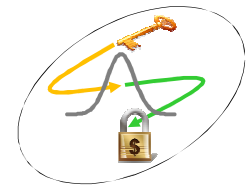
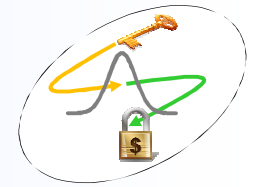


# Critical Parameter Development & Mgt.

Deriving Capability Indices from “Scratch”



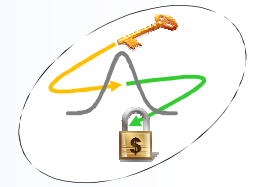
# Agenda



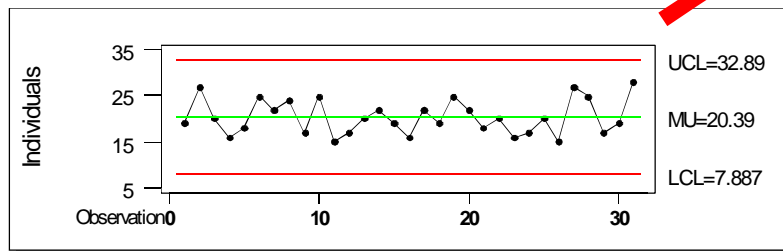
- Demonstrate the 4 simple steps for deriving a Cp Index from Sample Data
- How it impacts the 7 Checks for Criticality!

- *Measurable?*
- *Stable?*
- *Adjustable?*
- *Interactive?*
- *Sensitive?*
- *Robust?*
- *Capable?*

# Step 1: Measurement of samples of functions



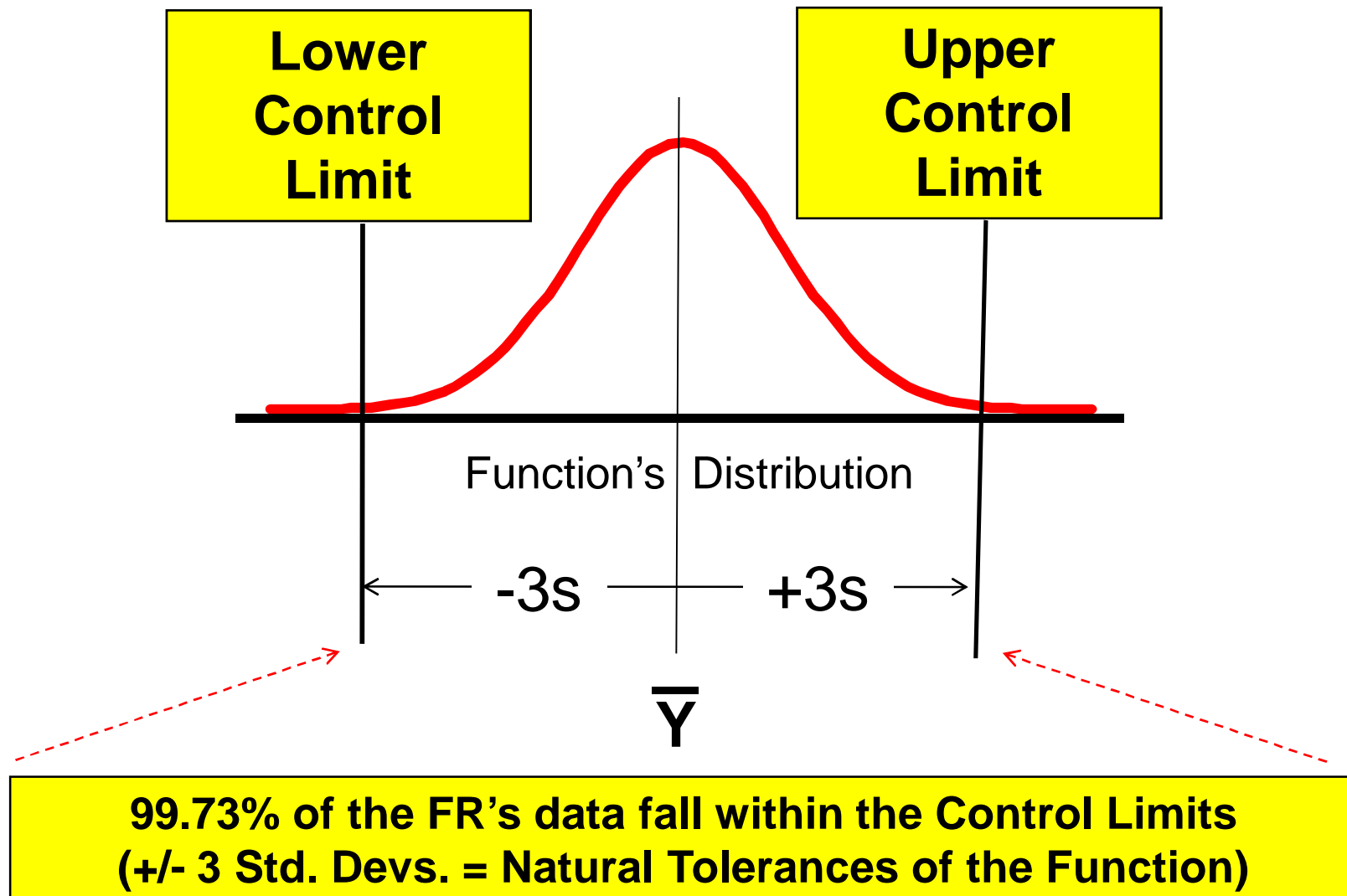
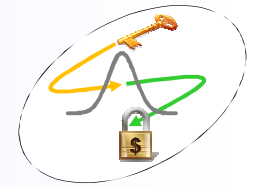
- **Measure** the function by taking data as random, independent, **stable** samples of a function within the design...



