Introducing Process Improvement

To New Employees

November 9, 2021

Meet the Presenters

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PQ Systems

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Product & Application Support Manager
PQ Systems

First day on the job…

Standard Operation Sheet

faurecia	STANDARD OPERATION	FAU-F-PB-241 / EN version 02	Plant:	Washington	Document No.:	xxxx
					Revision Level:	4

Part Number	xxx	Part Name	Bolster	Line :	EQ Bolster	Work-station:	Woodstock	Page No:	1/1

No.	Operation	✚ = SAFETY ◆ = QUALITY ● = TIP	Time: 30 Sec
1	Remove parts from tool		**Remove cavities 3 & 4** from the mould tool. Place parts onto left side of bench (Fig1)
2	Remove the spiking frame from the upper tool	●	Remove the waste then **place the frame onto the bench** **Ensure frame handle is pointing away** from you and spikes are pointing upwards.
3	Fold waste and place onto to stand.		Fold the waste from the frame and place it onto the granulator cooling stand, using it to push the existing waste into the granulator (fig 2).
4	Remove the spiked frame from the underneath bench	◆	Remove the spiked frame from underneath the bench **place it into the guides on the upper mould** tool (fig 1) Ensure that the **handle** is pointing towards you **is fully located against the censor**
5	Place one white & green clip into cavities 3&4	●	- Take one white & green LH clip from the dispenser. - Place the green clip into the center clip position and the white into the bottom location on cavity 4. - Take one white & green RH clip from the dispencer. - Place the green clip into the center cl

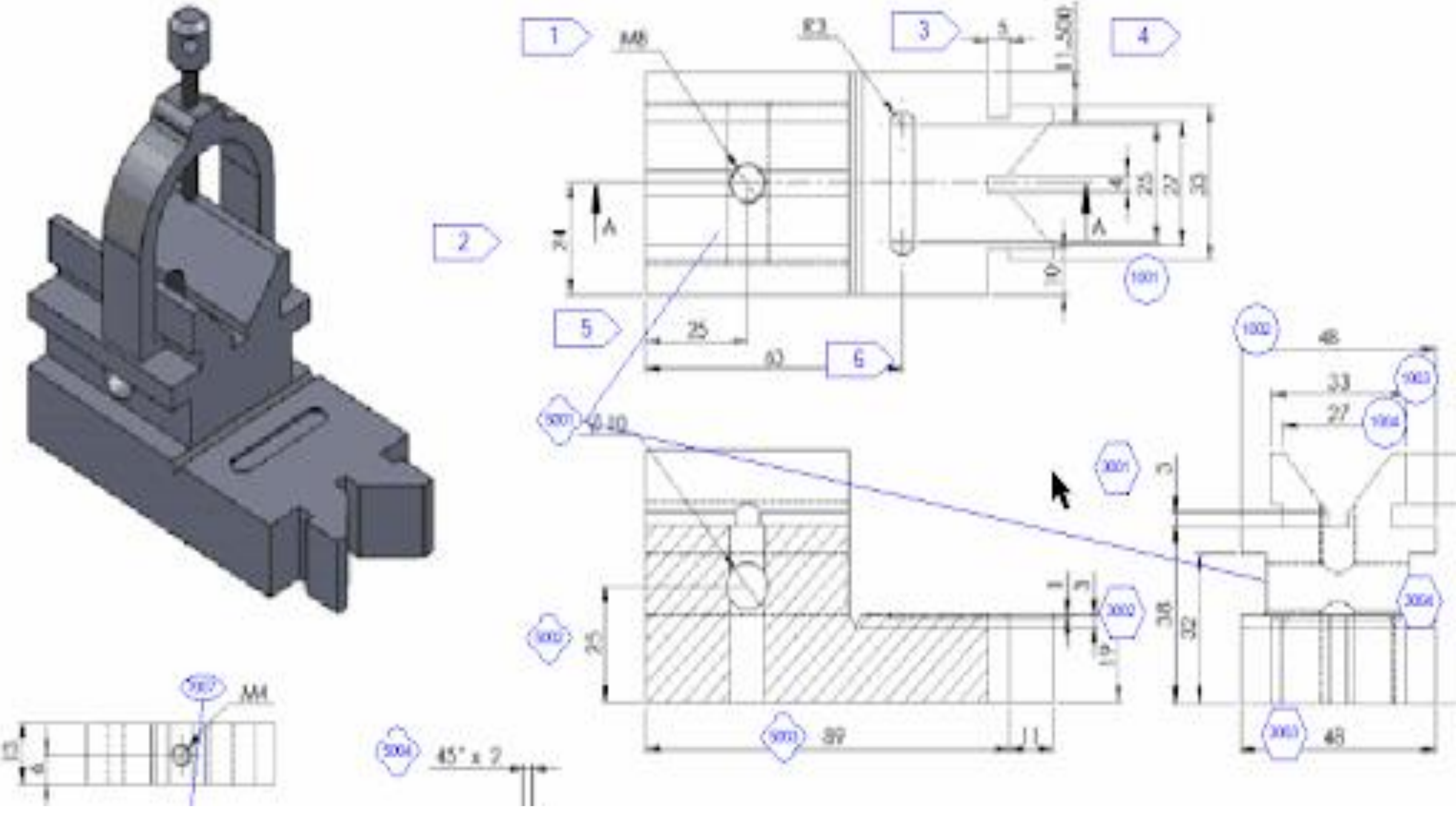
Sketches / Photo's / etc.

Fig 1.

Fig 2.

Fig 3.

Issued	Signature/Date	Checked	Signature/Date	Approved	Signature/Date	SKILLED OPERATOR	Signature/Date	Non Conforming Product:
Name:		Name:		Name:				Place rejects in reject container. Record on Process Monitor Sheet. If 3 or more rejects found with same fault call Gap Leader.
Function:		Function:		Function:		Name:		



