
MULTI-VARI ANALYSIS

Learning Objectives

- Understand how to use multi-vari charts in completing an improvement project.
- Know how to properly gather data to construct multi-vari charts.
- Know how to construct a multi-vari chart.
- Know how to interpret a multi-vari chart.

How does it help?

Multi-Vari charts are a:

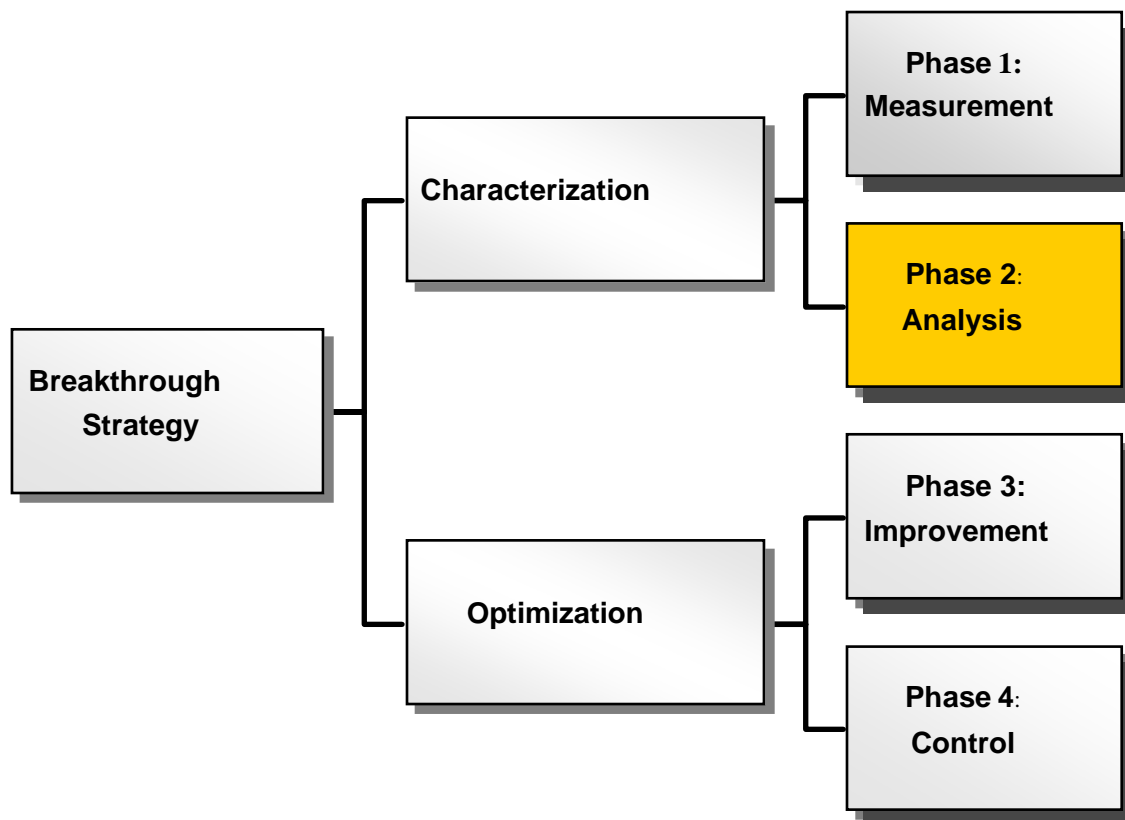
- Simple, yet powerful way to significantly reduce the number of potential factors which could be impacting your primary metric.
- Quick and efficient method to significantly reduce the time and resources required to determine the primary components of variation.



IMPROVEMENT ROADMAP

Uses of Multi-Vari Charts

Common Uses



- Eliminate a large number of factors from the universe of potential factors.