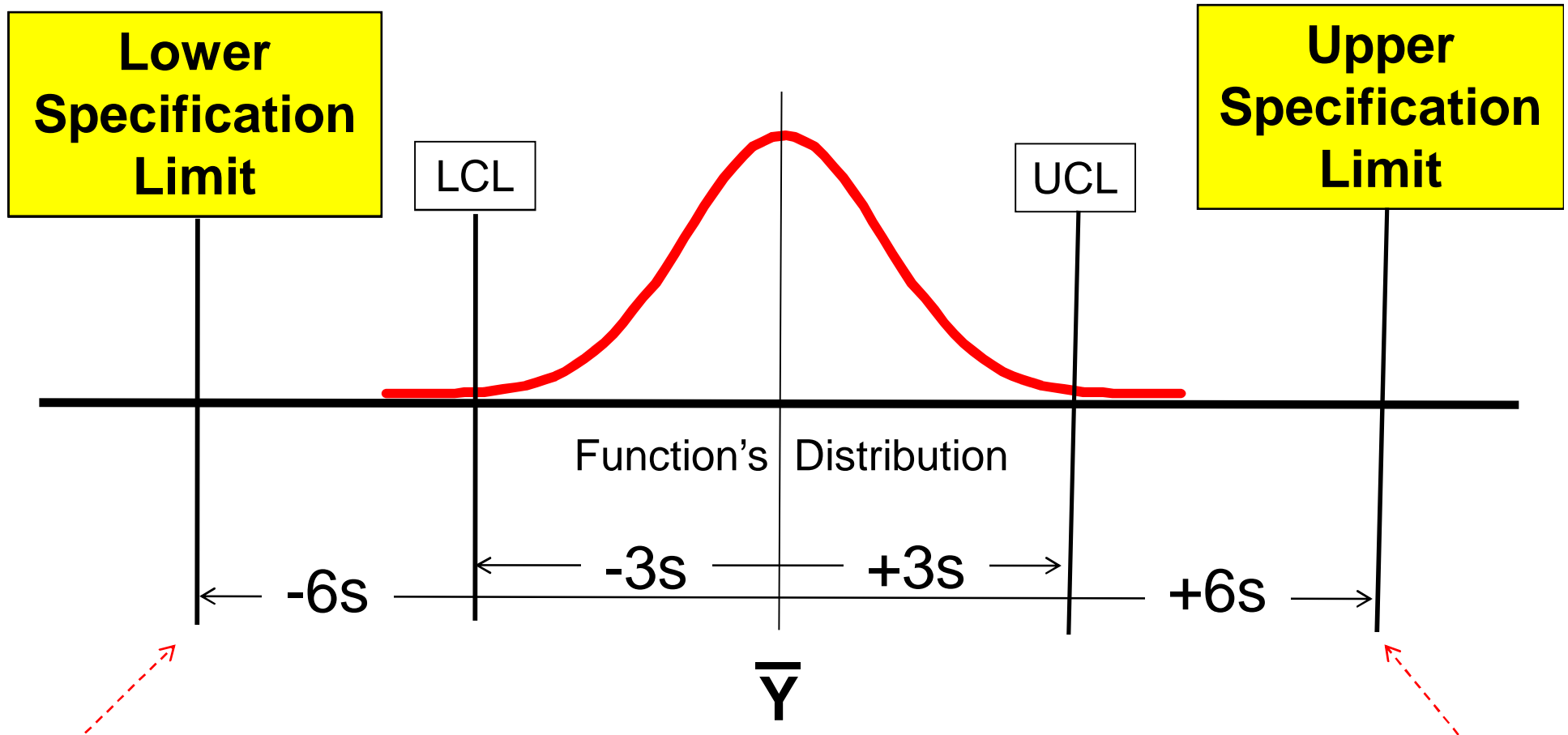
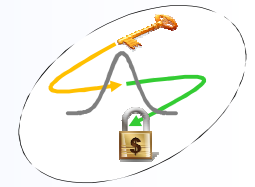
Function's Distribution

