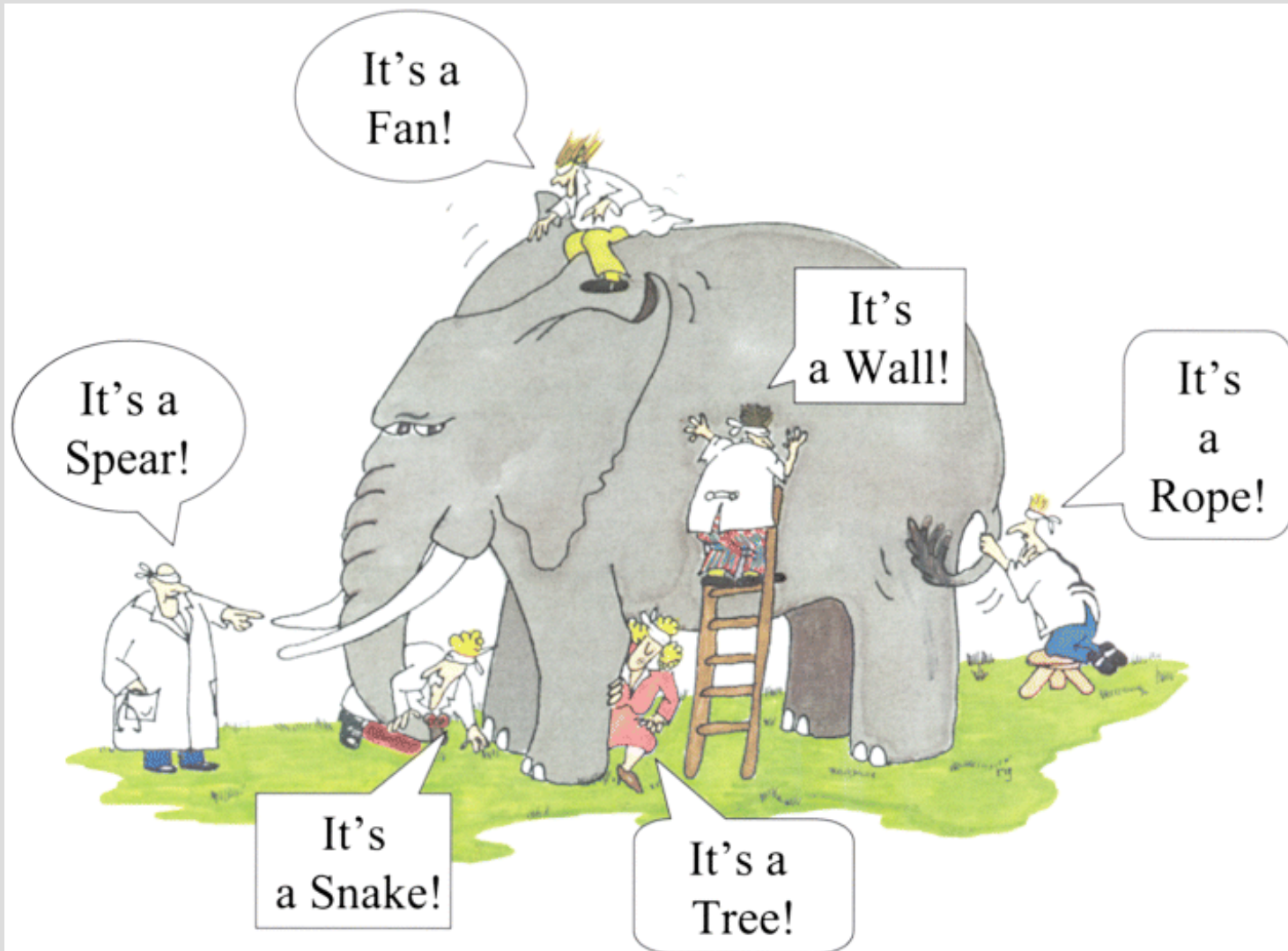




SIX
SIGMA
QUEST FOR EXCELLENCE

Andy K. Lesko, PhD
Six Sigma Master Black Belt
MacDermid Enthone Industrial Solutions

What is Six Sigma?





Six Sigma
scares me.



Six Sigma is
very cool.



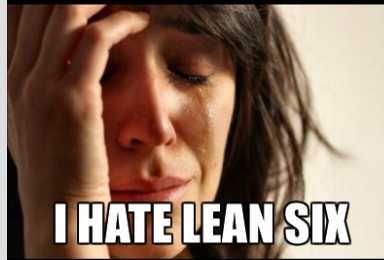
I love Six
Sigma.



I hate Six
Sigma.



MATH IS SO HARD.

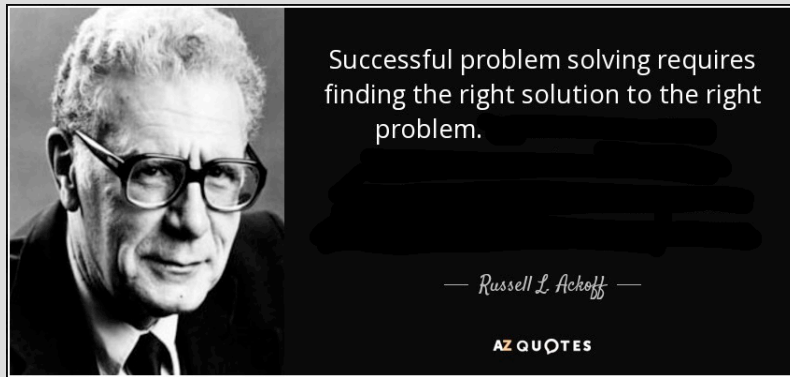


**I HATE LEAN SIX
SIGMA.**

memegenerator.net



What is Six Sigma?



The primary benefit of SS is a focus on problem definition.

- Effect: Fall down.
 - Wrong problem: Intoxicated.
 - Right problem (cause): Shoe laces untied.
-
- Effect: Plating is thin.
 - Wrong problem: ASF too low.
 - Right problem (cause): Bad connections.

What is Six Sigma?



“ YOU CAN'T MANAGE
WHAT YOU DON'T MEASURE.

- W. Edward Deming

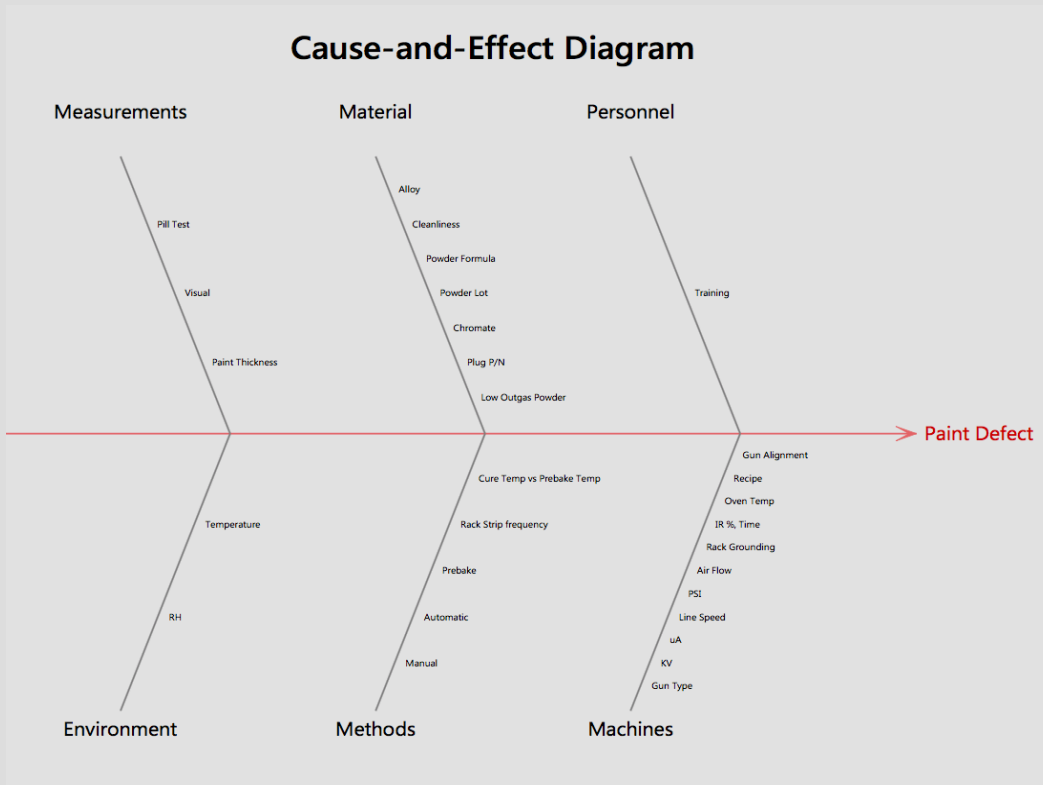


The second benefit
of Six Sigma is a
focus on measuring.

What is Six Sigma?



Problem: Paint adhesion to ZDC parts



Another benefit of Six Sigma is finding root causes and fixing them.

