Using techniques of inductive inference, control charts go from specific "real world" observations to general principles. For **example**: If the average percentage of medical records completed within 30 days has been 72%, it will remain so in the future unless the system is changed.

Dr. Shewhart's Control Charts

- Statistician from Bell Laboratories (1920s)
- Work in Japan under General McArthur after WWII.
- Worldwide success best attested by the Japanese dominance in the automobile industry.
- Six sigma, TQM, Zero Defects, Lean Manufacturing and others.

Dr. Shewhart

Based on his work at Bell laboratories in the early 1920s, Dr. Shewhart looked at variability either as:

- **Controlled Variation** caused by chance and characterized by a stable and consistent pattern of variation over time or
- **Uncontrolled Variation** caused by assignable causes and characterized by a pattern of variation that changes over time.

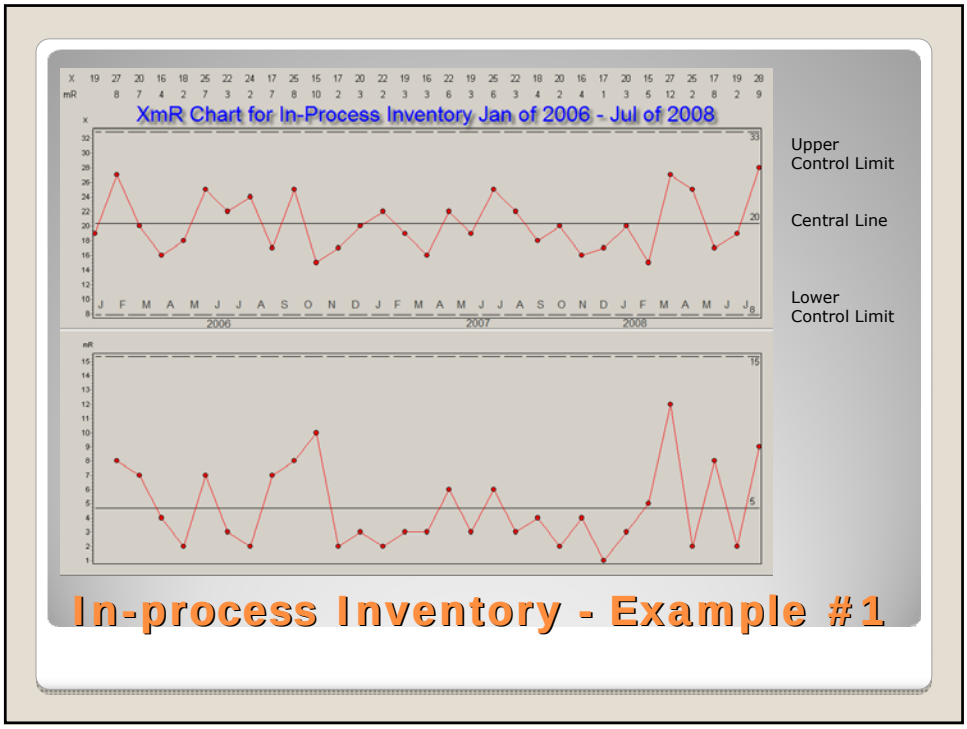
Dr. Shewhart's Concept of Controlled and Uncontrolled Variation