**During a Design Functional Capability Study we gather design Functional Response data**

## Step 2: Assign *Natural Tolerance Limits* to the Function's Distribution...

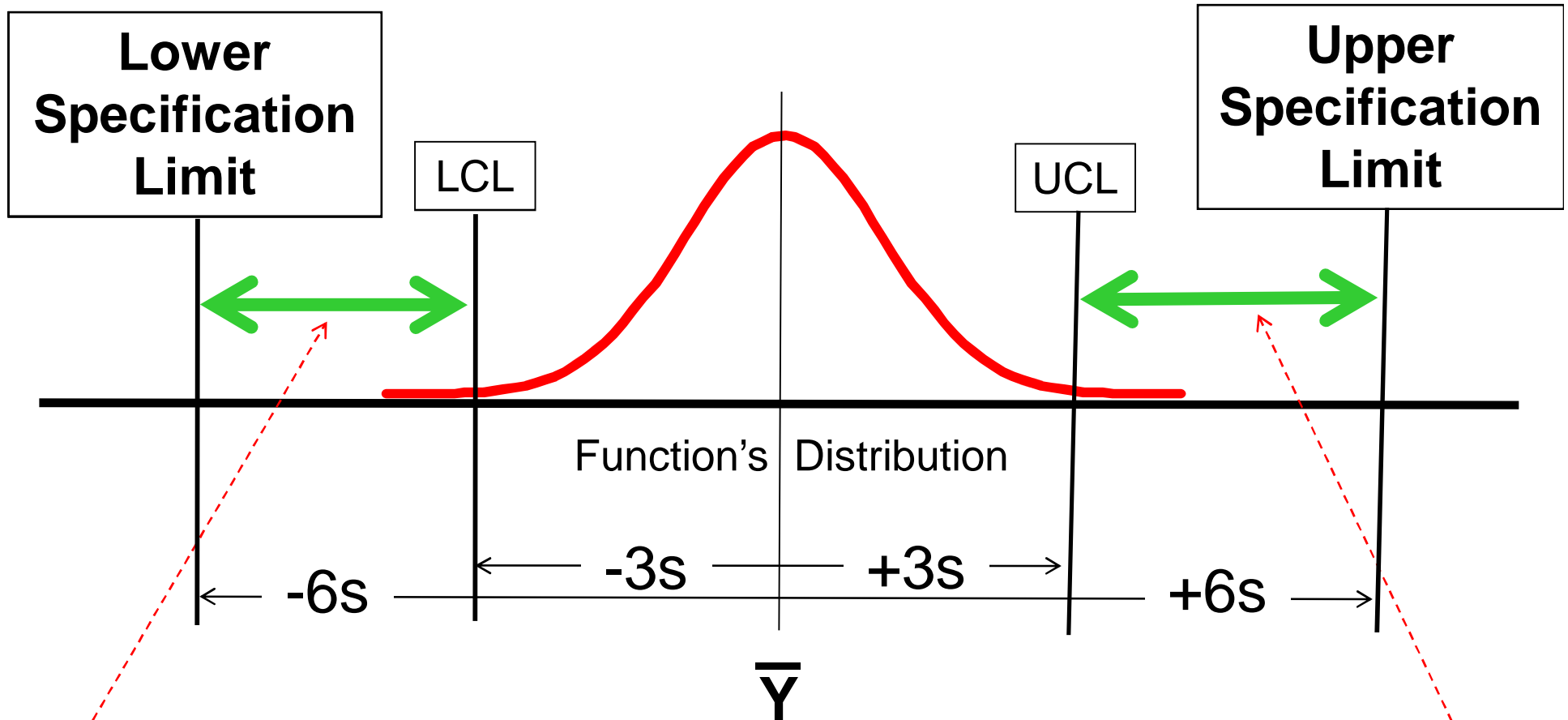
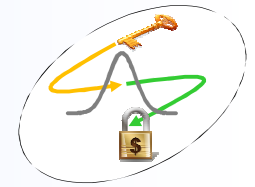


# Step 3: Assign *Customer-based Tolerance Limits* to the Function's Distribution...



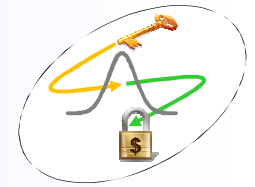
**99.9999998% of the FR's data fall within the Spec. Limits  
( $\pm 6$  Std. Devs. = Customer-based Tolerances of the Function)**