What is Six Sigma?



A BAD SYSTEM WILL BEAT
A GOOD PERSON EVERY TIME

- W. EDWARDS DEMING

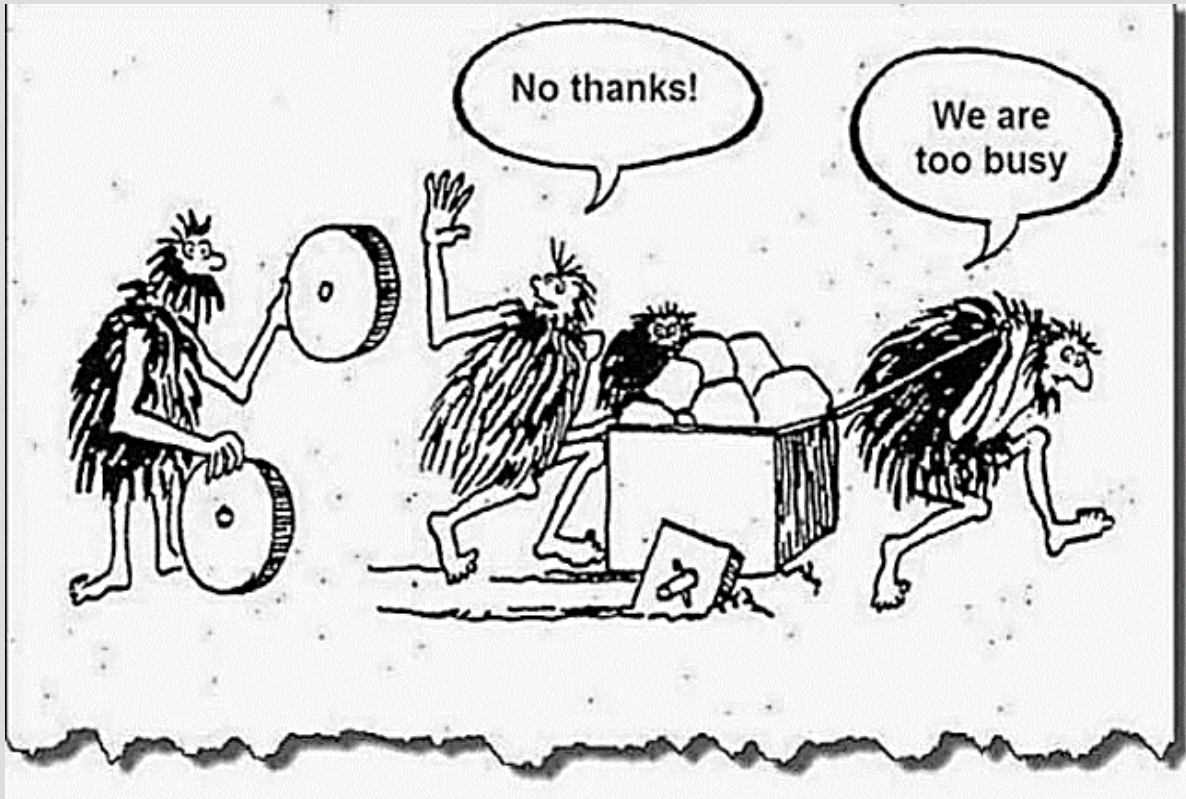


A good system will beat a bad
person every time.

The DMV
The post office
American Airlines
Comcast

Tesla
Amazon
Disneyland
Chick-fil-a

Six Sigma reduced to one image.



1. Hard to pull cart.
2. Takes over 200 lbs(f); want ≤ 40 lbs(f).
3. Wheels are square.
4. Use round wheels.
5. Replace all square wheels with round.

Six Sigma Methodology



DMAIC Roadmap

What's broken?

Define the problem and the objectives.

Why is it broken?

Analyze the process.
Define factors of influence.

Keep it fixed.

Assure that improvements will sustain.



How broken is it?

What do we need to improve?
Can we measure this?

Fix it.

Identify and implement improvements.



Traditional Six Sigma

- Define
- Measure
- Analyze
- Improve
- Control

Six Sigma Lite

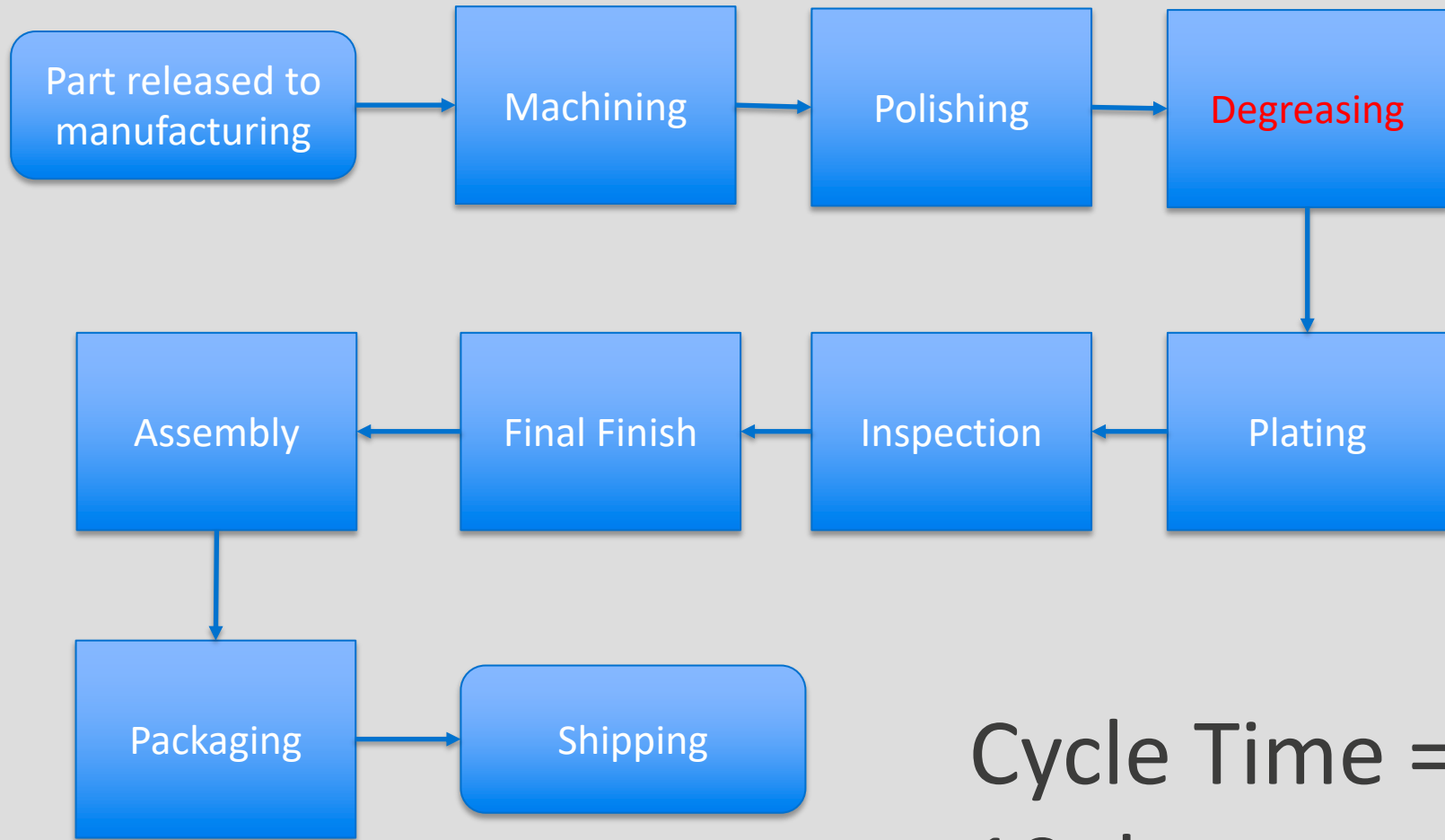
- What's broken?
- How broken is it?
- Why is it broken?
- Fix it!
- Keep it fixed.

Problem Definition (Define Phase)



- In a plating shop, you can't get enough product to the customer.
- **Why?**
- Not enough output.
- **Why?**
- Takes too long to process parts.
- **Why?**
- Parts backup at solvent cleaner before plating.
- **Why?**
- **Not enough capacity at solvent cleaner.**

Process Map (Measure Phase)



Cycle Time =
10 days

Analyze/Improve Phases



Effect: Can't meet customer demand.

Cause: Parts backup at degreasing.

How do we fix this?

Improve Phase



Eliminate solvent degreasing and replaced it with improved cleaning in the plating line?

Cycle time reduce by 2 days. A 20% reduction in cycle time. Result is a 25% increase in output. Now only takes 8 days to process 5000 parts instead of 10.

Takt Time goes from 108 sec to 86 sec.



- Reduce waste
- Reduce cycle times.
- Reduce inventories.
- Cut costs.
- Improve level of service.