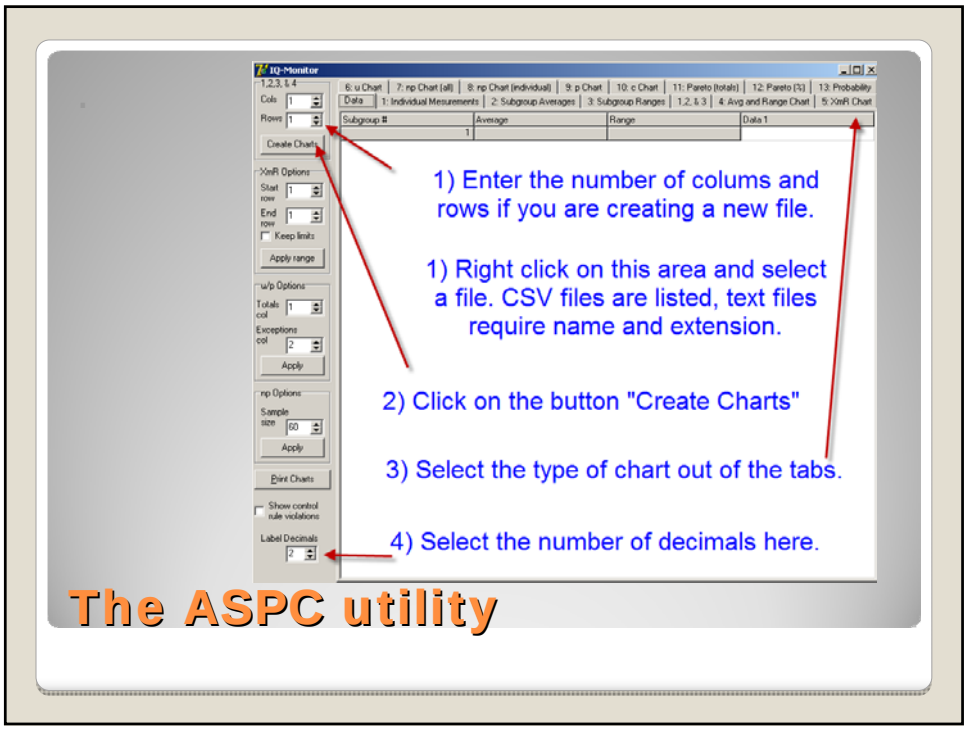
- **Variability by chance** is produced by the choice of materials, machines, operators, and methods interacting with each other. Such chance variability is relatively consistent over time.
- **Variability assigned to special factors** maybe machines out of adjustment, differences between workers, differences created by inconsistent management. This type of variability must be identified and removed.

Variability assigned to chance versus variability due to assignable causes

Data	Chart Type
Measurements	Average & Range OR XmR Chart

Data	Characteristic	Chart
Measurements OR Counts	Universally used	XmR
Counts (Binomial)	Area of opportunity constant: np-Chart	
Counts (Binomial) Yes/No, Good/Bad	Area of opportunity variable: P-Chart	
Counts (Poisson) Continuous data	Area of opportunity constant: C-Chart Example: problems in a car	
Counts (Poison)	Area of opportunity variable: U-Chart	
Other count data	Area of opportunity constant: XmR Chart	
Other count data for rates	Area of opportunity variable: XmR Chart	


XmR Chart for In-Process Inventory Jan of 2006 - Jul of 2008
Upper Control Limit
Central Line
Lower Control Limit
2006
2007
2008
In-process Inventory - Example #1


IQ-Monitor
1) Enter the number of colums and rows if you are creating a new file.
1) Right click on this area and select a file. CSV files are listed, text files require name and extension.
2) Click on the button "Create Charts"
3) Select the type of chart out of the tabs.
4) Select the number of decimals here.
The ASPC utility

The Memorial Hospital started to track physician's efficiency last month. Dr. Sims saw the following number of patients:

Monday	Tuesday	Wednesday	Thursday	Friday
22	24	23	23	29
23	24	23	29	23
24	24	23	29	23
24	23	24	29	23
24	24	28		

What do these numbers tell you?

Physician's Efficiency Example # 2

Measures of Location

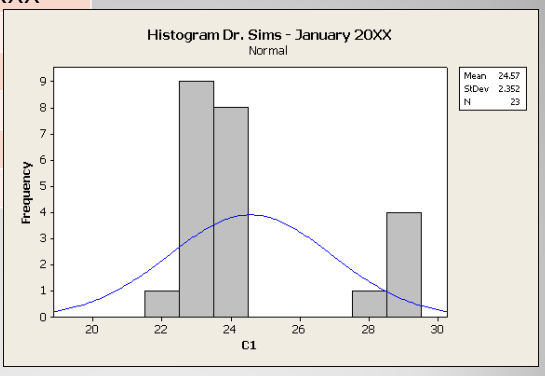
- The **average** patients seen is **24.57**. (565/23)
- The **median** = 24. (arrange list; find middle value)
- The mode = 23

Measures of Dispersion

- **Range = 7** (Range = max – min; 29-22=7)
- **Root Mean Square Deviation = 2.29**
  (Based on the population (23), Excel: STDEVP)
- **Standard Deviation = 2.35**
  (Based on a sample (n-1 = 22), Excel STDEV)