KEYS TO SUCCESS

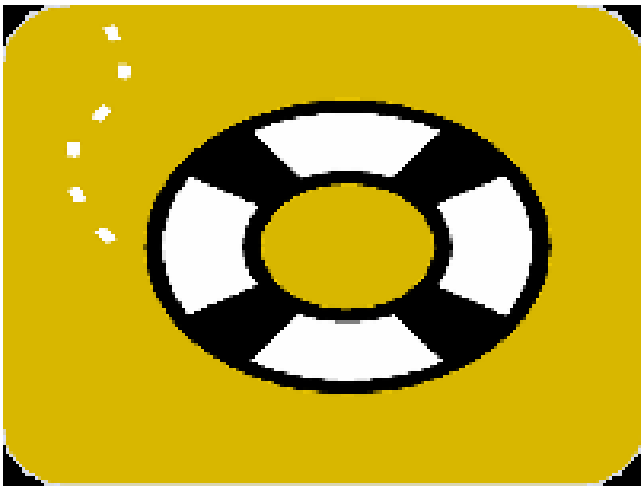
Careful planning before you start

Gather data by systematically sampling the existing process

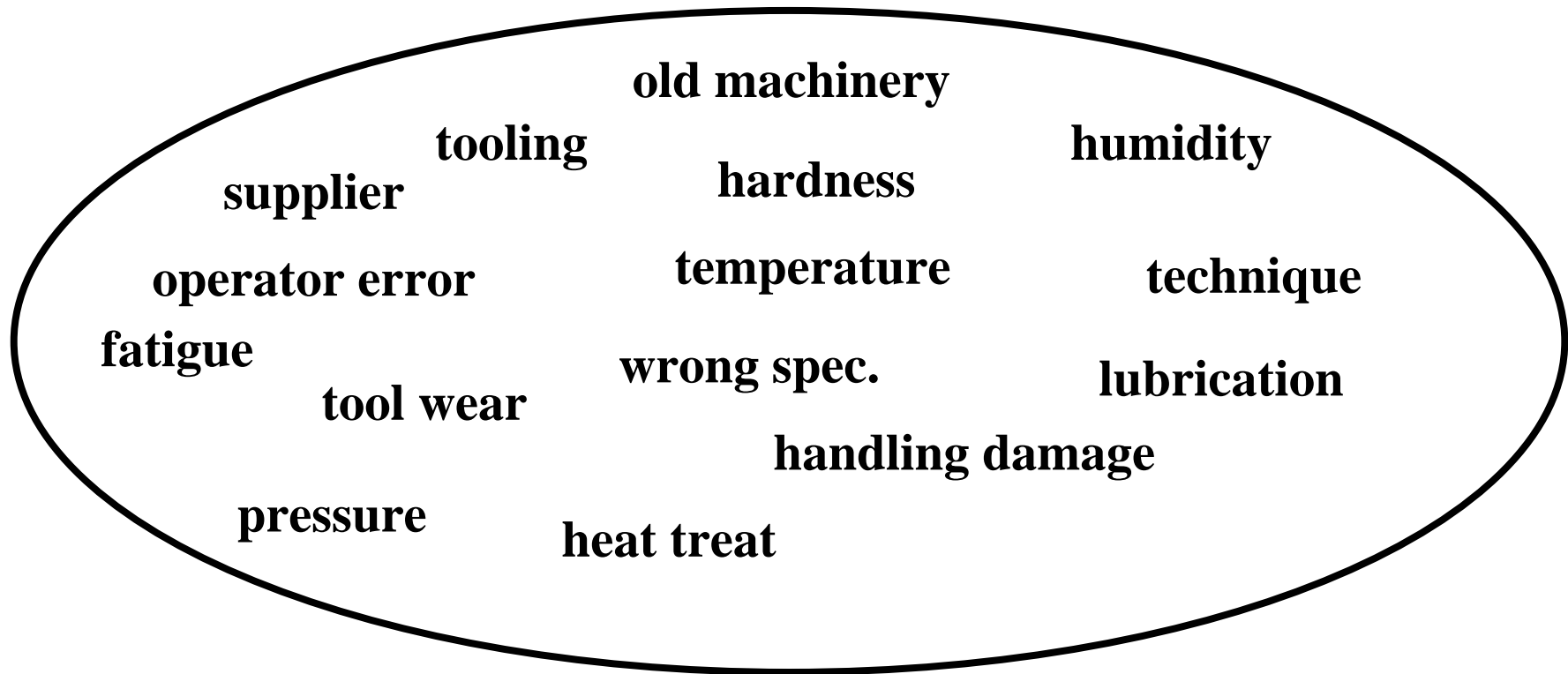
Perform “ad hoc” training on the tool for the team prior to use