1
M8
R3
3
5
4
2
24
A
A
16
25
27
30
10
5
25
6
62
48
33
27
38
32
25
89
11
48
M4
15
6
45° x 2

Header information

VARIABLES CONTROL CHART
X - MR CHART

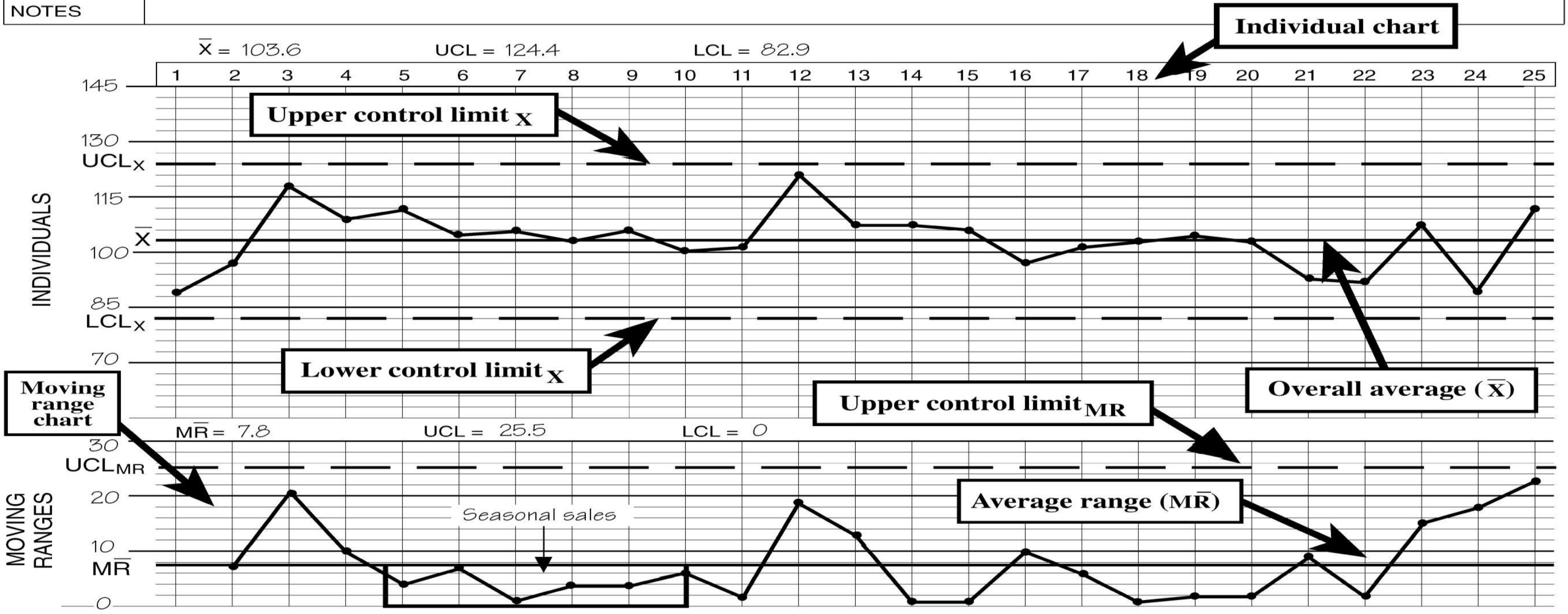
Quality measure	Chart no.
Sales $	

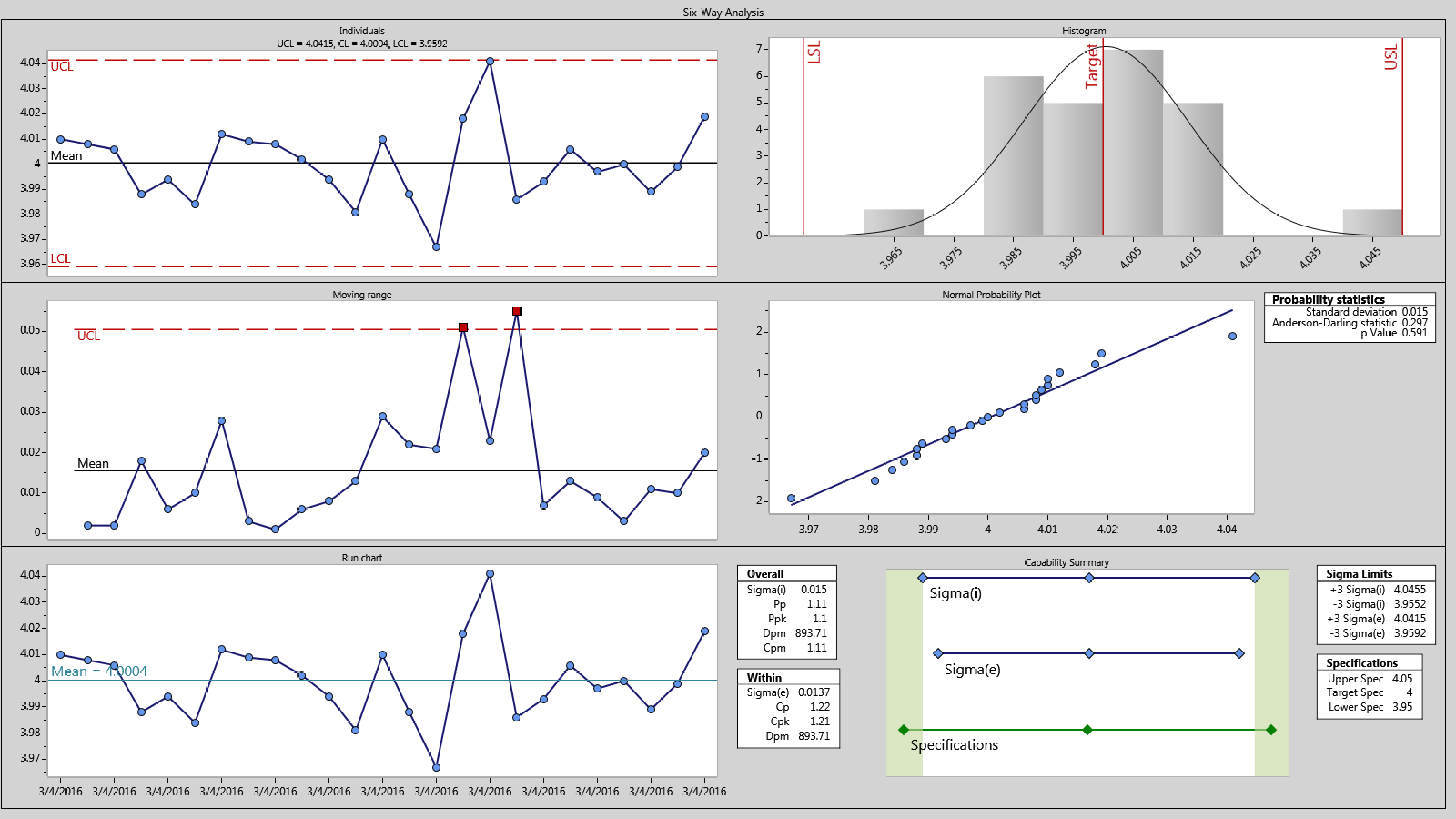
Product / Service	Process	Specification limits
Food service	Restaurant	

User name	Location	Measurement device	Unit of measure
Joan Rogers	Sherman	Sales receipts	$1,000

Data

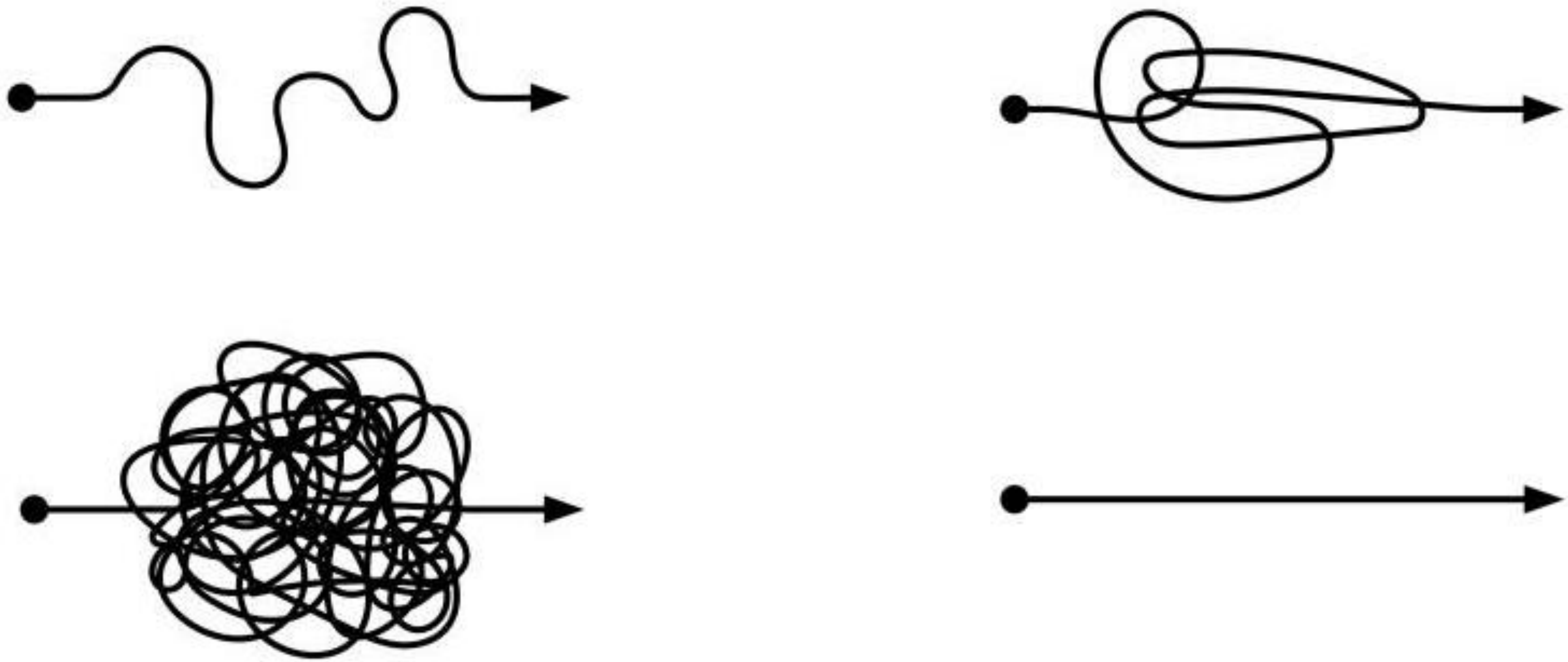
DATE	Aug 5	Aug 12	Aug 19	Aug 26	Sep 2	Sep 9	Sep 16	Sep 23	Sep 30	Oct 7	Oct 14	Oct 21	Oct 28	Nov 4	Nov 11	Nov 18	Nov 25	Dec 2	Dec 9	Dec 16	Dec 23	Dec 30	Jan 6	Jan 13	Jan 20
TIME	8p.m. →																								
SAMPLE MEASUREMENT 1	90	97	118	108	112	105	106	102	106	100	102	121	108	107	106	96	102	103	105	103	94	92	107	89	112
MOVING RANGE, MR		7	21	10	4	7	1	4	4	6	2	19	13	1	1	10	6	1	2	2	9	2	15	18	23
NOTES																									