- ❖ 5S
- ❖ Kanban
- ❖ TPM
- ❖ SMED
- ❖ OEE
- ❖ Kaizen

The History of Six Sigma



Motorola, Inc. invented Six Sigma in 1986. Achieved more than \$16 B in savings.

General Electric program starts in 1996. Achieved \$2 billion return in 1999.

Toshiba achieved \$1 billion return in fiscal year 2001.

Honeywell realized \$2.2 billion in cumulative savings activities during 1990s.

Companies using Six Sigma: Renault, Sun, Cisco, Seagate, Motorola, GE, Ford, Sony, Allied Signal, Applied Materials, Caterpillar, Nokia, DuPont, Kodak, Ebay, Intuit, Wells Fargo, JP Morgan Chase, Johnson Controls, The Home Depot, Raytheon, Sears, North MS Healthcare, Volt Services Group, Genentech, MacDermid Enthone, . . .



Traditional Six Sigma

Reduce Variation (standard deviation, σ)

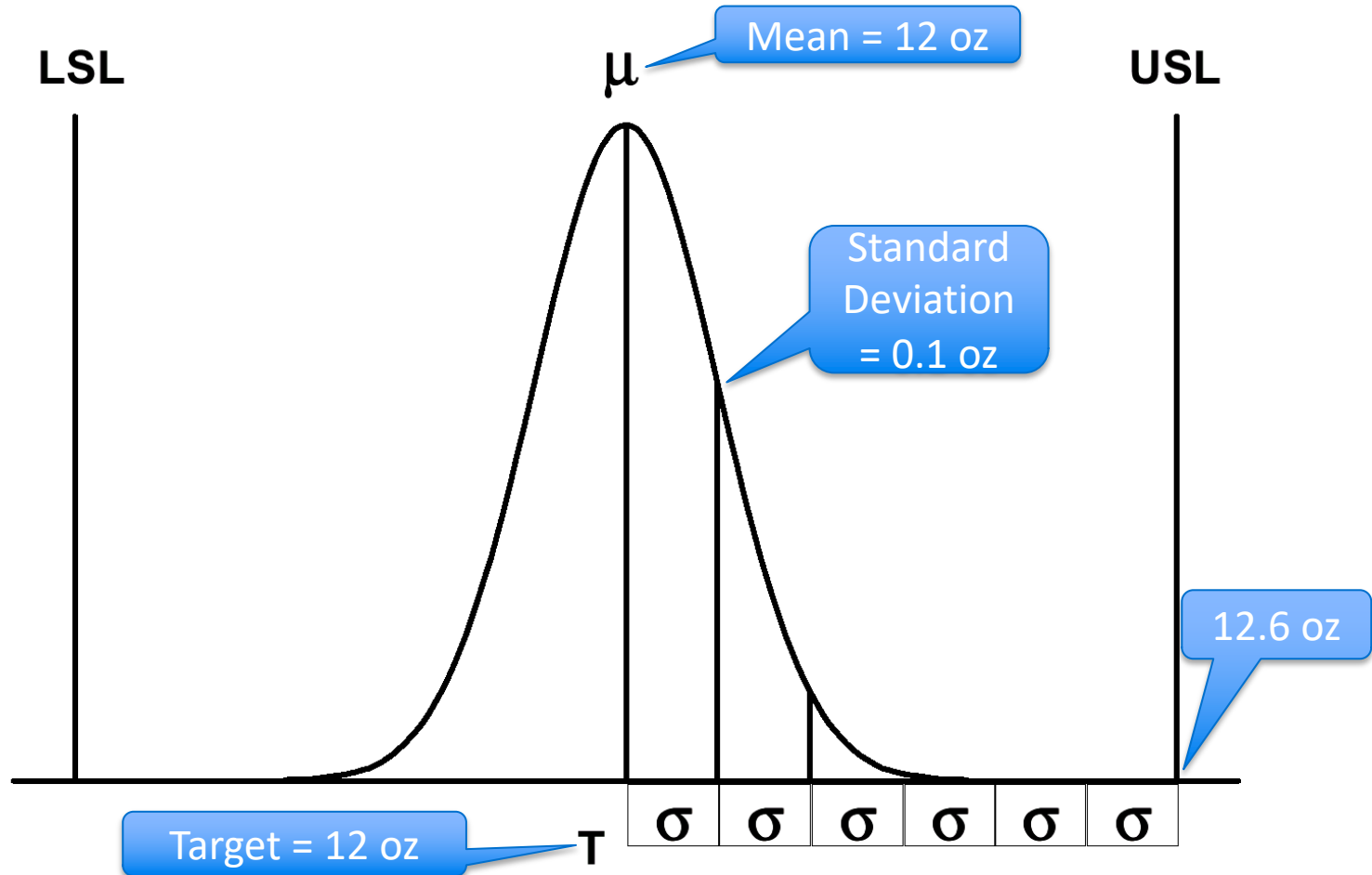
Do not allow defects!

6 σ = A process with 3.4 DPMO

- Incorrect surgeries: 15/week @ 4.5M/week
- Time without electricity: 1 hour/34 years
- Time drinking water bad: 1 minute/7 months
- Domestic airline fatalities: 3.1 ppm (6.5 σ)

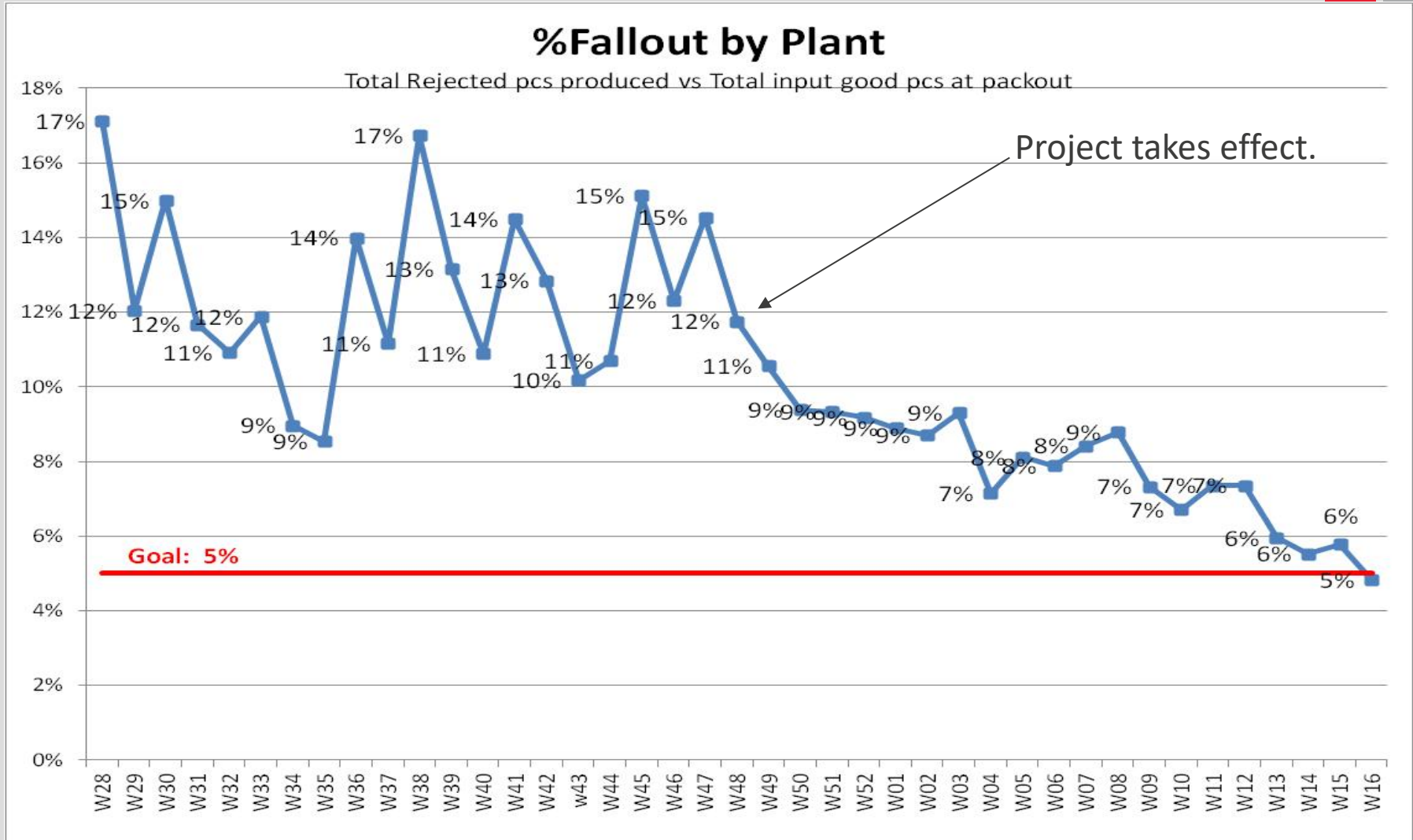
A Six Sigma Process (beer can fill)

Upper Spec. Limit = 12.6 oz.