Ensure your sampling plan is complete prior to gathering data

Have team members (or yourself) do the sampling to avoid bias



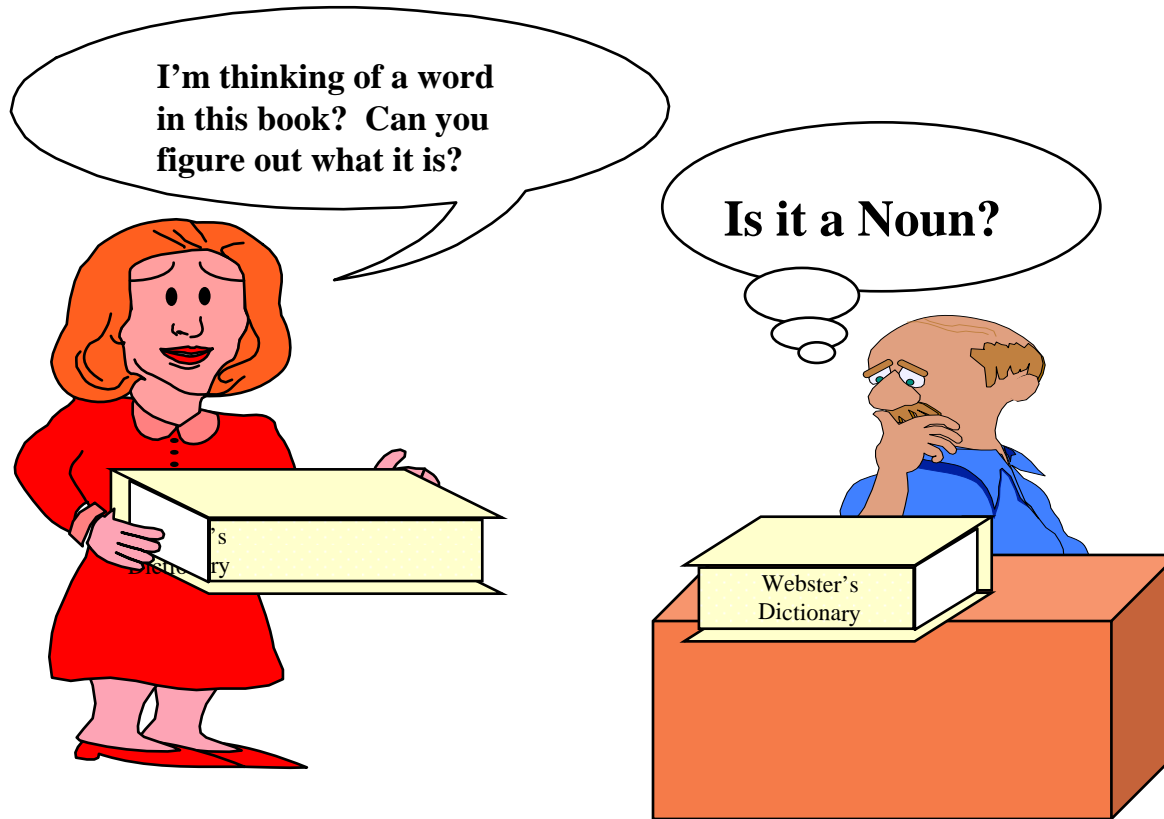
A World of Possible Causes (KPIVs).....



**The Goal of the logical search
is to narrow down to 5-6 key variables !**

REDUCING THE POSSIBILITIES

“....The Dictionary Game?”



**USE A LOGICAL APPROACH TO SEE
THE MAJOR SOURCES OF VARIATION**

REDUCING THE POSSIBILITIES

How many guesses do you think it will take to find a single word in the text book?

Lets try and see.....



REDUCING THE POSSIBILITIES

How many guesses do you think it will take to find a single word in the text book?

Statistically it should take no more than 17 guesses

$$2^{17} = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 131,072$$

Most Unabridged dictionaries have 127,000 words.

Reduction of possibilities can be an extremely powerful technique.....

PLANNING A MULTI-VARI ANALYSIS

- Determine the possible families of variation.
- Determine how you will take the samples.