# Step 4: Recognize the design latitude between the Control & Spec. Limits...



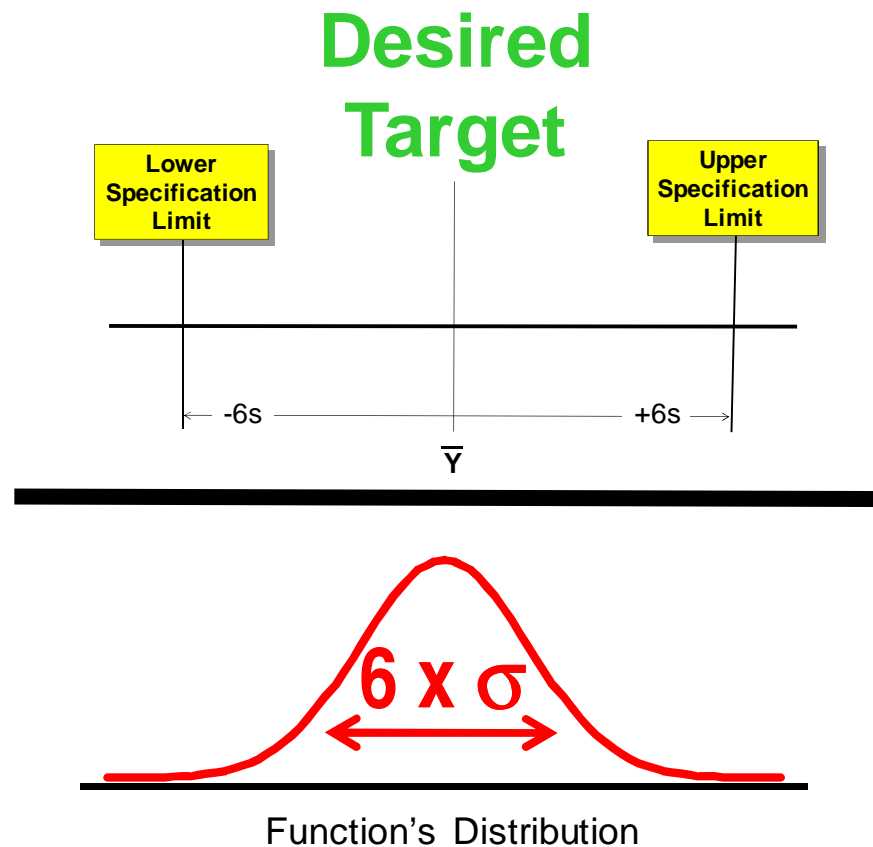
**Each side of the Function's distribution has 3s of latitude between the Control Limits & Spec. Limits, when the mean is centered on the VOC Target Value...**

# What is Cp?

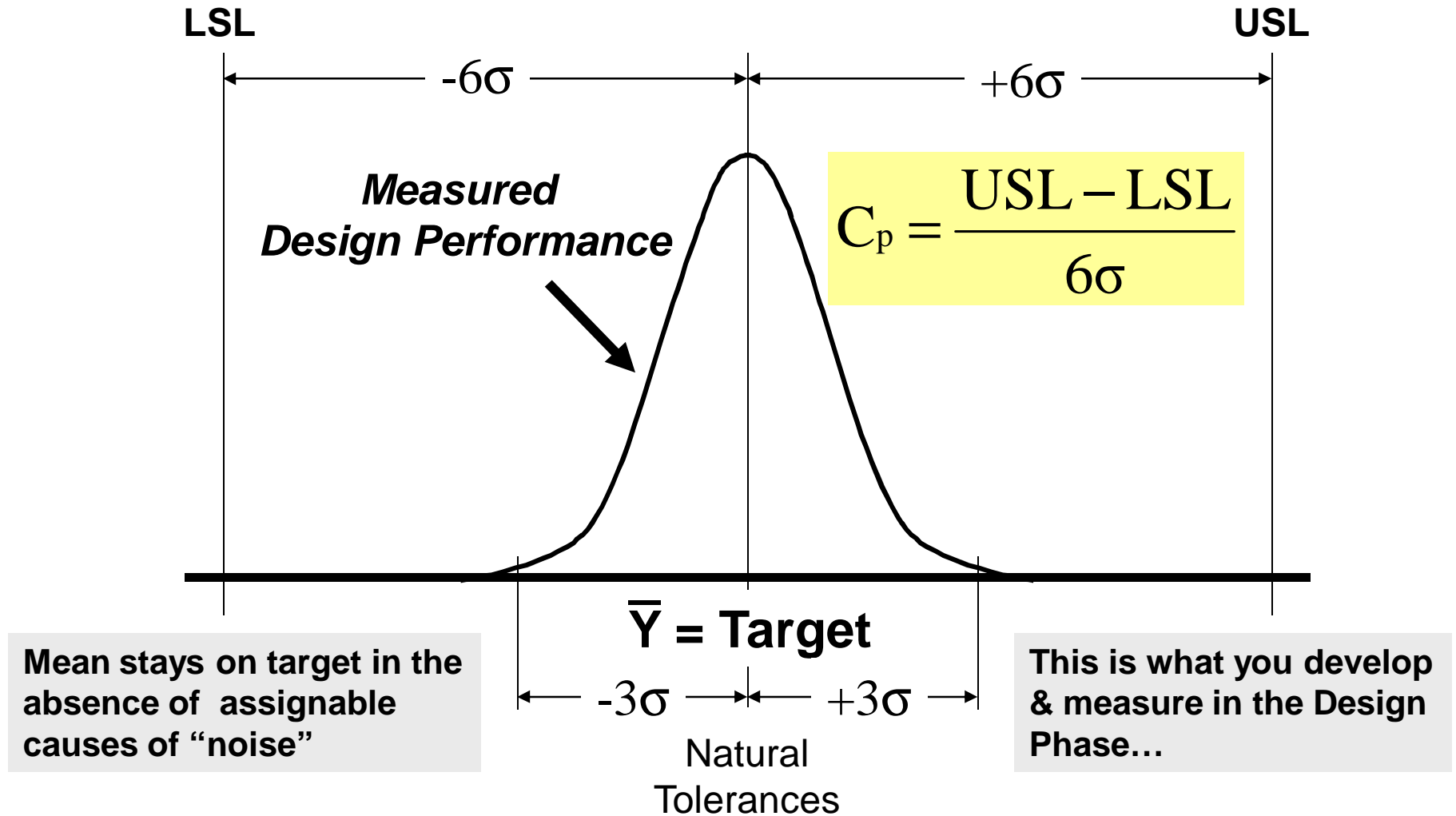
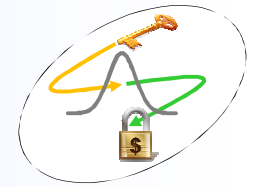