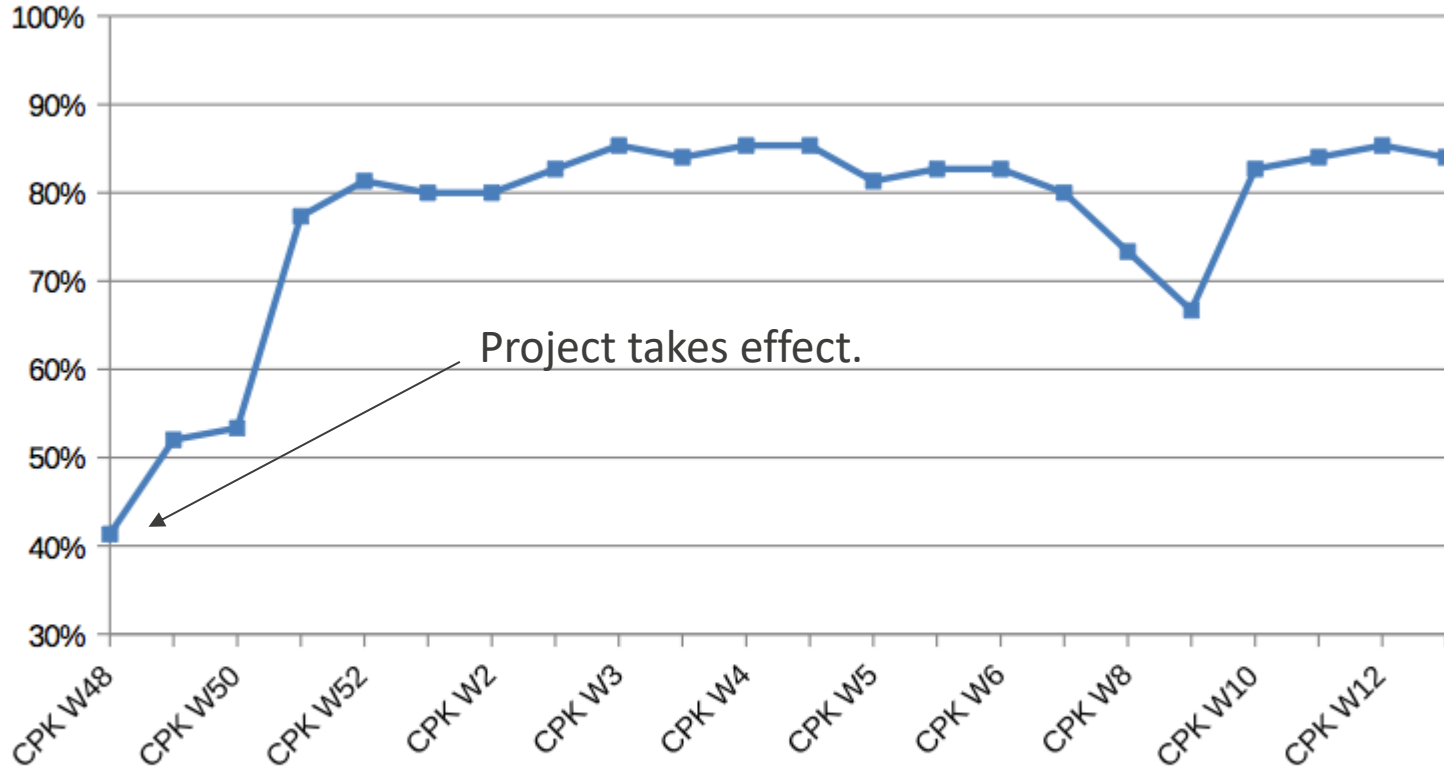


A six-sigma (6σ) process

Rework Rate at Metal Finisher



% of Cpk > 1 for chemical tanks



This chart shows the percent of process components on Line 4 with a Cpk > 1.0 from late December 2013 to late March 2014.

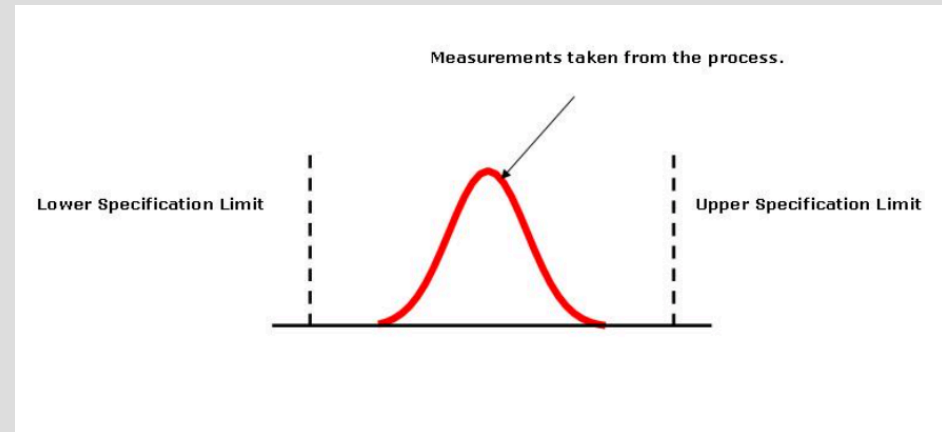
Capability Indexes



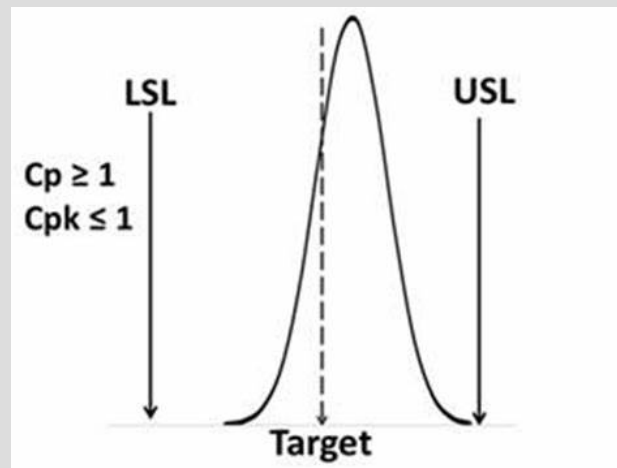
$$C_p = \text{VOC}/\text{VOP}$$

VOC = voice of customer
= USL - LSL

VOP = voice of process
= 6 stdev (6 sigmas)



$$C_{pk} = (\text{Average} - \text{Nearest VOC}) / (1/2 * \text{VOP})$$

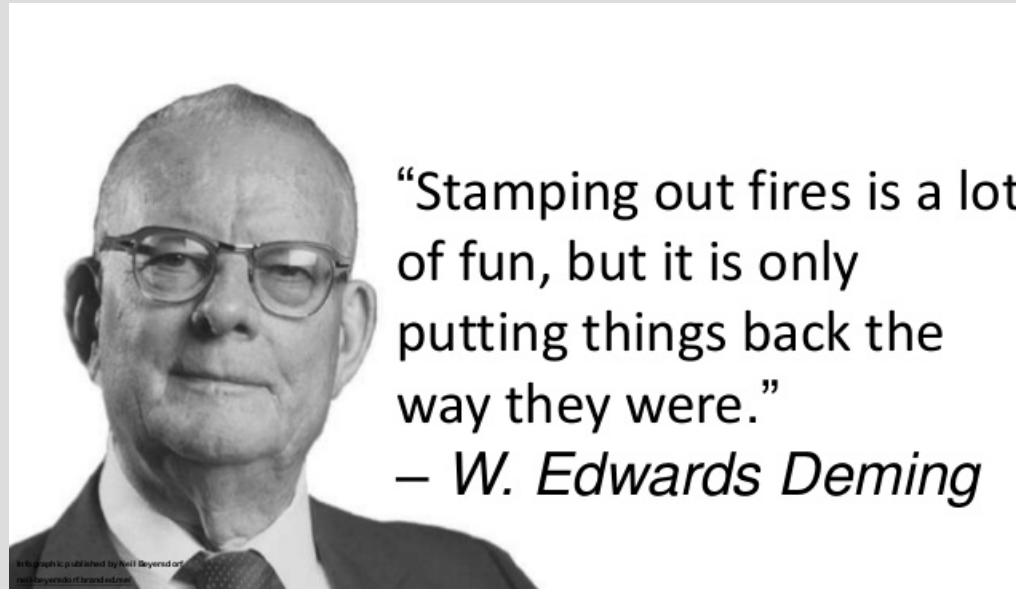




Cpk is related to the sigma level of a process.

- $Cpk = \sigma/3$ (short term).
- $\sigma \text{ level} = 3 * Cpk$.
- A Cpk of 2 = a Six Sigma process.