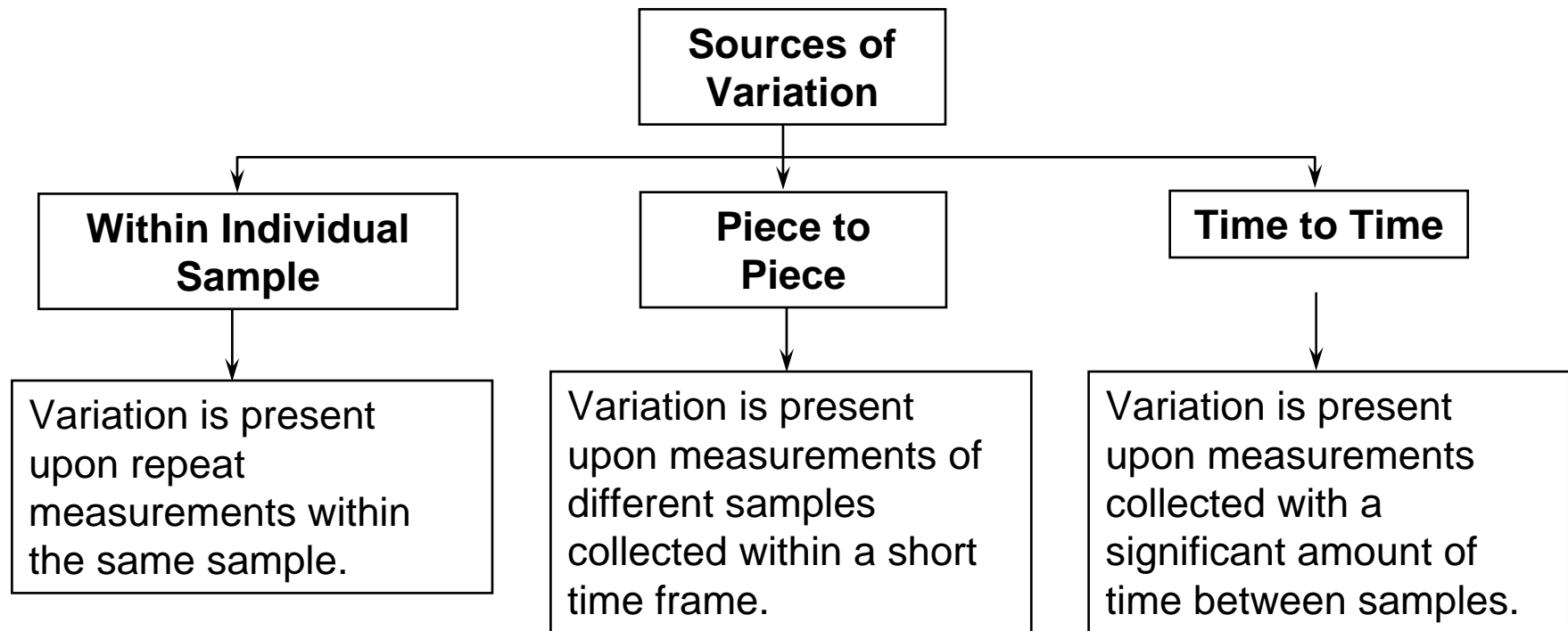
- Take a stratified sample (in order of creation).
- DO NOT take random samples.

- Take a minimum of 3 samples per group and 3 groups.
- The samples must represent the full range of the process.

- Does one sample or do just a few samples stand out?
- There could be a main effect or an interaction at the cause.

MULTI-VARI ANALYSIS, VARIATION FAMILIES

The key is reducing the number of possibilities to a manageable few....



MULTI-VARI ANALYSIS, VARIATION SOURCES

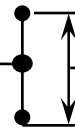
<p>Manufacturing (Machining)</p>	<p><u>Within Individual Sample</u> Measurement Accuracy Out of Round Irregularities in Part</p>	<p><u>Piece to Piece</u> Machine fixturing Mold cavity differences</p>	<p><u>Time to Time</u> Material Changes Setup Differences Tool Wear Calibration Drift Operator Influence</p>
<p>Transactional (Order Rate)</p>	<p><u>Within Individual Sample</u> Measurement Accuracy Line Item Complexity</p>	<p><u>Piece to Piece</u> Customer Differences Order Editor Sales Office Sales Rep</p>	<p><u>Time to Time</u> Seasonal Variation Management Changes Economic Shifts Interest Rate</p>

HOW TO DRAW THE CHART

Step 1

Average within a single sample

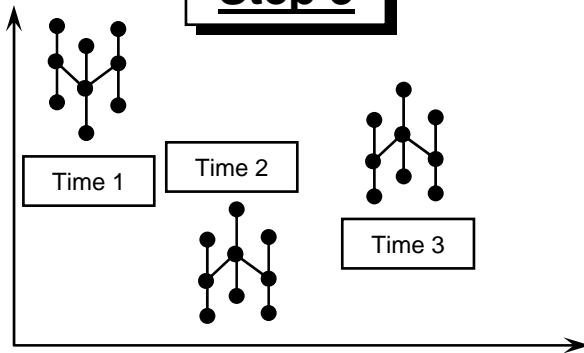
Sample 1



Range within a single sample

Plot the first sample range with a point for the maximum reading obtained, and a point for the minimum reading. Connect the points and plot a third point at the average of the within sample readings