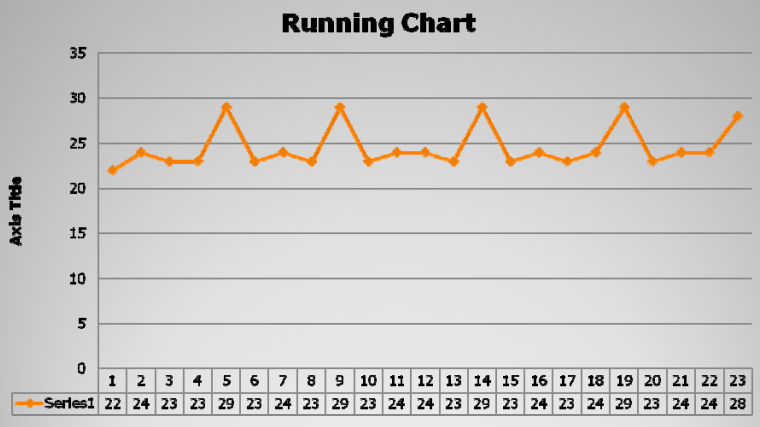
Measures of Location and Dispersion

	Value	Leaf
1	22	X
9	23	XXXXXXXXX
8	24	XXXXXXXX
0	25	
0	26	
0	27	
1	28	X
4	29	XXXX



Stem and Leaf and Histogram

Dr. Sims – January, 2009

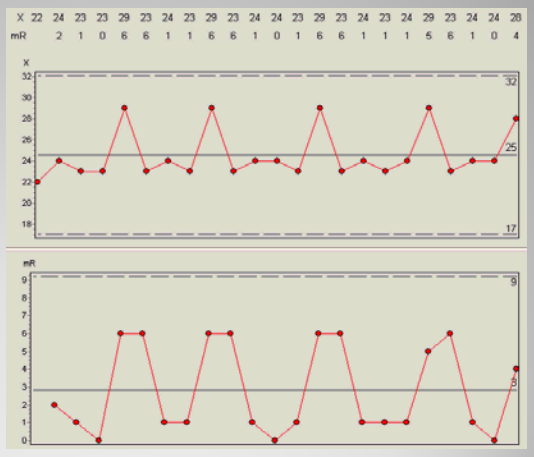


Running Chart

What is the meaning of the pattern?

•The Chart is telling us that the data is in control.
• Most of the values fall below the center line.
•The minimum number of patients seen ranges between 17 and 32.
•The exceptions happen roughly once a week.

•When and why? Dr. Sims does not have hospital visitation duty once a week. Those are the days he sees more patients.



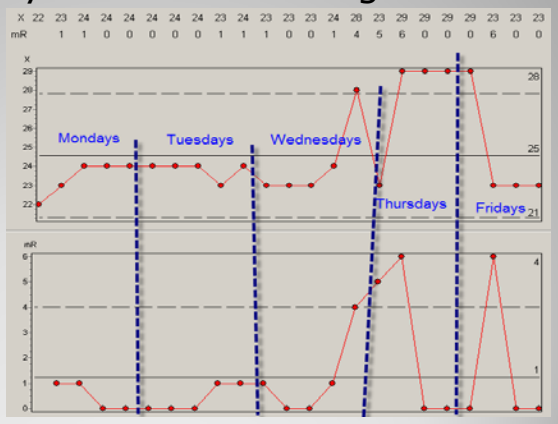
XmR - Chart

If instead of analyzing from Mo – Fri, we analyze by day of the week we get:

•With this view, the most efficient days are seen as an exception.

Which of the charts is better?

• Both because the combination of the charts tells us the whole story.



Analysis by day of the week

Descriptive Statistics pros and cons	
Easy to understand	Unusual features missed
Extraneous details removed	Do not provide whole story
Useful for set comparisons	

Graphic Summaries pros and cons	
Better at revealing unusual and interesting features	Remove fine detail to express in geometric form the overall relationship of the points
Even the absence of unusual features is useful and not provided by numerical summaries	Less specific than numerical summaries

Descriptive Statistics and Graphic Summaries are complementary

1. Present original data as to preserve the evidence of the original data so that predictions are useful.
2. Any summary of a distribution should not cause human action to be different than the one taken if the original data were used as evidence.