Reacting to Data—Control Charts

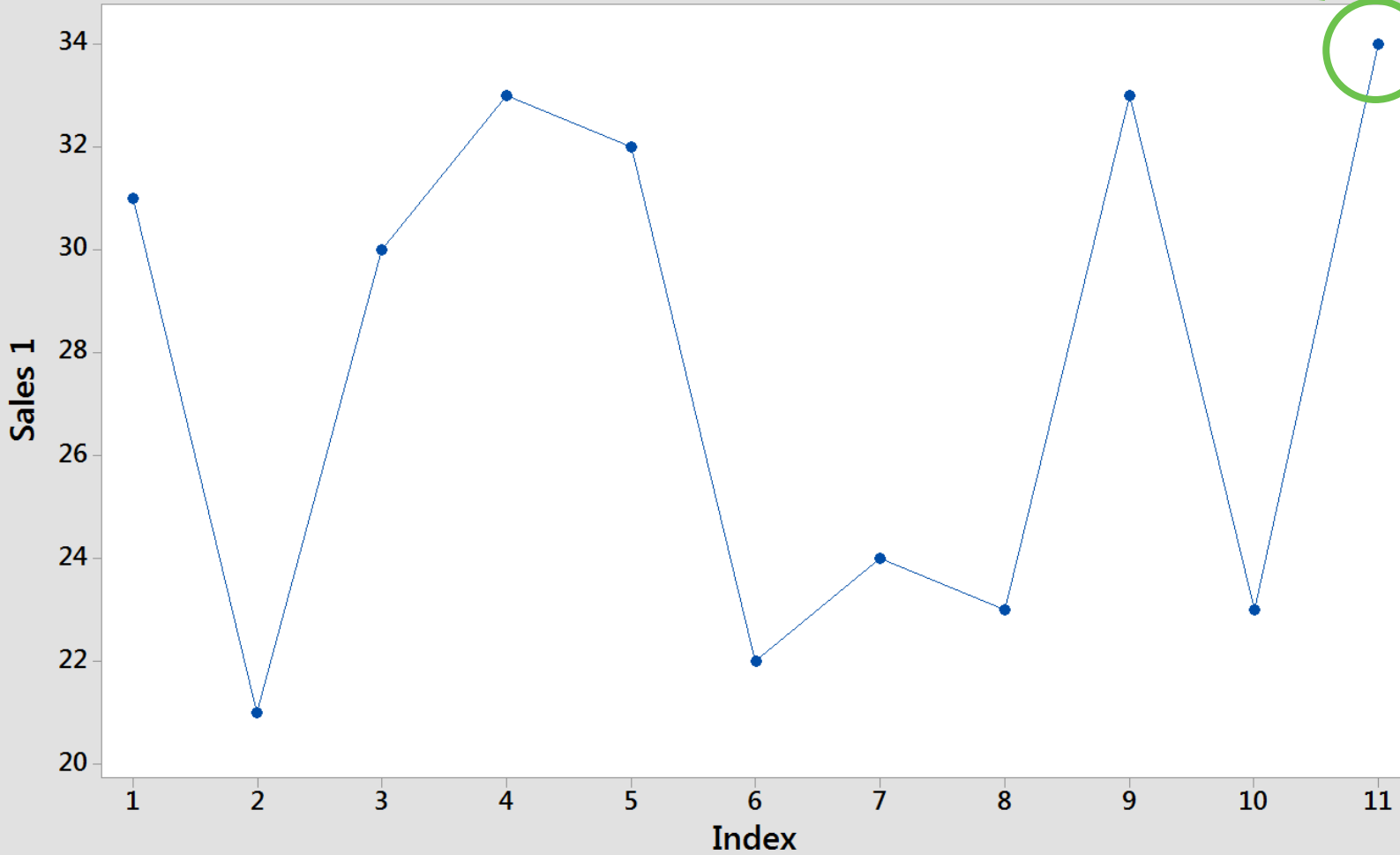
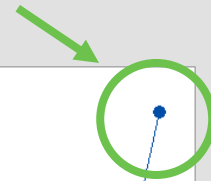


The ABC Company has best sales ever!



Award given to manager!

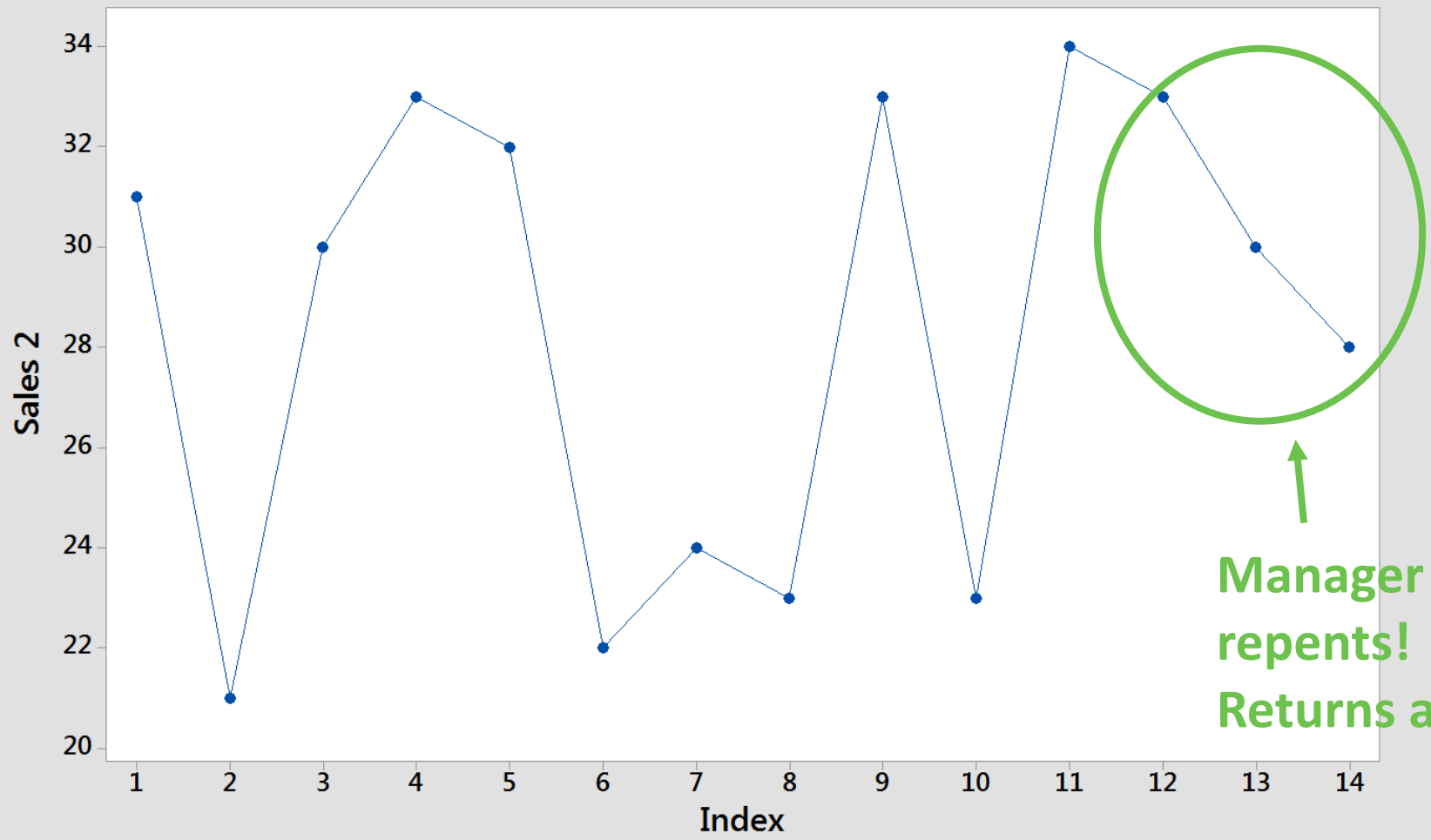
Time Series Plot of Sales 1



But sales drop the next three months.