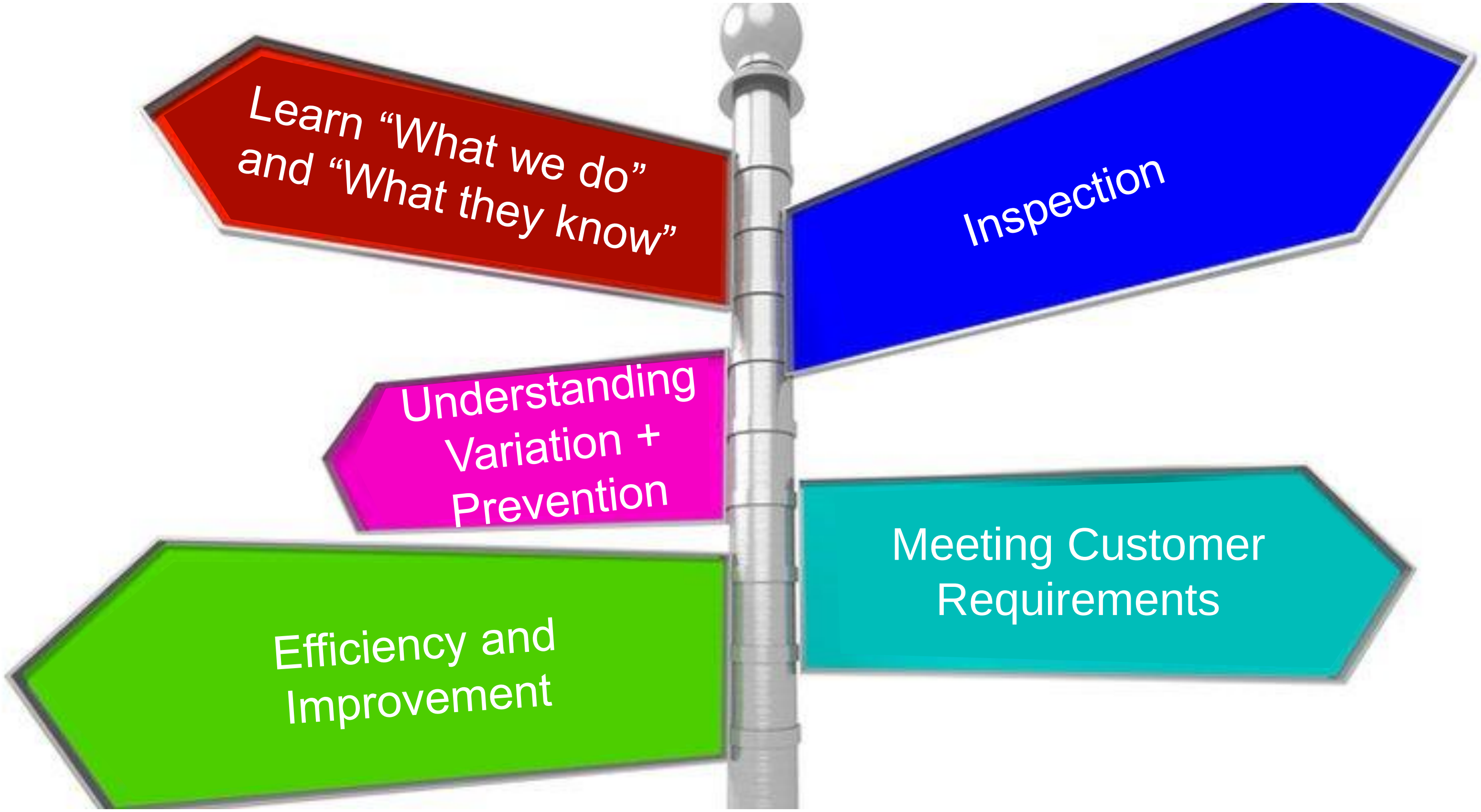

Six-Way Analysis
Individuals
UCL = 4.0415, CL = 4.0004, LCL = 3.9592
UCL
Mean
LCL
Histogram
LSL
Target
USL
Moving range
UCL
Mean
Normal Probability Plot
Probability statistics
Standard deviation 0.015
Anderson-Darling statistic 0.297
p Value 0.591
Run chart
Mean = 4.0004
3/4/2016
Overall
Sigma(i) 0.015
Pp 1.11
Ppk 1.1
Dpm 893.71
Cpm 1.11
Within
Sigma(e) 0.0137
Cp 1.22
Cpk 1.21
Dpm 893.71
Capability Summary
Sigma(i)
Sigma(e)
Specifications
Sigma Limits
+3 Sigma(i) 4.0455
-3 Sigma(i) 3.9552
+3 Sigma(e) 4.0415
-3 Sigma(e) 3.9592
Specifications
Upper Spec 4.05
Target Spec 4
Lower Spec 3.95


Policies
Procedure

New Employee Onboarding



Introducing… The 5 Step plan



1. Learn “What we do”

Pretend with us…

We make Paddles

Each Paddle has 30 dimples to catch beads

These paddles are designed to capture 7 red beads on each dip into a bucket full of both red and white beads.

We're all different…

Maybe it doesn't fit all?

What do they know?