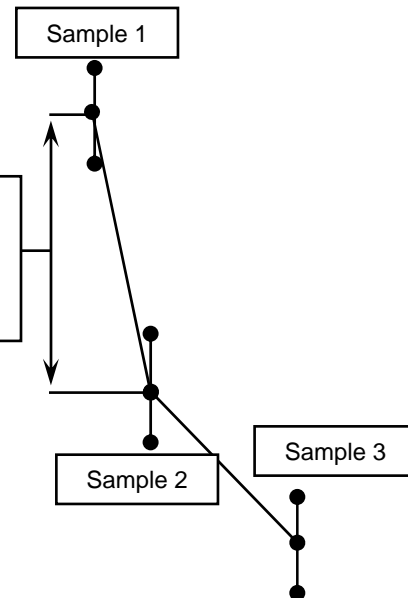
Step 3



Plot the "time to time" groups in the same manner.

Step 2

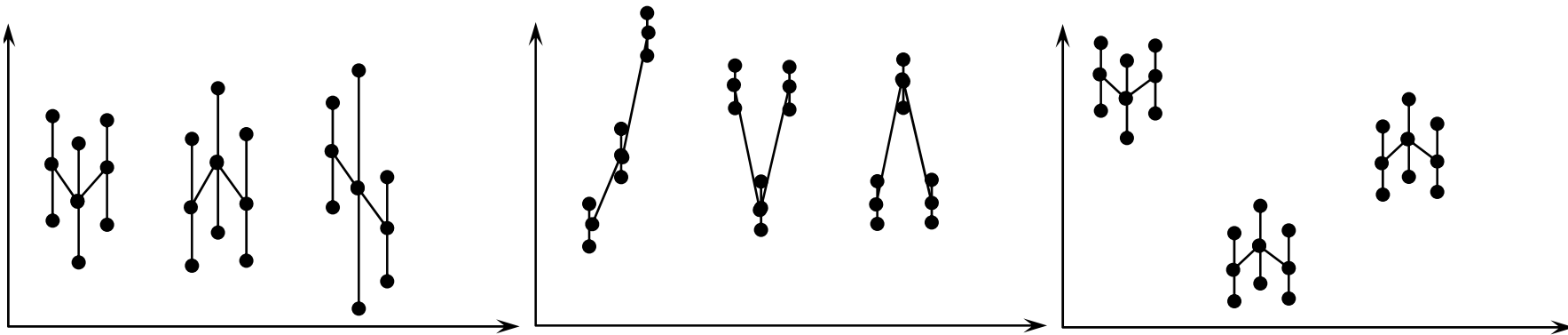
Range between two sample averages



Plot the sample ranges for the remaining "piece to piece" data. Connect the averages of the within sample readings.

READING THE TEA LEAVES....

Common Patterns of Variation



Within Piece

- Characterized by large variation in readings taken of the same single sample, often from different positions within the sample.

Piece to Piece

- Characterized by large variation in readings taken between samples taken within a short time frame.

Time to Time

- Characterized by large variation in readings taken between samples taken in groups with a significant amount of time elapsed between groups.

MULTI-VARI EXERCISE

We have a part dimension which is considered to be impossible to manufacture. A capability study seems to confirm that the process is operating with a $C_{pk}=0$ (500,000 ppm). You and your team decide to use a Multi-Vari chart to localize the potential sources of variation. You have gathered the following data:

Construct a multi-vari chart of the data and interpret the results.

Sample	Day/ Time	Beginning of Part	Middle of Part	End of Part
1	1/0900	.015	.017	.018
2	1/0905	.010	.012	.015
3	1/0910	.013	.015	.016
4	2/1250	.014	.015	.018
5	2/1255	.009	.012	.017
6	2/1300	.012	.014	.016
7	3/1600	.013	.014	.017
8	3/1605	.010	.013	.015
9	3/1610	.011	.014	.017

Learning Objectives

- Understand how to use multi-vari charts in completing an improvement project.
- Know how to properly gather data to construct multi-vari charts.
- Know how to construct a multi-vari chart.
- Know how to interpret a multi-vari chart.