Time Series Plot of Sales 2

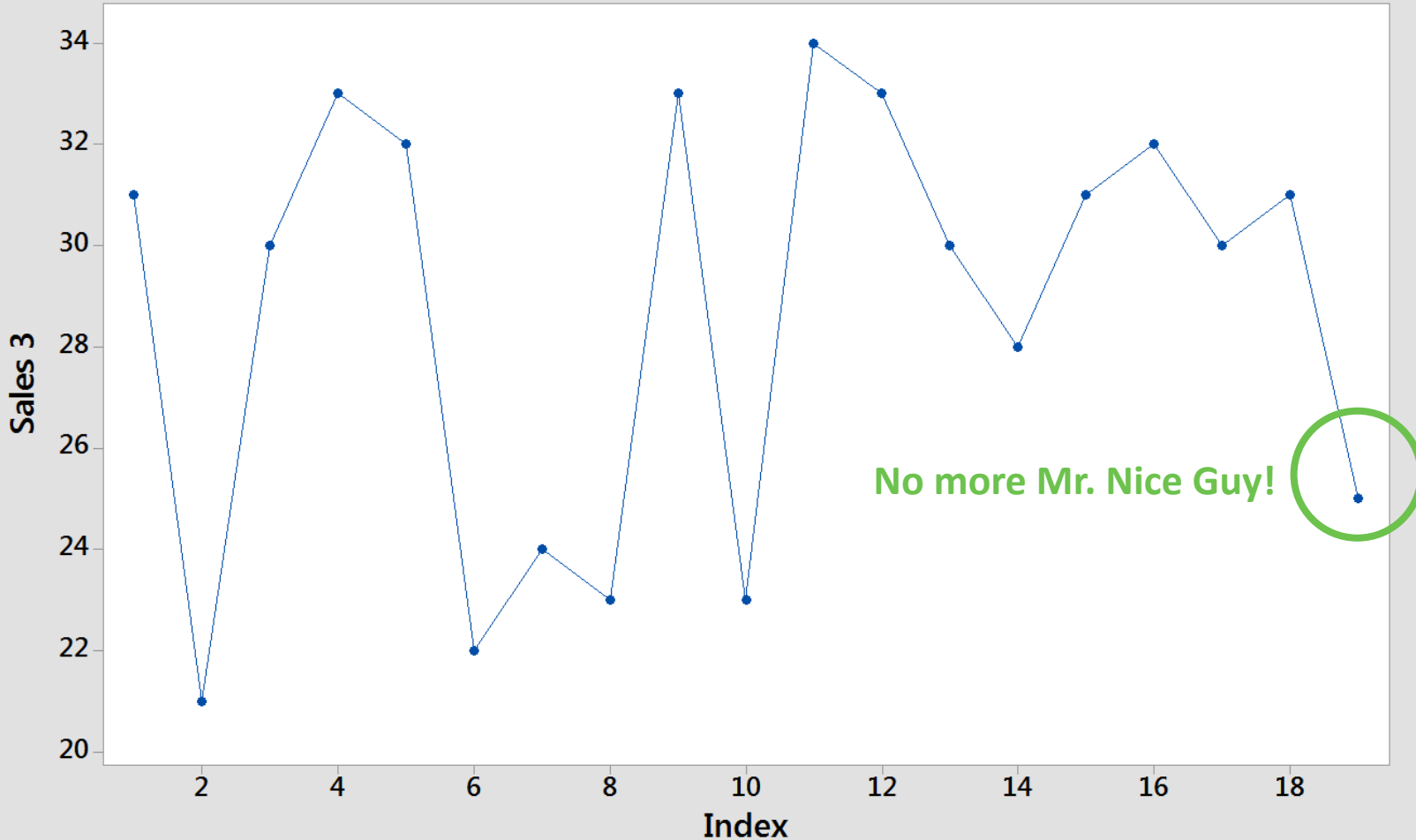


Manager repents!
Returns award.

It keeps getting worse. Jobs at stake.



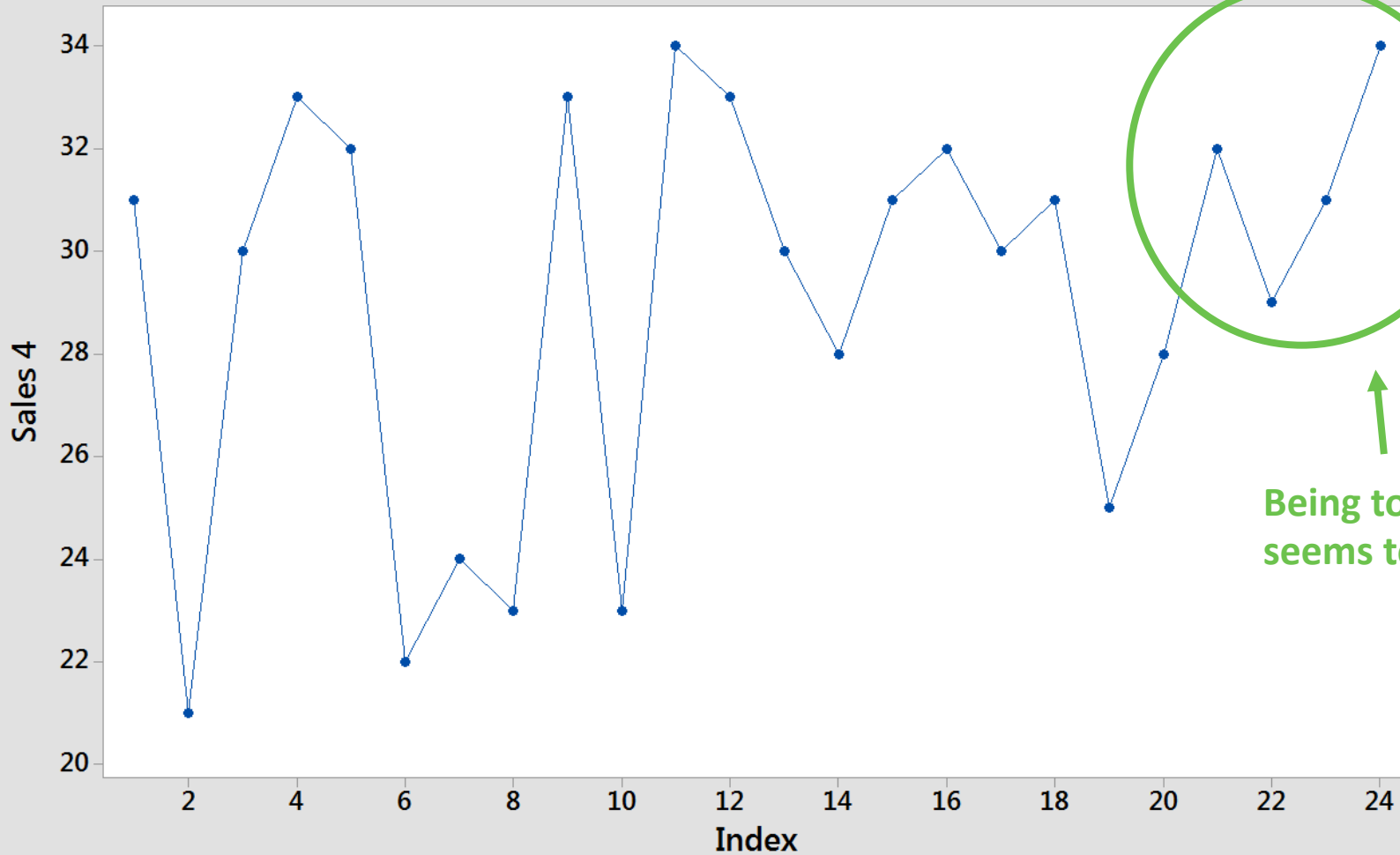
Time Series Plot of Sales 3



Tough management seems to work and sales climb again.



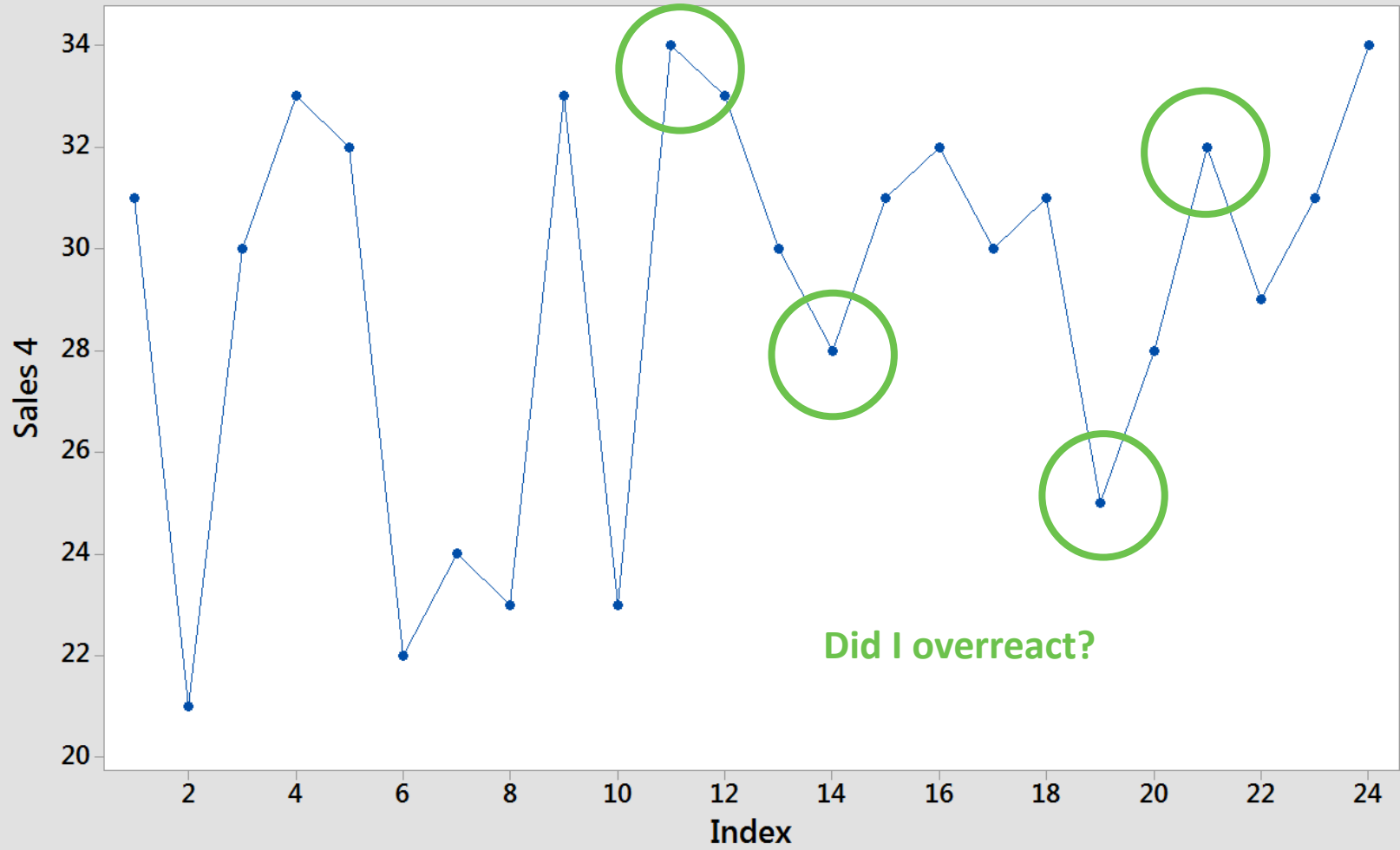
Time Series Plot of Sales 4



Being to tough guy seems to work!