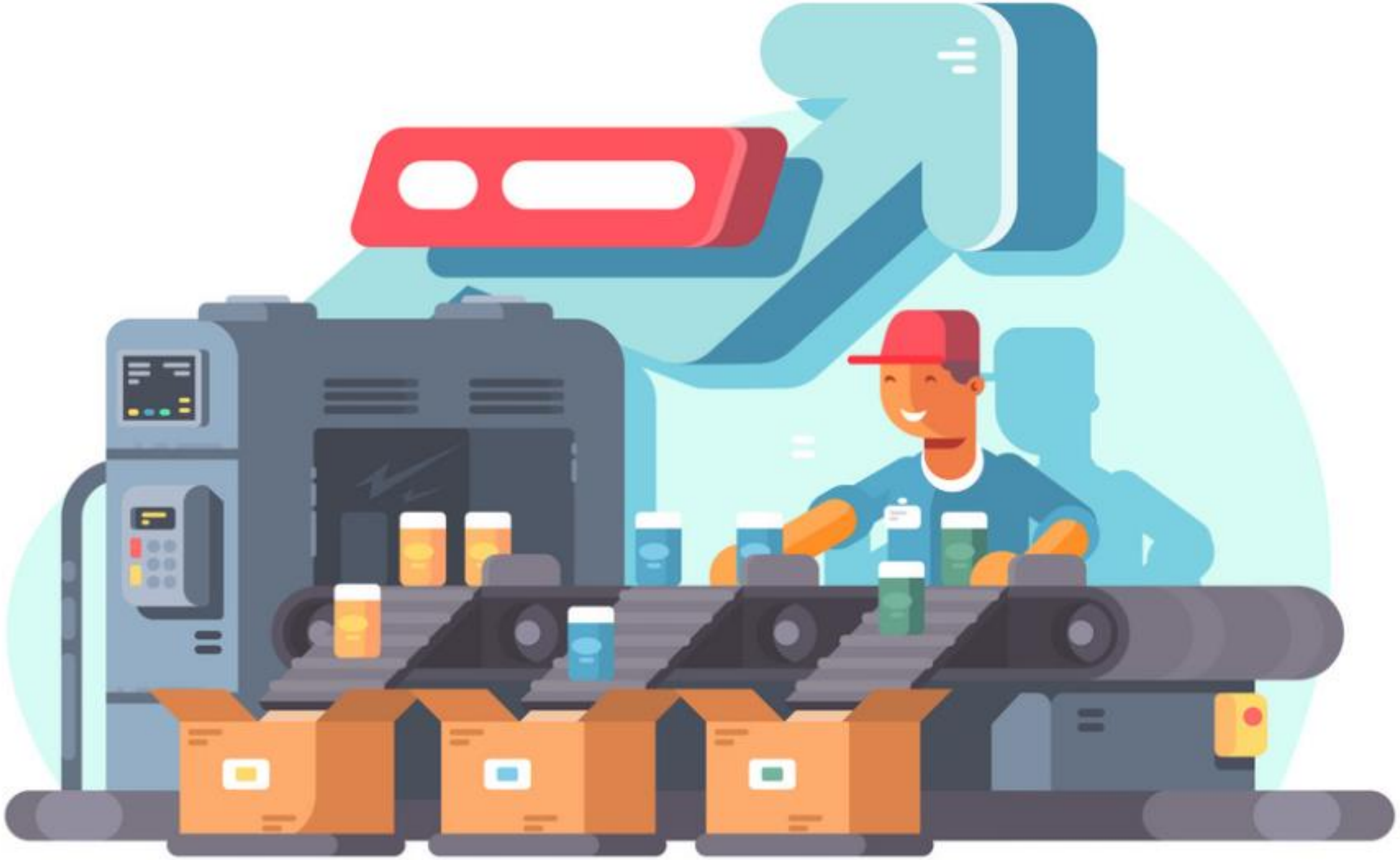
What don't they know?

Experience with Quality?

Experience with Manufacturing?

Experience with our products?

2. Inspection



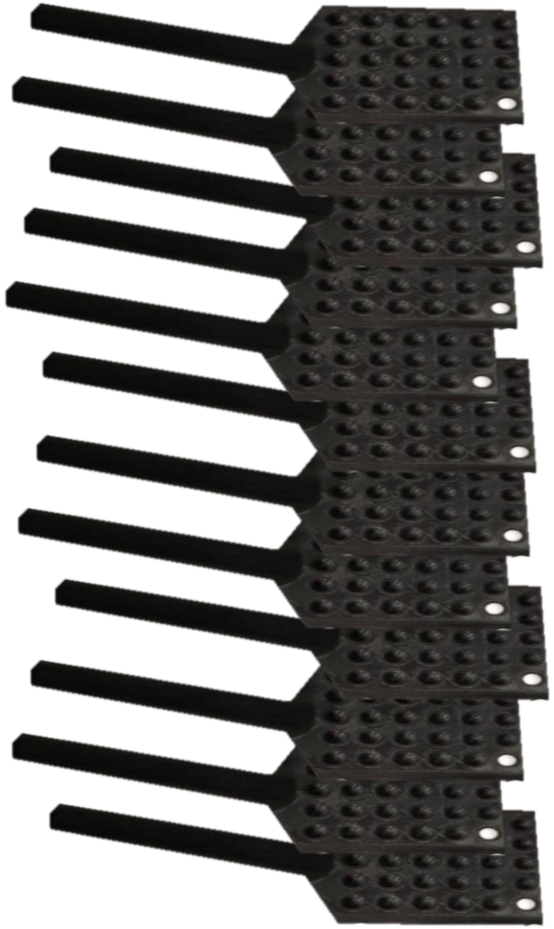
“These parts have to be made **<u>to print</u>**”

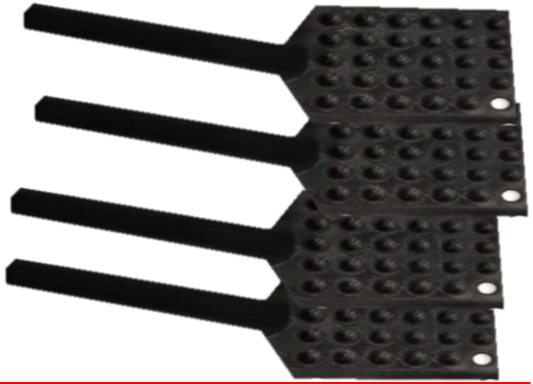
“We cannot ship non-conforming parts to the customer”

“Let’s make sure all our data is in spec”


100%

In the case of our Red-Bead Paddle Factory…





Good

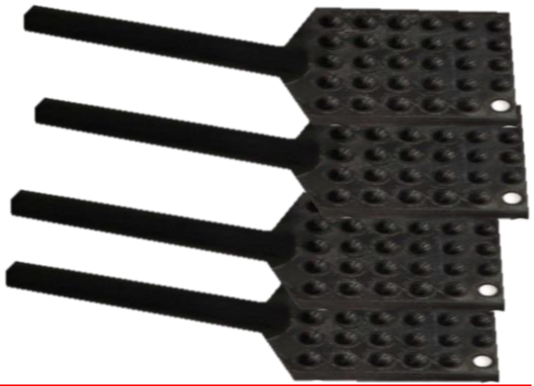
Bad

What do you do with the bad ones?

In manufacturing, how much money is spent/lost each year in the form of waste?

$8 trillion

#1 Contributor to the waste…



Defects

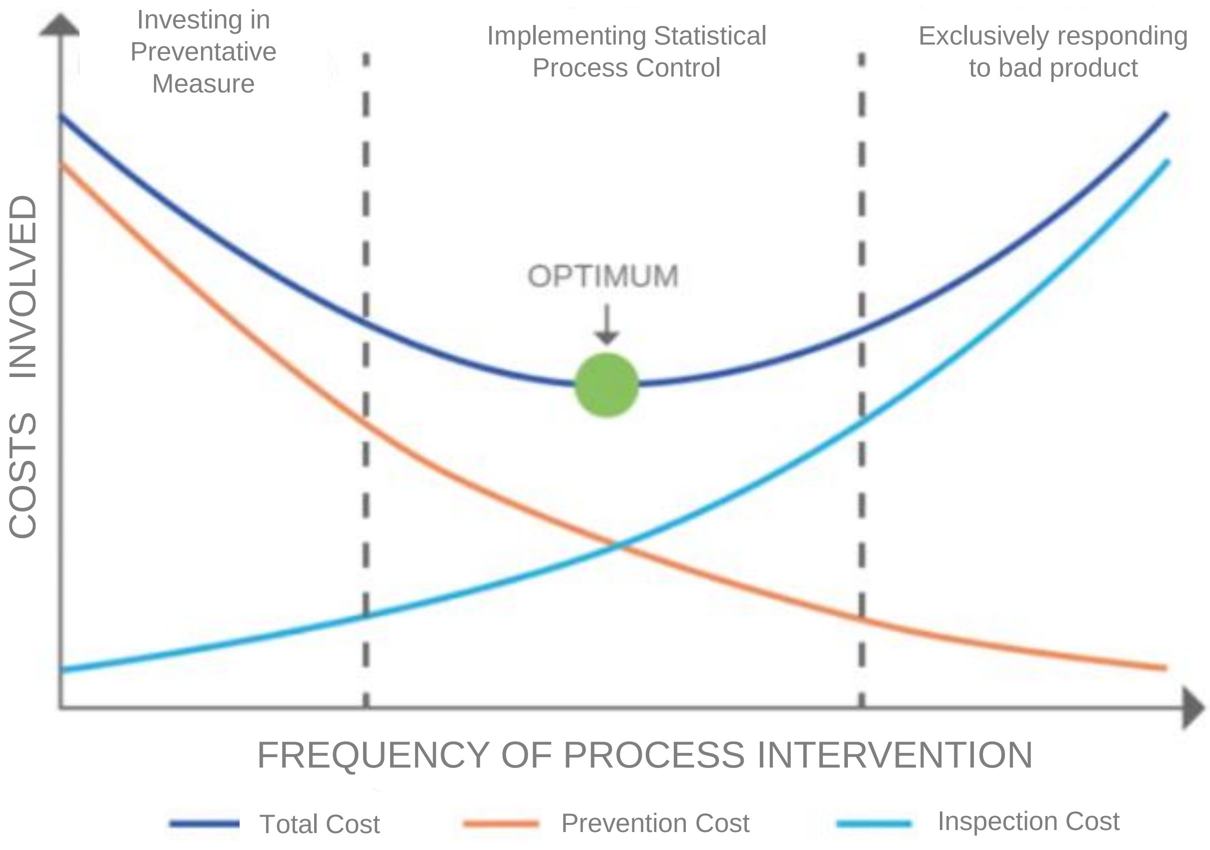
We hired you to find and quarantine the defects.