Cp is the ratio of....

*Mean is centered on the desired Target.*

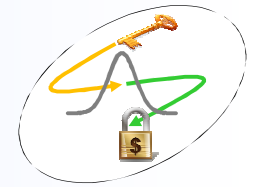


# Short Term Capability Performance

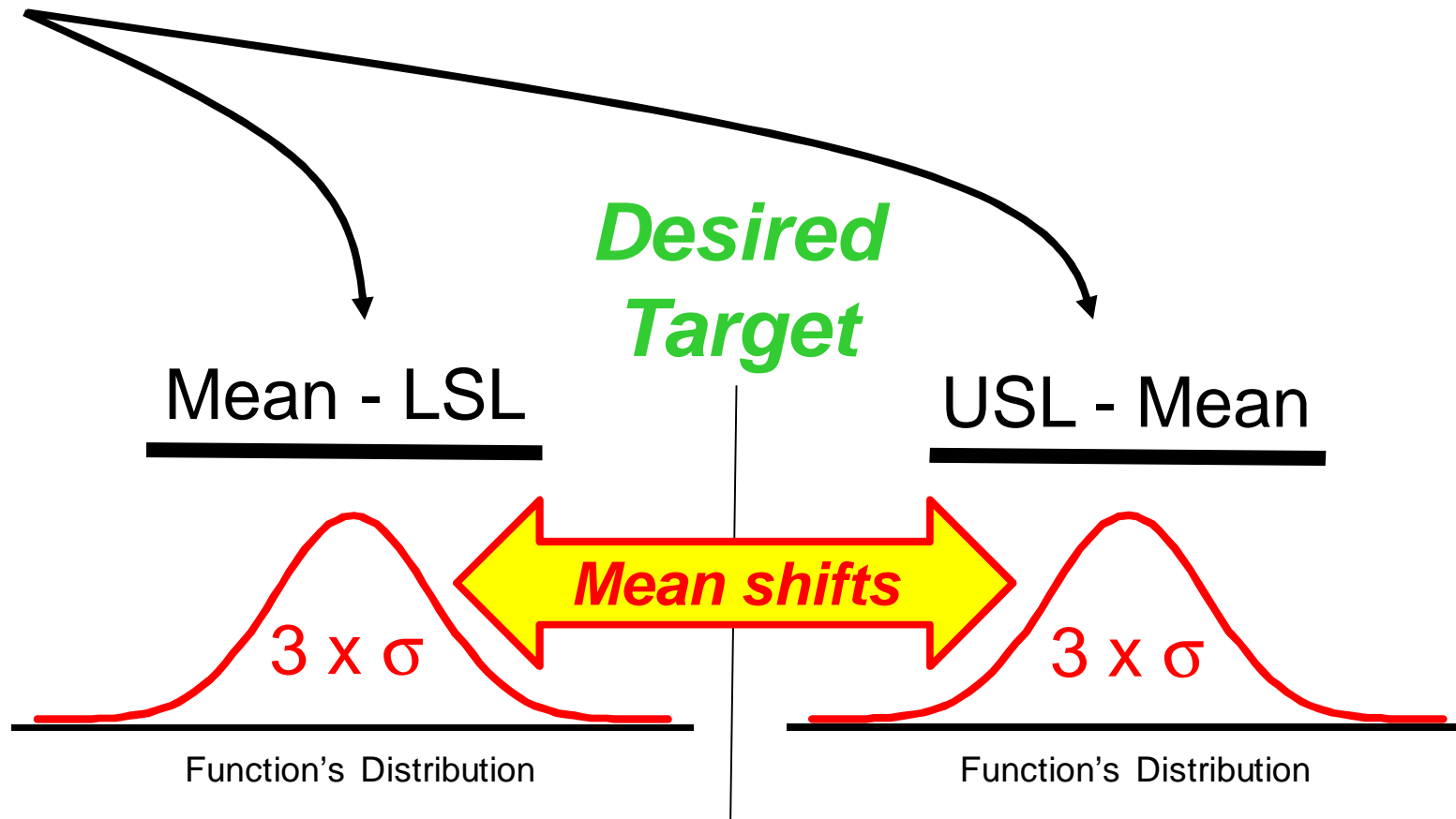