In short: Do NOT by commission or omission lie with statistics.

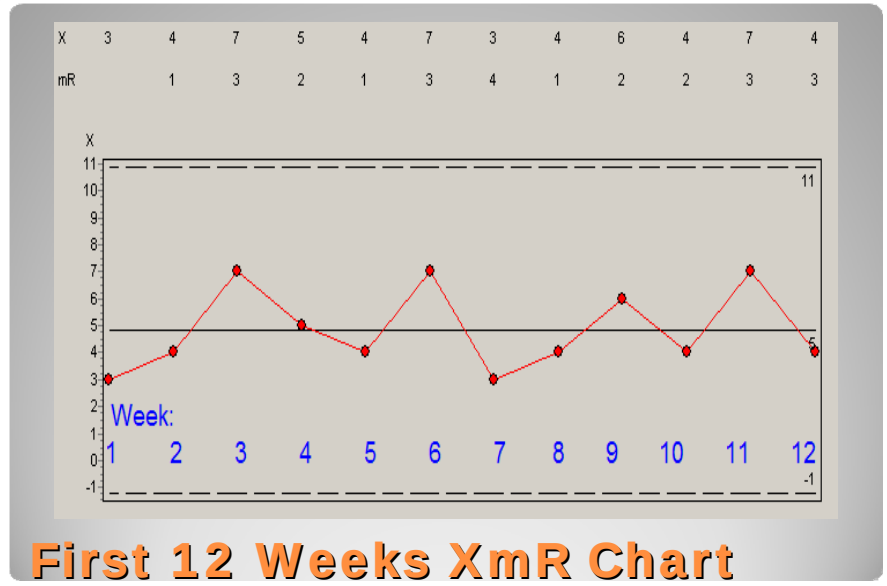
Dr. Shewhart's 2 rules for Data Presentation

- The ultimate use of control charts is to reduce system variation
  - Once processes are in statistical control, the continued use of the charts will naturally lead to continuous improvement

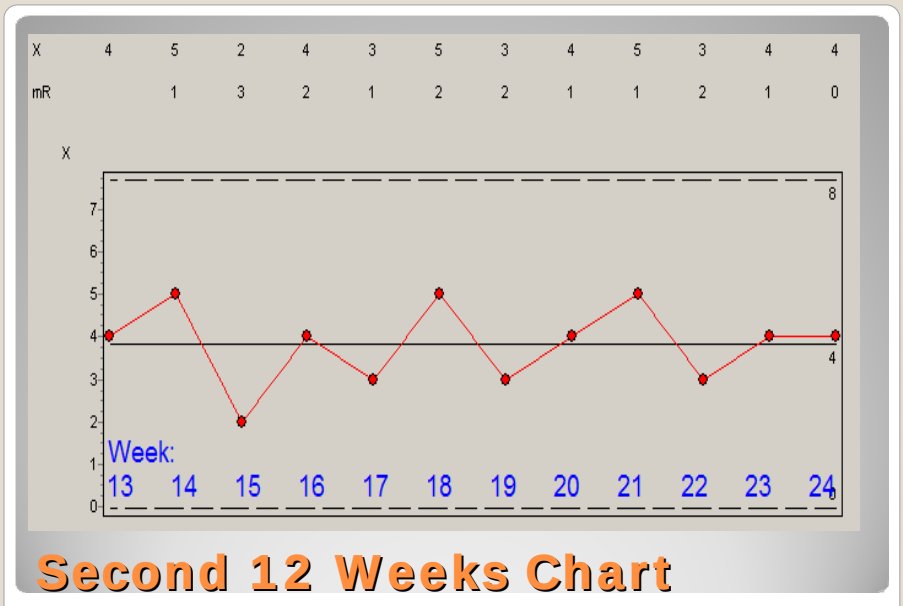
Using Charts for Continuous Improvement

- At the Memorial Hospital, the Intensive Care Unit (ICU) has been using control charts to reduce the number of medication errors. For the past 12 weeks, the process has displayed statistical control.
- The Chief Nursing Officer (CNO) is setting the objective to reduce the number of medication errors to at least 10% during the next 12 weeks.