The customer receives all good paddles.

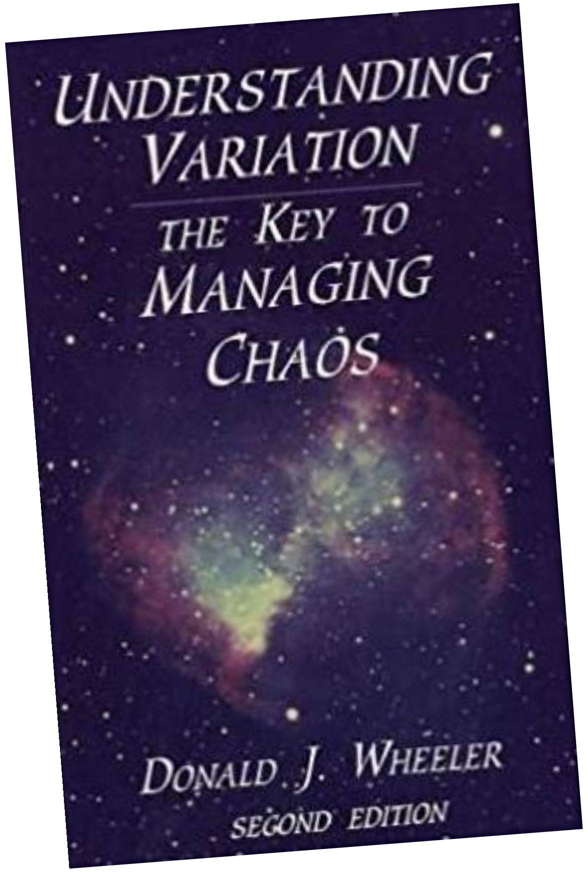
Everyone is happy!

Prevention over Inspection

The ... nting
mist ... ın the
c(... ·m.



3. Understanding Variation



Statistical Process Control (SPC) is the use of statistical tools to monitor production processes in order to ***prevent*** defective product.

Organizations that implement an SPC program move beyond the costly quality control method of ***inspecting*** for waste.

An SPC program allows manufacturers to identify the possibilities for product flaws early so that they can prevent producing scrap.

Find the Special-Cause Variation

UNDERCONTROLLING

Treating special-cause variation as common-cause
(Failing to make changes when they were necessary)

OVERCONTROLLING

Treating common-cause variation as special-cause
(Making changes when none were necessary)

PQ SYSTEMS

X-MR Control Chart

When is it used?

Answer "yes" to each of the following:

– Do you need to assess the variability in the system?
– Can the data be collected or does a collection of data already exist?
– Is the time order of the data preserved?
– Is the data in variables format?
– Is the data collected in subgroups of one?

SYSTEMS

Pen and paper!

X-MR Control Chart

How is it made?

1. Complete the header information.
2. Record the data.
3. Calculate the moving ranges.
4. Calculate the overall averages.
5. Calculate the control limits.
6. Scale the control chart.
7. Draw the average line and control limits.
8. Plot the values on the control chart.
9. Interpret the control chart.

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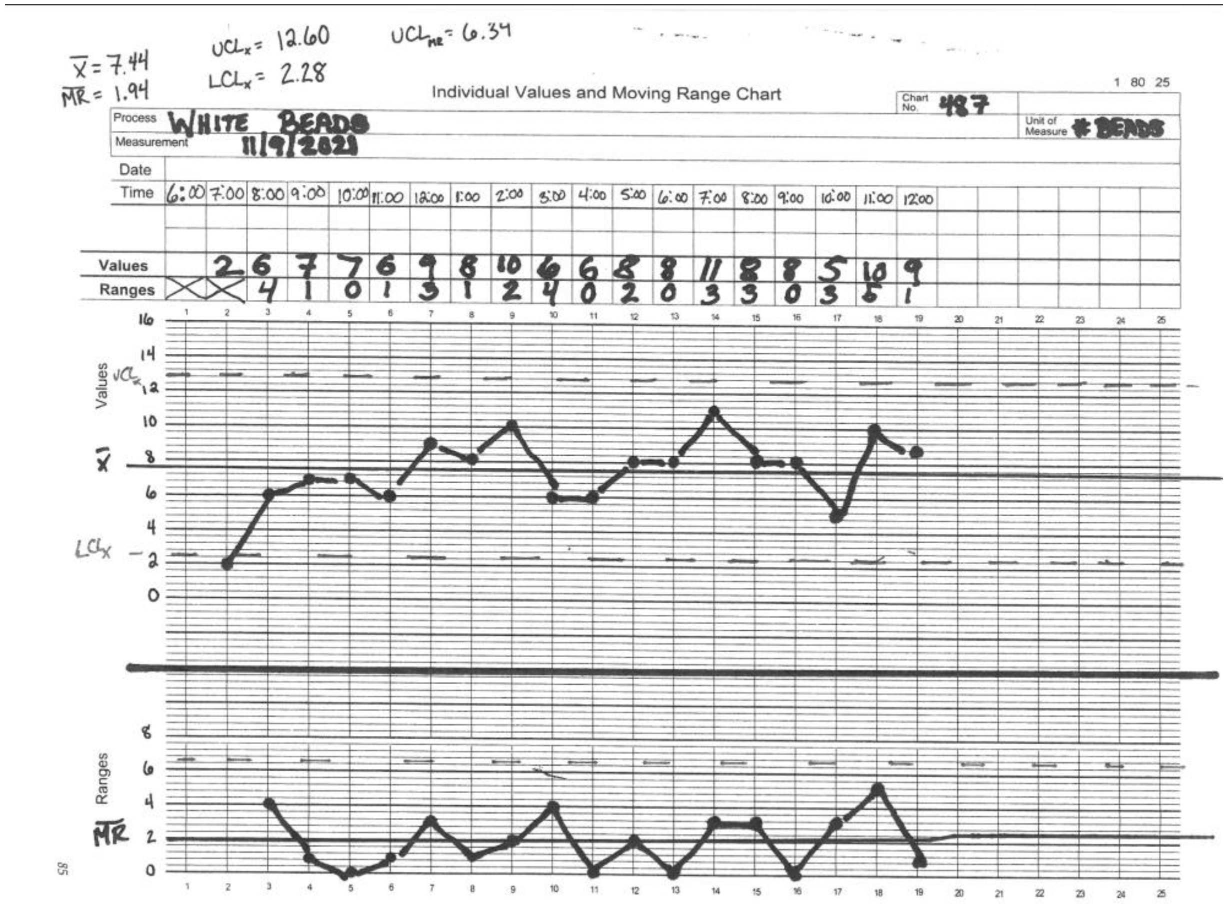


X-MR Control Chart

9. Interpret the control chart.

- *Basic rules for interpretation*
  - Any point lying outside the control limits.
  - Run of seven points:
    - Seven or more points in a row above or below the center line.
    - Seven or more points in a row going in one direction, up or down.
  - Any non-random pattern, including the following typical cases:
    - Too close to the average.
    - Too far from the average.
    - Cycles.