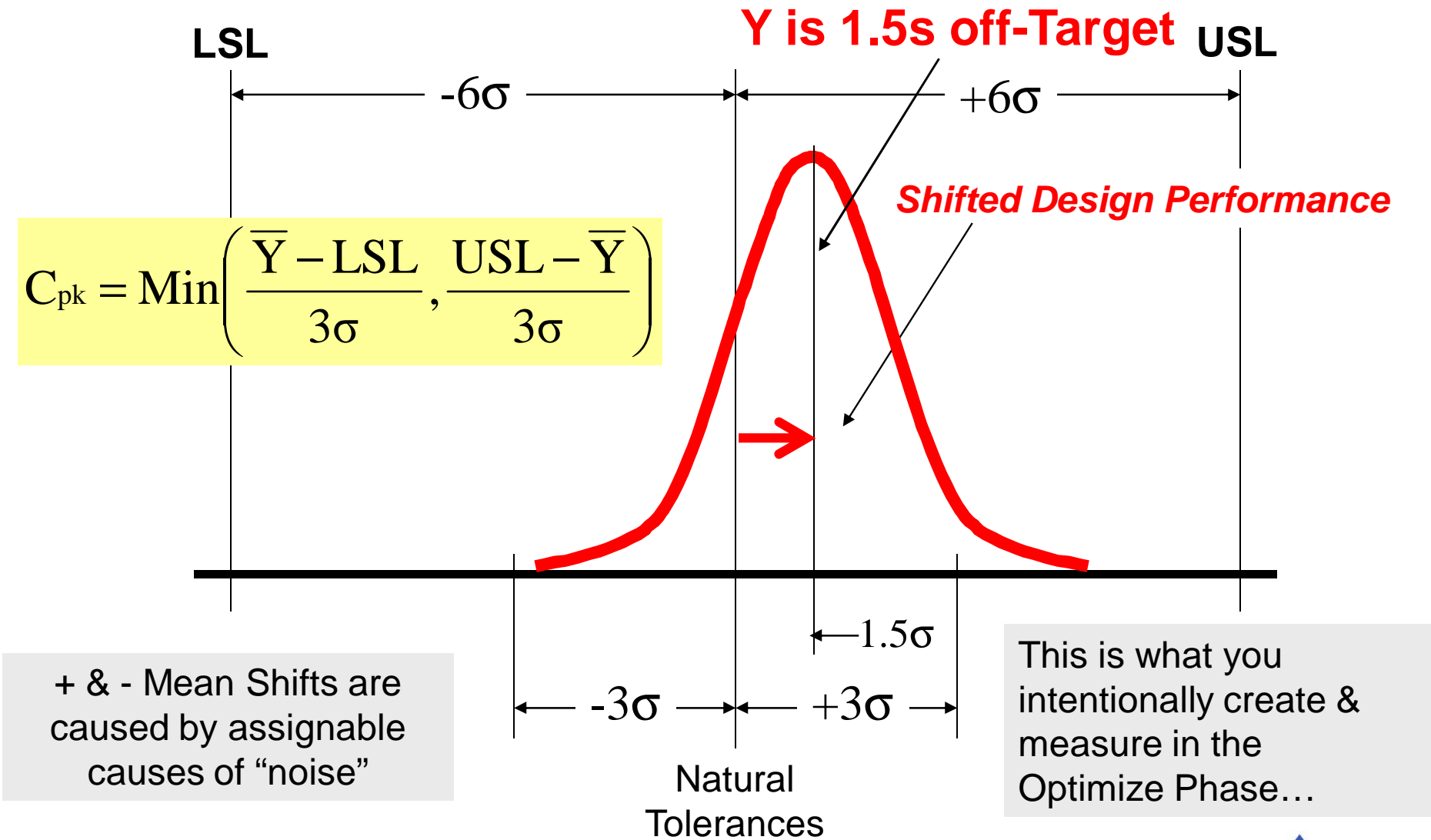
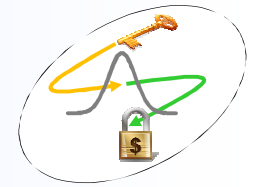
# What is Cpk?



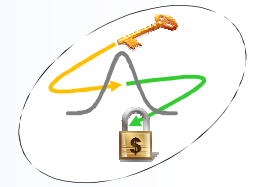
Cpk is the ratio of....