Time Series Plot of Sales 4

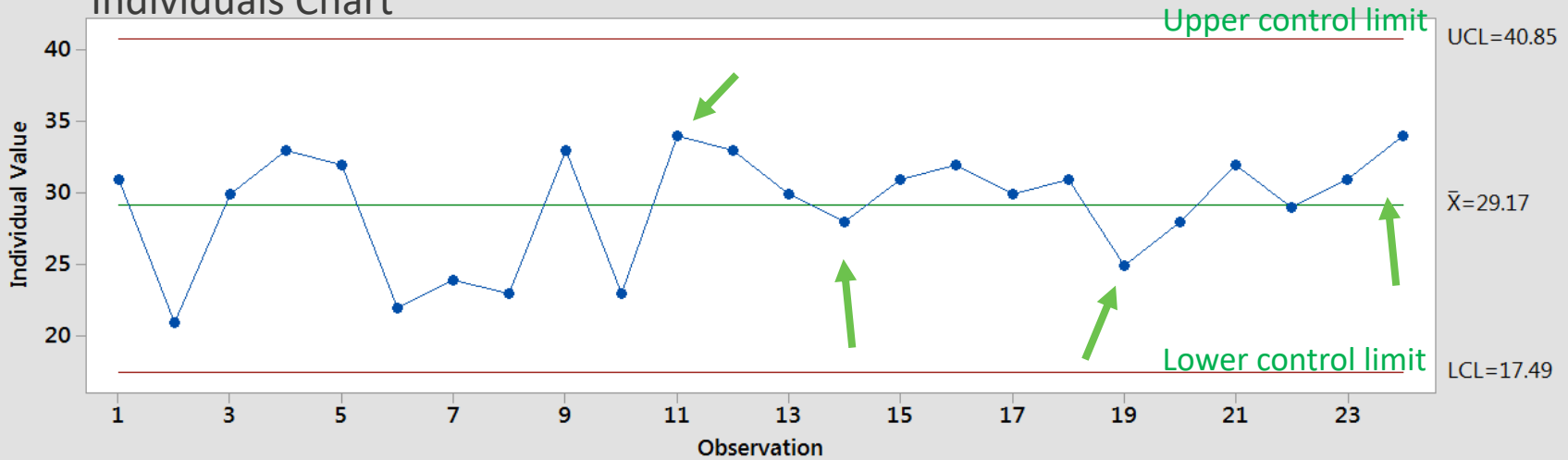


Unless you change the system, it's just noise.

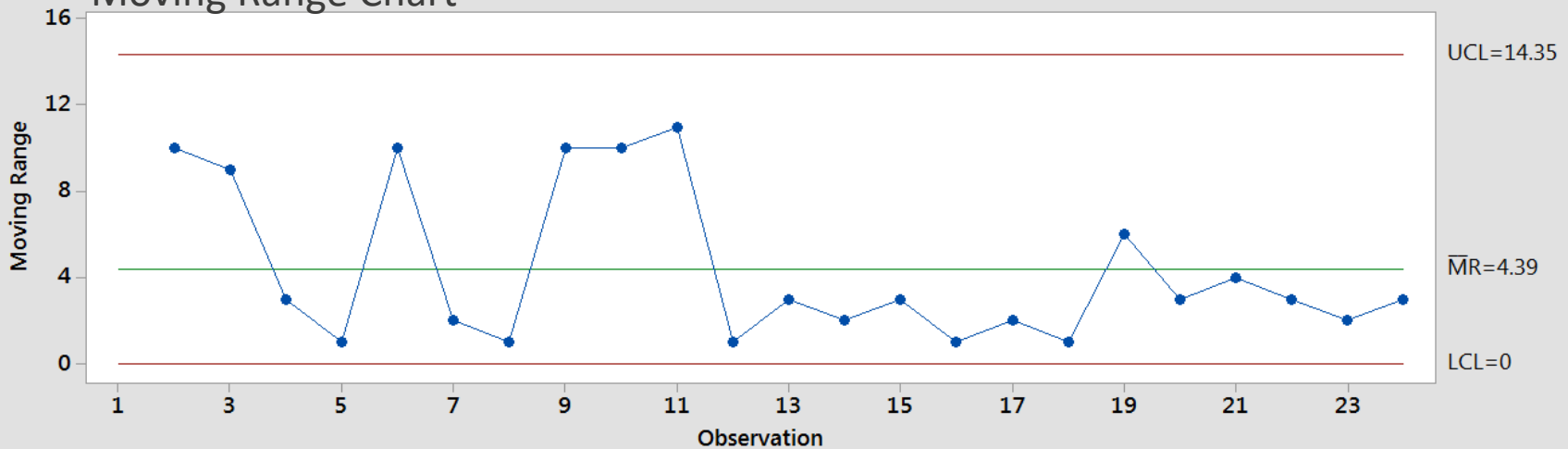


I-MR Chart of Sales 4

Individuals Chart



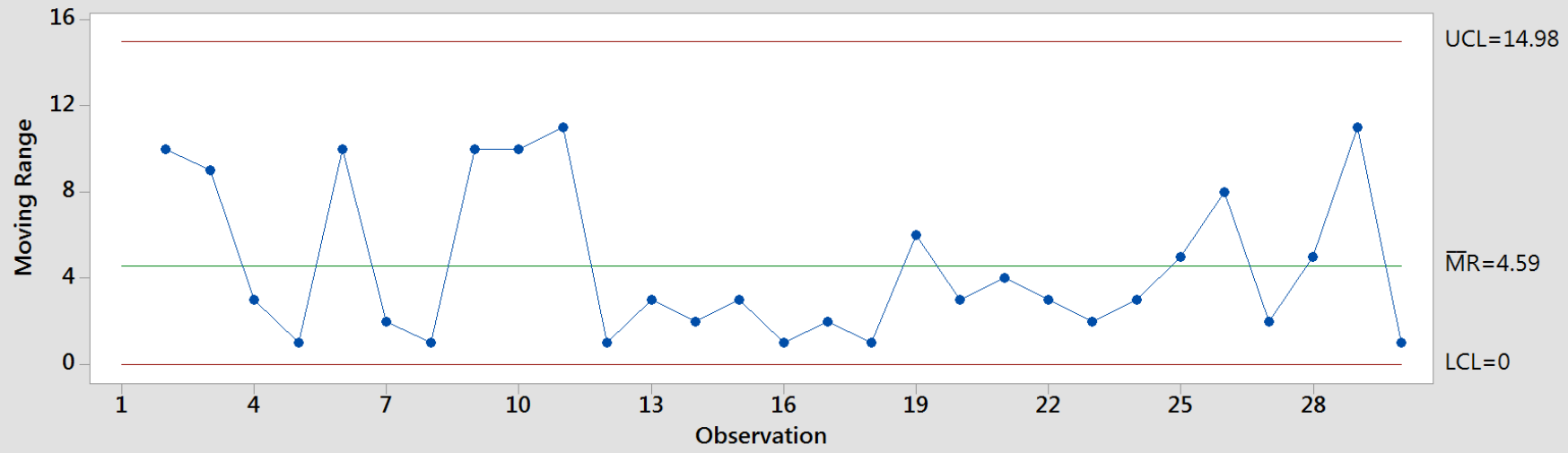
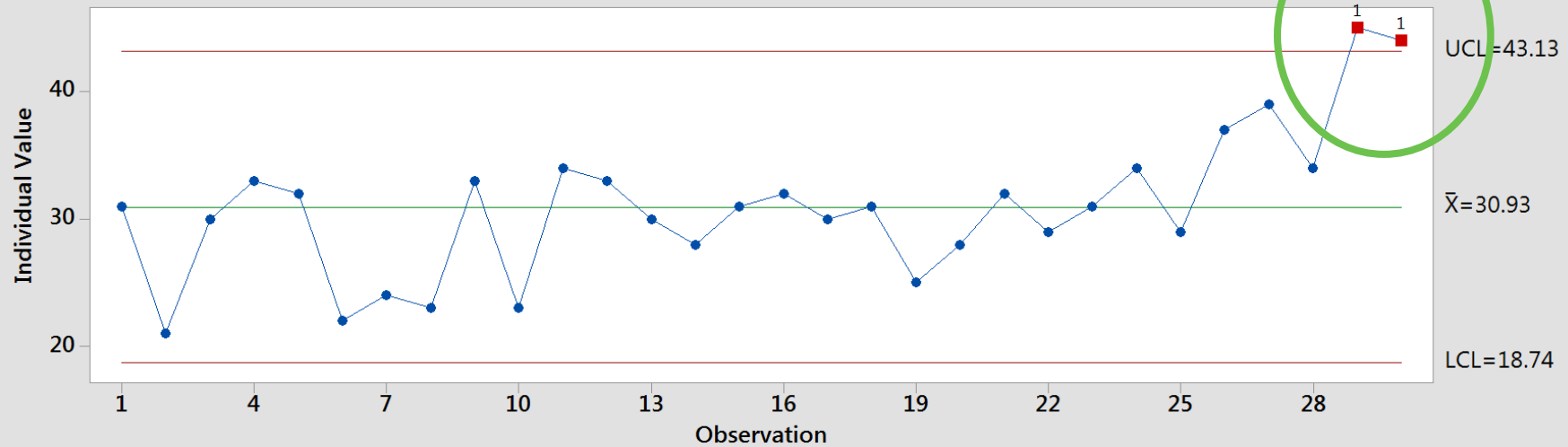
Moving Range Chart