Rules for: **AIAG**

Name
Beyond limits
7 ascending
7 descending
7 above centerline
7 below centerline

Rules for: **Western**

Name
Beyond limits
2 of 3 beyond 2 sigma
4 of 5 above 1 sigma
4 of 5 below 1 sigma
8 above centerline
8 below centerline

Rules for: **Hughes**

Name
Beyond limits
2 of 3 above 2 sigma
2 of 3 below 2 sigma
3 of 7 above 2 sigma
3 of 7 below 2 sigma
4 of 10 above 2 sigma
4 of 10 below 2 sigma
7 above centerline
7 below centerline
10 of 11 above centerline
10 of 11 below centerline
12 of 14 above centerline
12 of 14 below centerline
7 ascending
7 descending

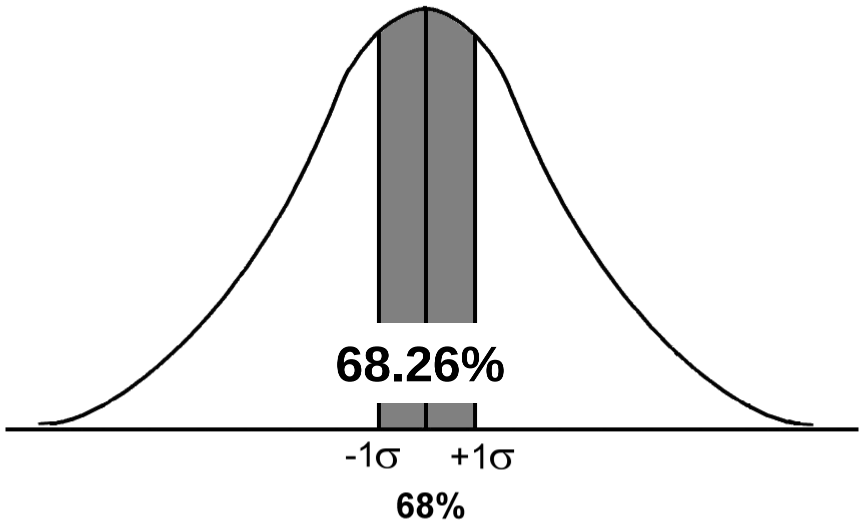
Rules for: **Shewhart**

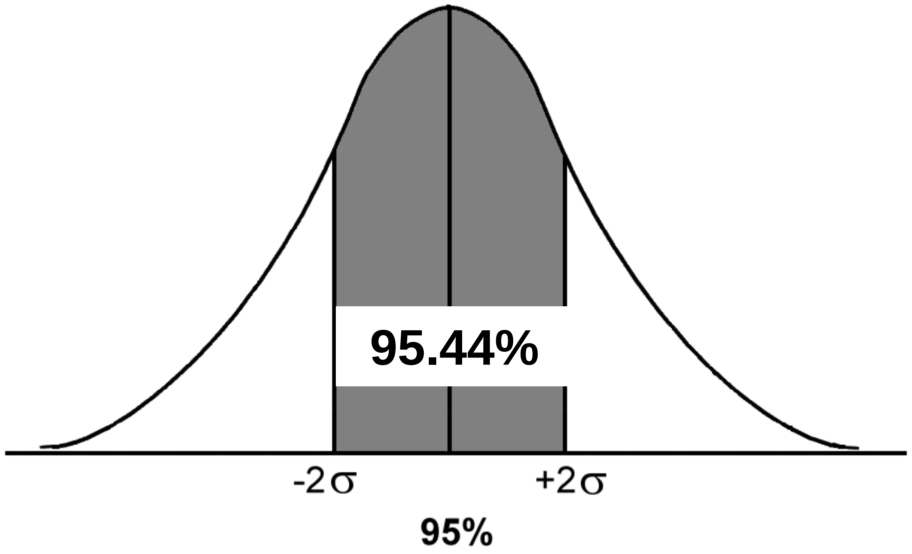
Name
Beyond limits
2 of 3 above 2 sigma
2 of 3 below 2 sigma
4 of 5 above 1 sigma
4 of 5 below 1 sigma
8 above centerline
8 below centerline

Rules for: **Juran**

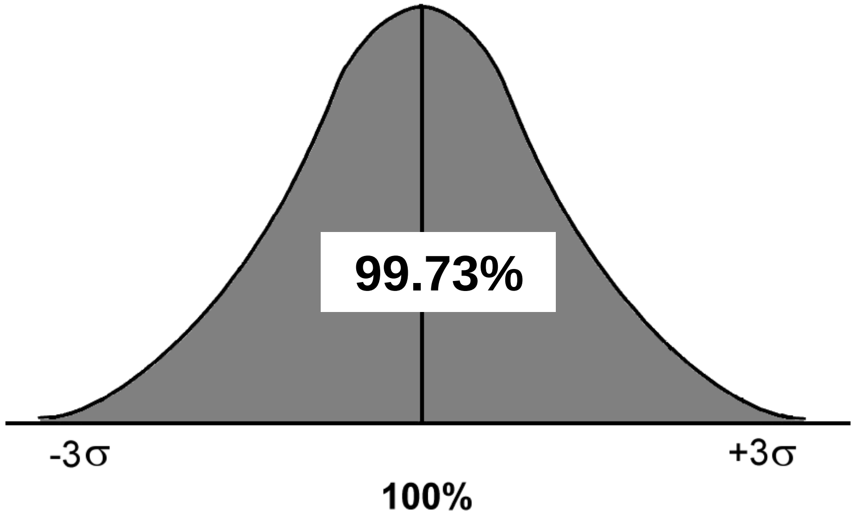
Name
Beyond limits
2 of 3 above 2 sigma
2 of 3 below 2 sigma
4 of 5 above 1 sigma
4 of 5 below 1 sigma
9 above centerline
9 below centerline
6 ascending
6 descending
8 beyond 1 sigma