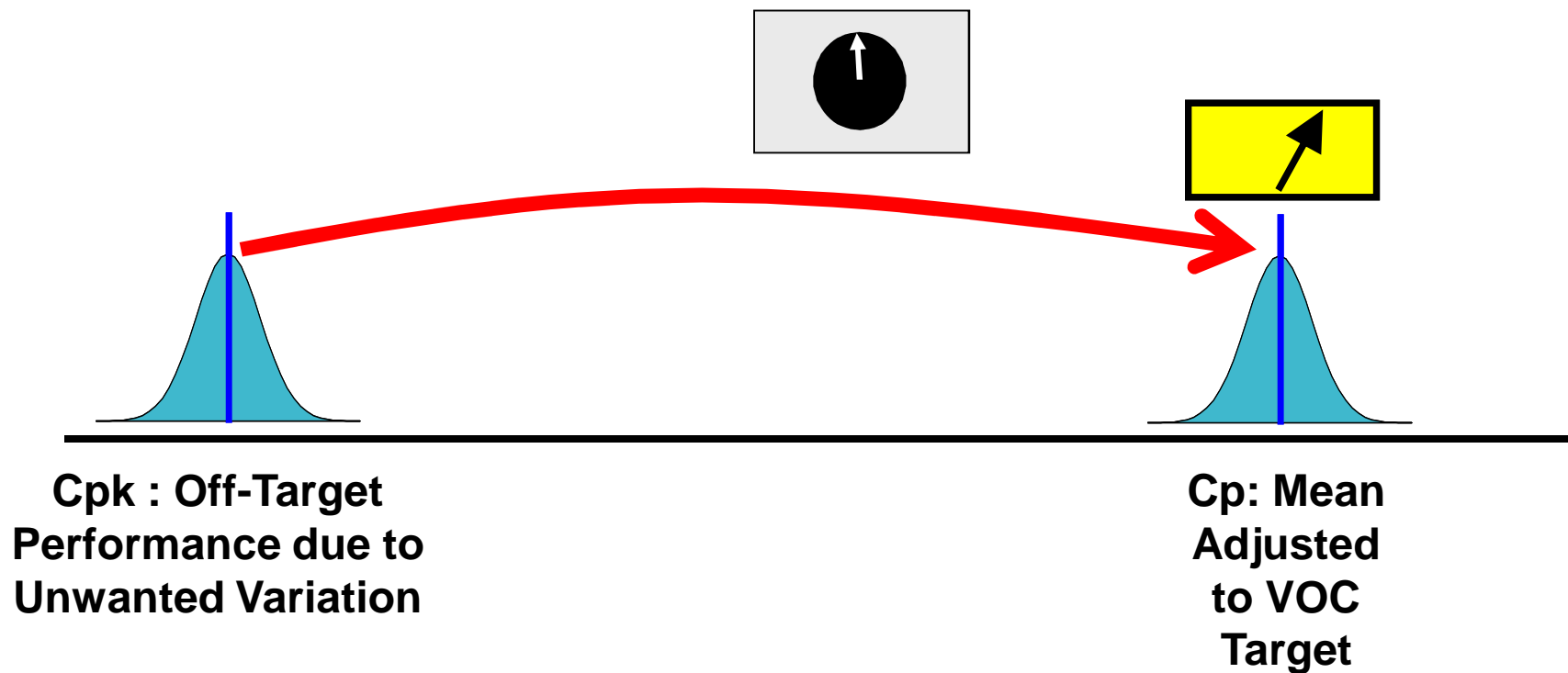
# Long Term Capability Performance



# Forcing $C_{pk} = C_p$ : **Adjustability!**

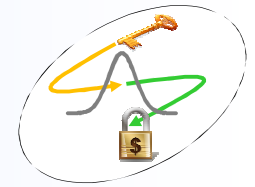


*Function Adjustment Parameters are  
FR Mean Shifters... driving  $k = 0!$*

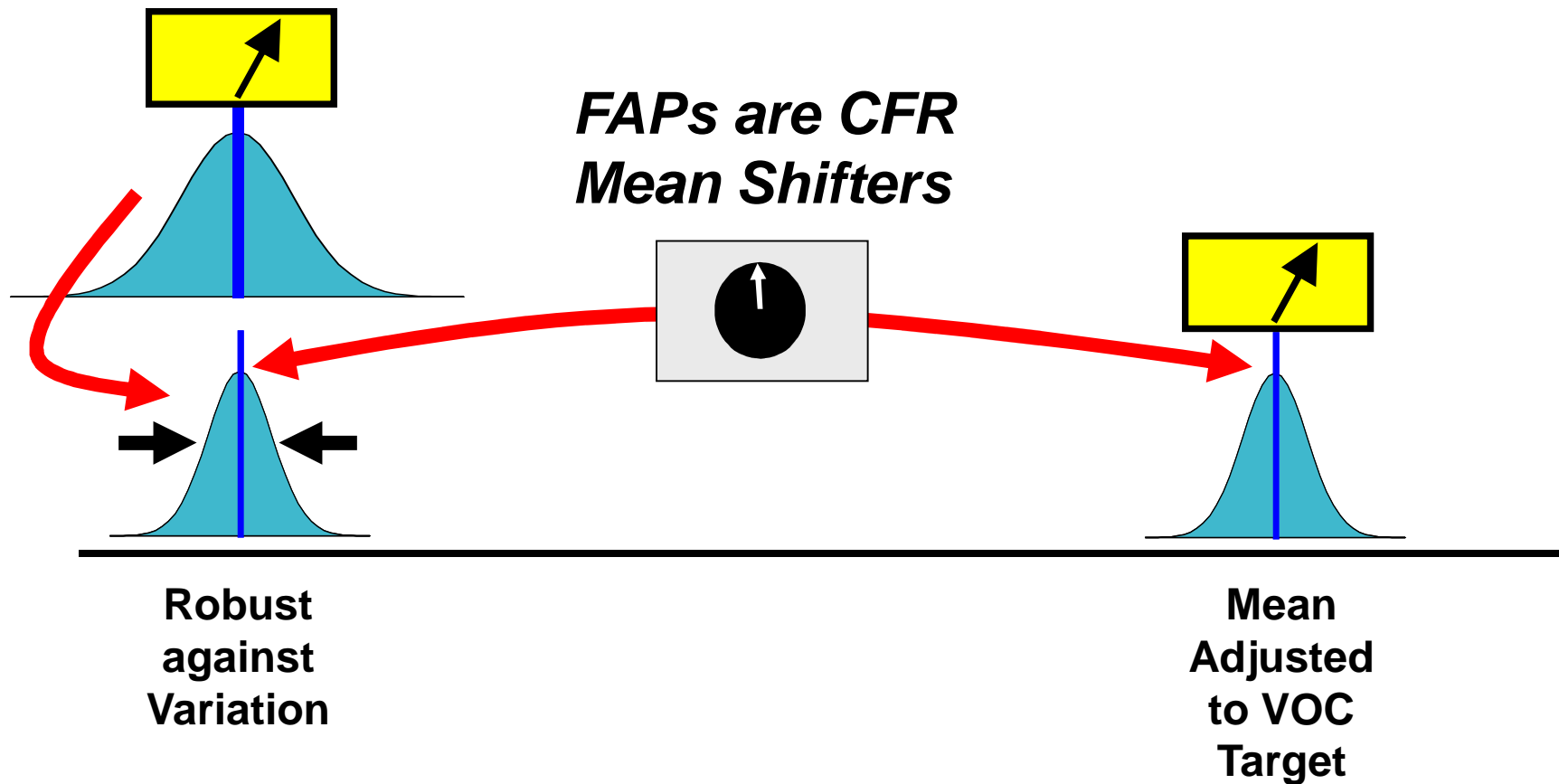
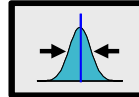