Now this is something real—a true and good special cause.



I-MR Chart of Sales 5

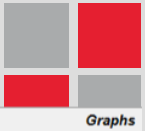


Examples of variation in a sales system.

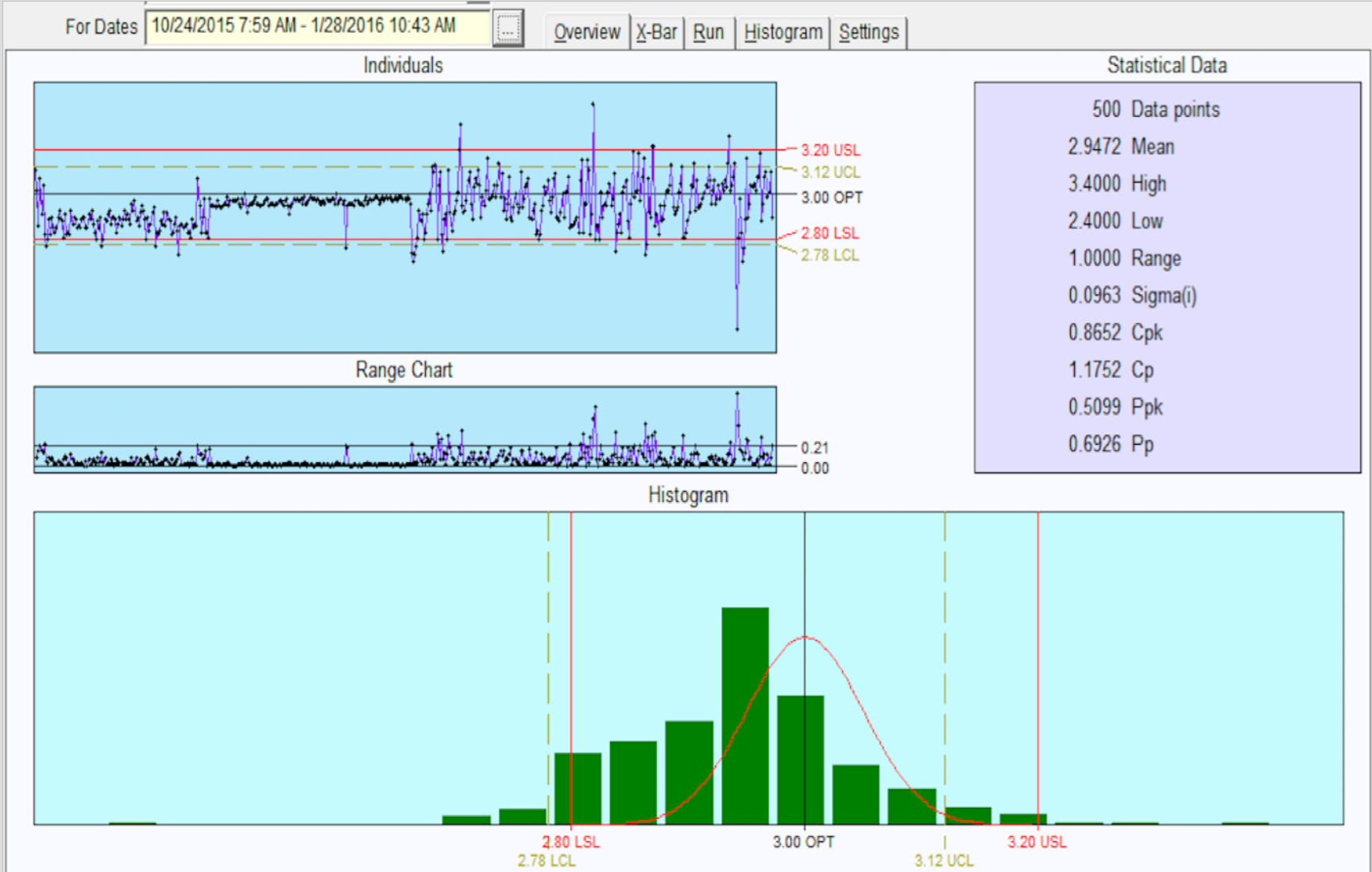


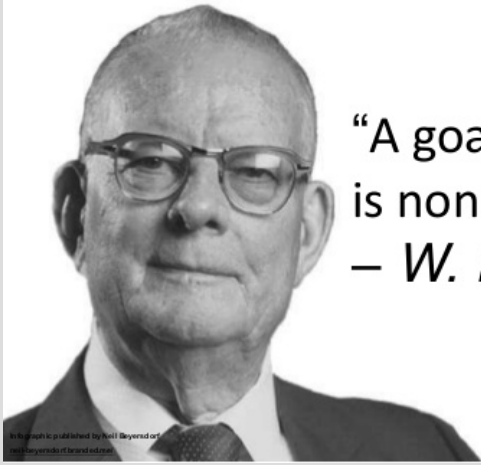
Common Cause	Special Cause
Economy	Pandemic (short term)
Business cycles	Material error (short term)
Vacations	Gov't Politics (long term)
Retires/hires/attrition	Projects executed (long term)
Pricing action	Change sales model (long term)
Morale	Change tech model (long term)
Customer acquisition/loss	New product invention (long term)
Weather	Acquisition (long term)
Seasons	?

SPC for Chromic Acid



Changing the system





“A goal without a method
is nonsense.”
– *W. Edwards Deming*



Six Sigma defines a
goal and is a strategy
to get there.

- What’s broken?
- How broken is it?
- Why is it broken?
- Fix it!
- Keep it fixed.

What do you think now?



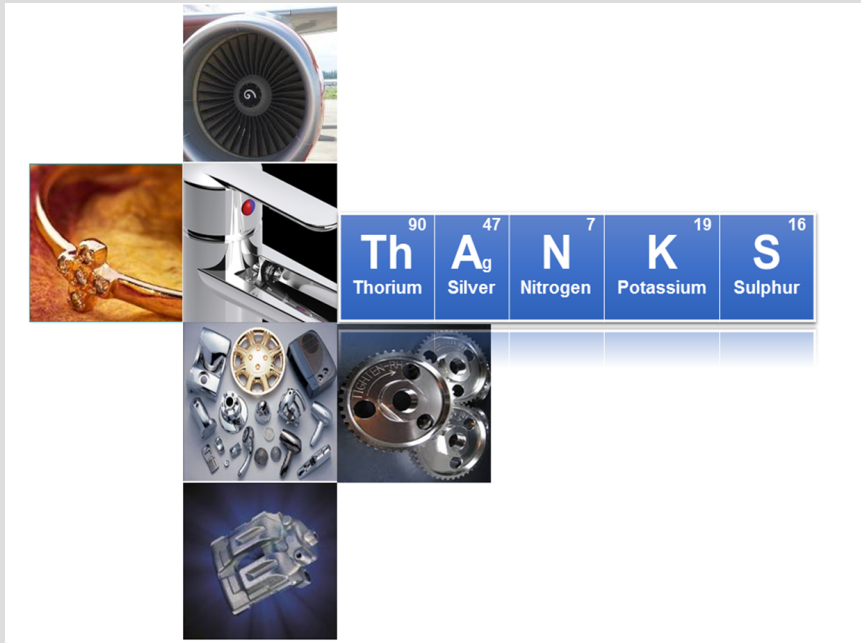
Love



Cool



Thank you!



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971-239-1562