Characteristics of the normal distribution

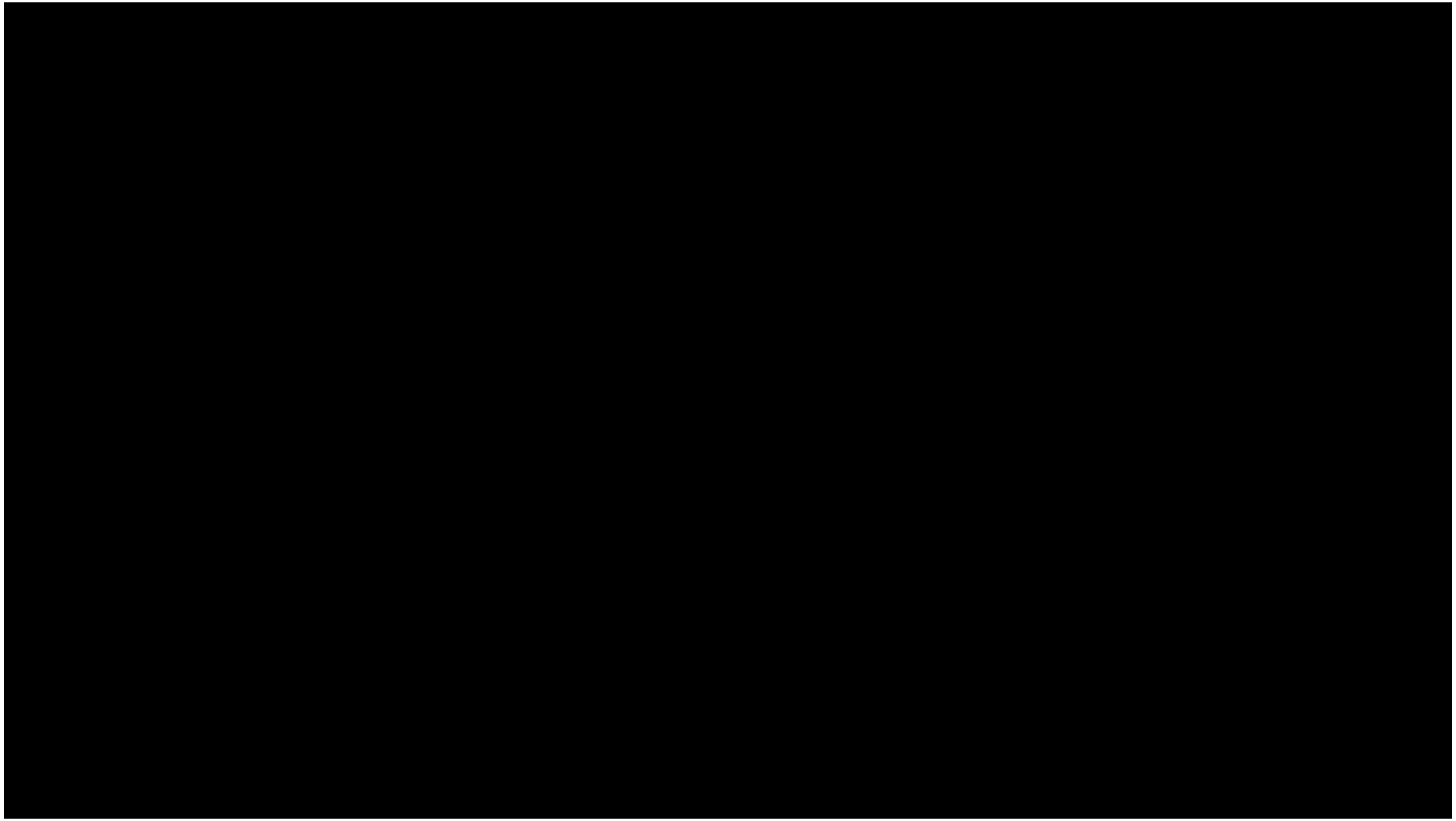




Since +/- 3 sigma = 99.73%, each tail of the curve has the remaining 0.135% of data



Predicting the Future



4. Meeting Customer Requirements

Capable

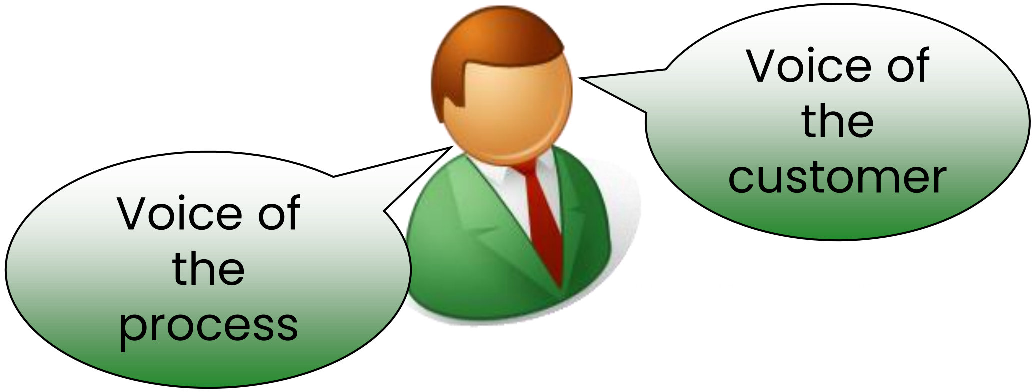
Capable- Meaning:

Capable : Adjective. The ability to be competent. Being able to do something well.

Capability indices

- Control charts are not designed for comparisons to a specification
- Capability analysis allows you to assess your ability to meet customer needs
- Capability analysis brings together the process limits (+/- 3 sigma) and specification limits

The two voices:



Meeting Specifications

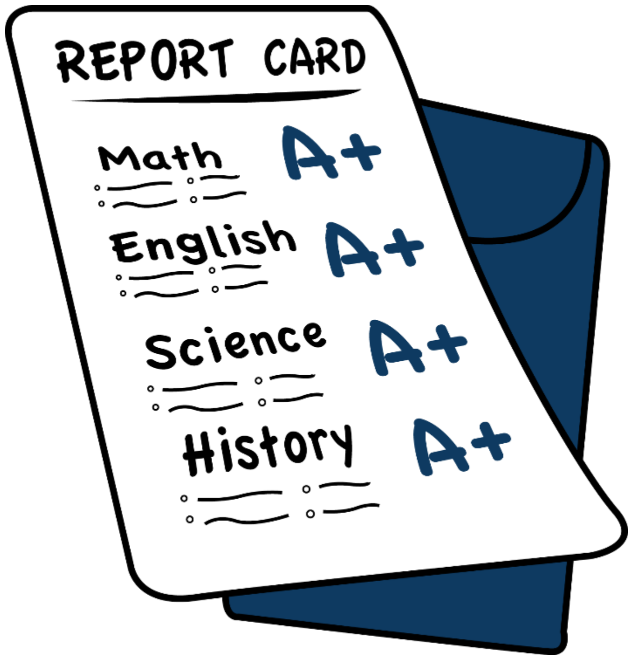
- We need the paddles to catch **<u>7</u>** red beads per dip

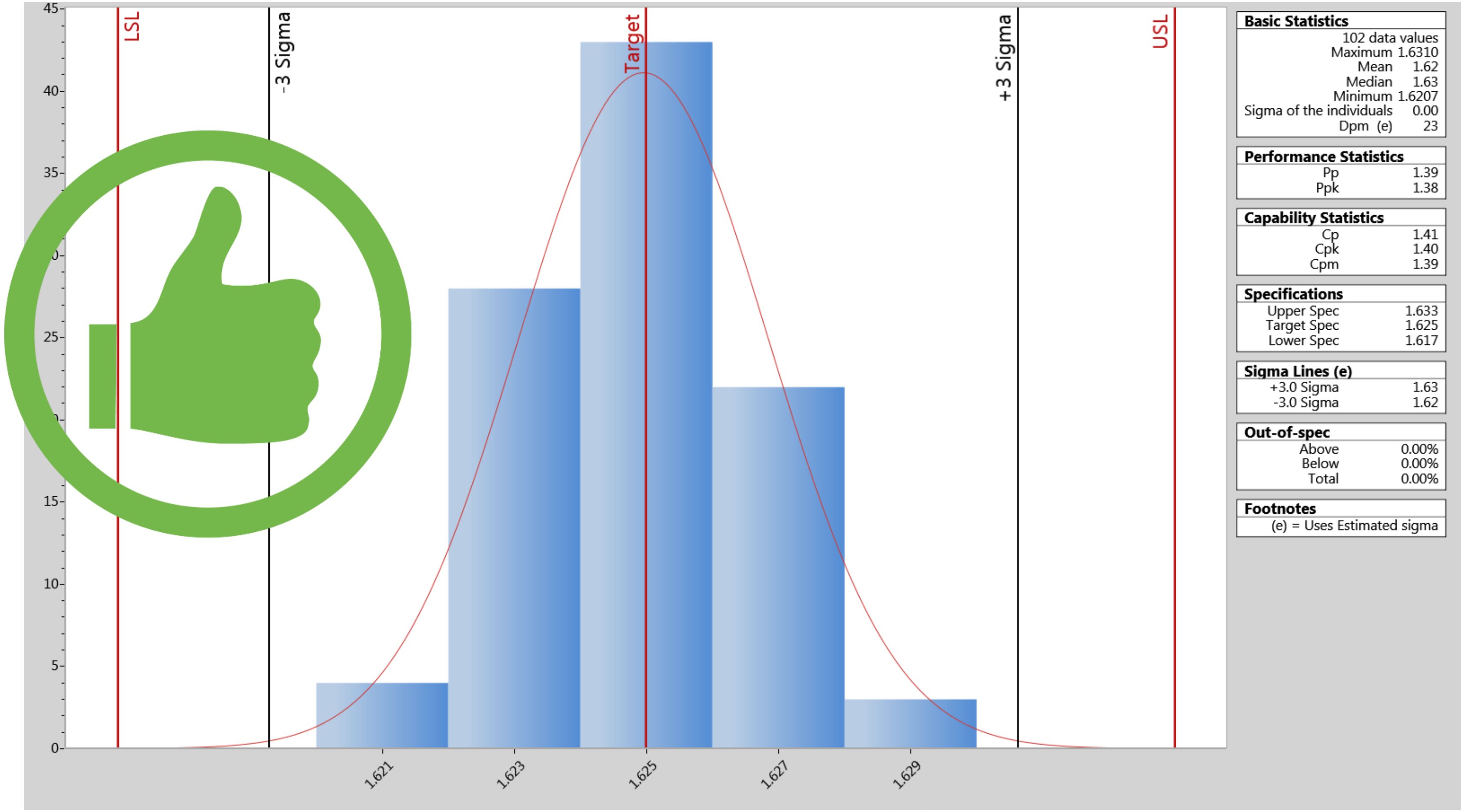
We understand common-cause variation, so…