# Maximizing Cp:

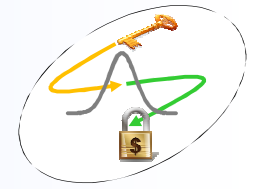
## Linking Robustness & Adjustability!



*Functional Robustness Parameters  
are FR Variance Reducers*

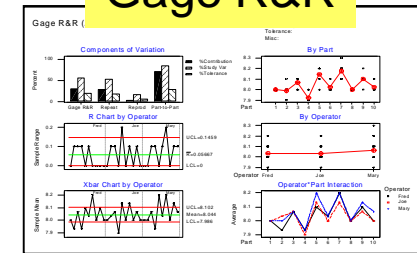


# Required KP Mgt. Data for any form of Capability Assessment

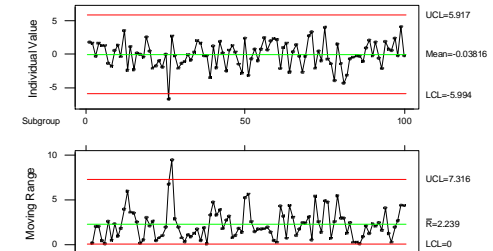


- All FRs or Functional Spec.s must have a capable **measurement process** documented & in use
  - Gage R&R Study
- Each FR or Functional Spec. is placed **under stable SPC** so the Cp can be routinely quantified for Phase-by-Phase growth & Life Cycle stability characterization
- All FRs & Functional Spec.s are **Capable** - typically w/ **target of Cp = 2 & Cpk of 1.5**

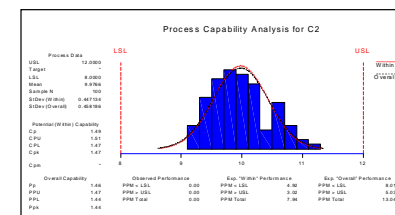
## Gage R&R



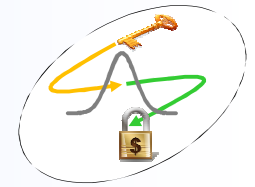
## I & MR Chart



## Capability Study



# Y as a Function of Controlling Xs



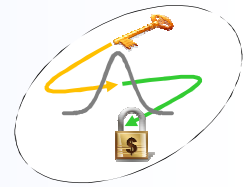
For a given Y there can be numerous controlling Xs....

There can be 3 ways for a controlling X to influence Y:  
 $X_j$  dominates the Mean... for Adjusting  
 $X_j$  dominates the Standard Deviation... for Robustness  
 $X_k$  co-contributes to **both** the Mean &  $\sigma$ ... You pick!

The question CPD&M asks is “do you know how Xs affect Ys in light of the 7 Checks???”

**- Which ones are out of control!?!?**

# Summary



- You should be able to repeat this explanation
  - It is important for you to be able to do this for **anyone** you work with.
  
- An organization practicing CPD&M must understand Capability
  - How it degrades....
  - how it grows & matures due to intentional investment in KP development tasks....
  - How it is calculated....
  - What it means in the context of CPD&M....

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