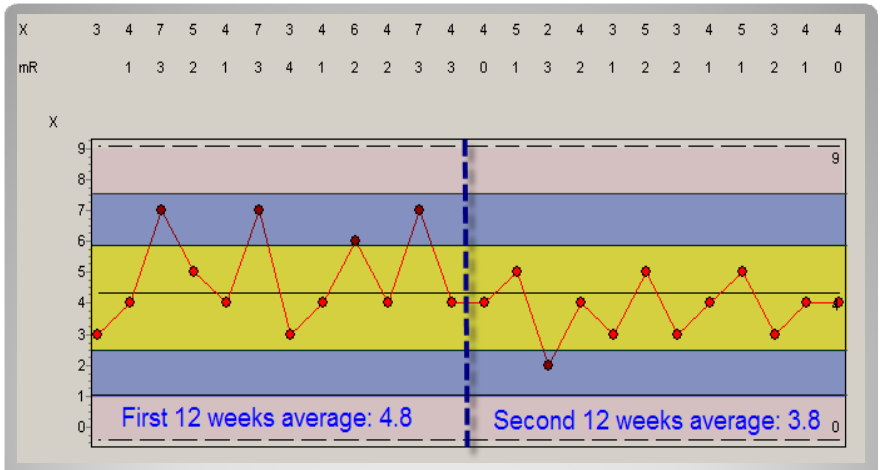
Medication Error Continuous Improvement Effort – Example #3



First 12 Weeks XmR Chart



Second 12 Weeks Chart



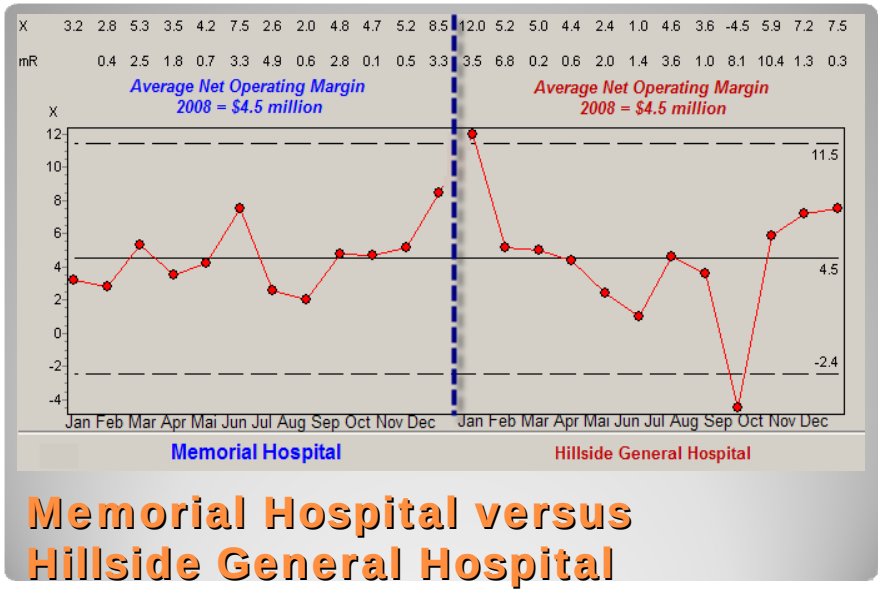
Percentage change: (4.8 – 3.8) / 4.8 = 20.83%

Continuous Improvement Results

- You are a member of the board of trustees of the Memorial Hospital and the Hillside General Hospital.
- You have knowledge that the Memorial Hospital is a well managed organization with a solid financial condition while the Hillside Memorial Hospital appears to be poorly managed and their financial condition may be unstable.
- You are however, when you received the end of the year reports you found out that both have the same average Net Operating Margin.
- You feel that you need to investigate the matter and ask both hospitals to send you monthly statements for the entire year.

Net Operating Margin Example – Example # 4

NET OPERATING MARGIN	Memorial Hospital	Hillside General Hospital
January	3.2	12.0
February	2.8	5.2
March	5.3	5.0
April	3.5	4.4
Mai	4.2	2.4
June	7.5	1.0
July	2.6	4.6
August	2.0	3.6
September	4.8	-4.5
October	4.7	5.9
November	5.2	7.2
December	8.5	7.5
AVERAGE	**4.5**	**4.5**
VARIATION	**6.5**	**16.5**



Thank you for attending this presentation.

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Any Questions?