- **<u>2</u>** red beads is our minimum acceptable amount

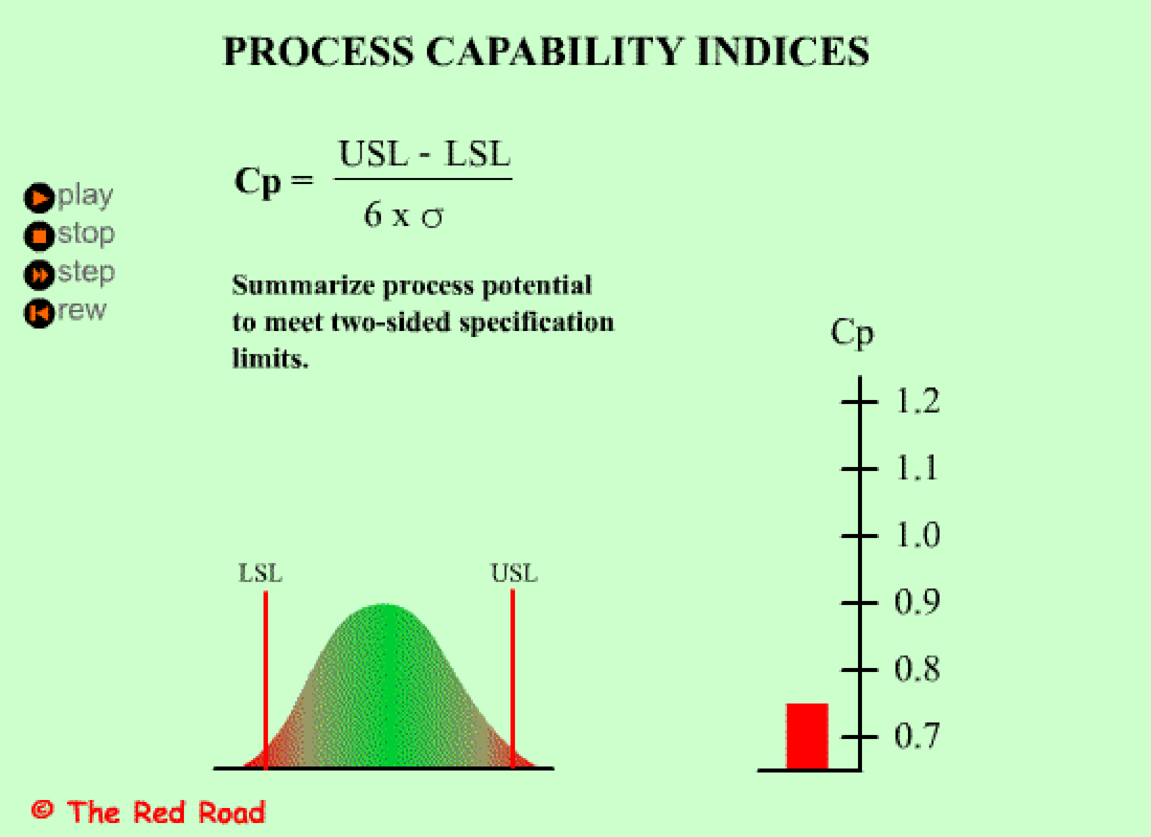
- **<u>12</u>** red beads is our maximum acceptable amount

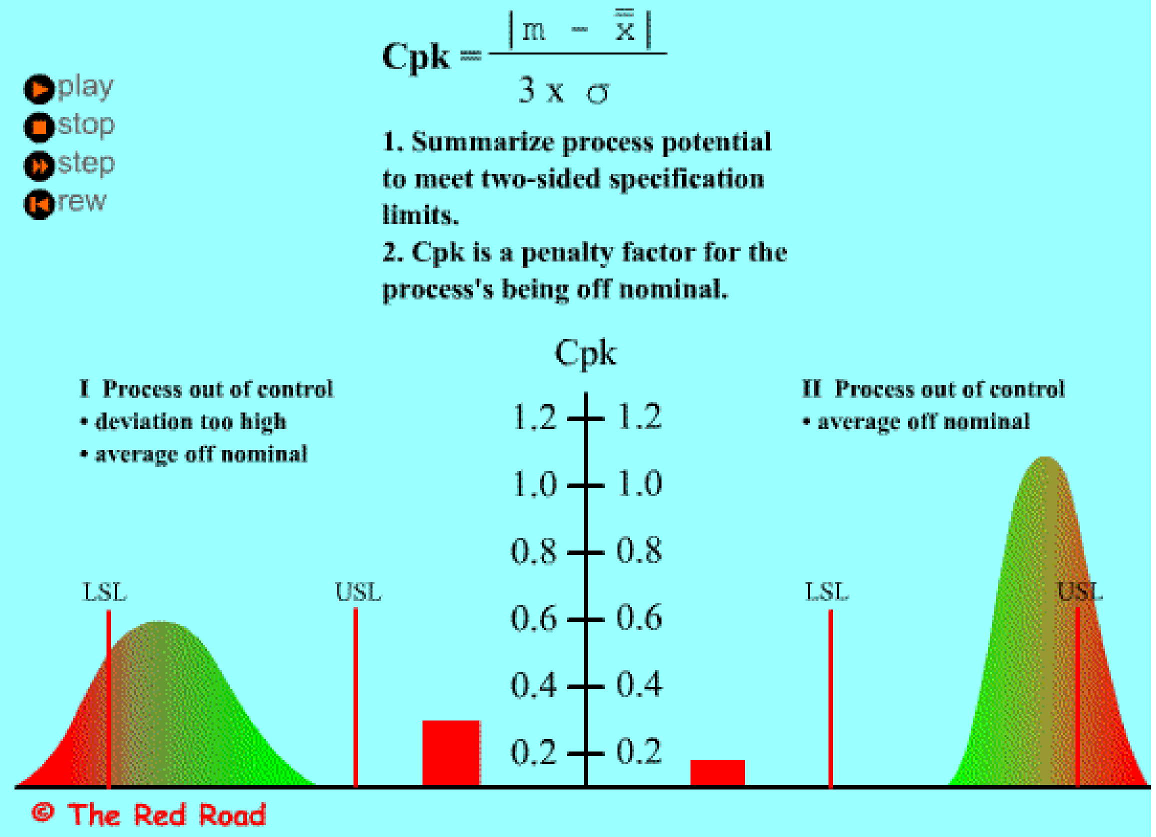
The Capability Study!

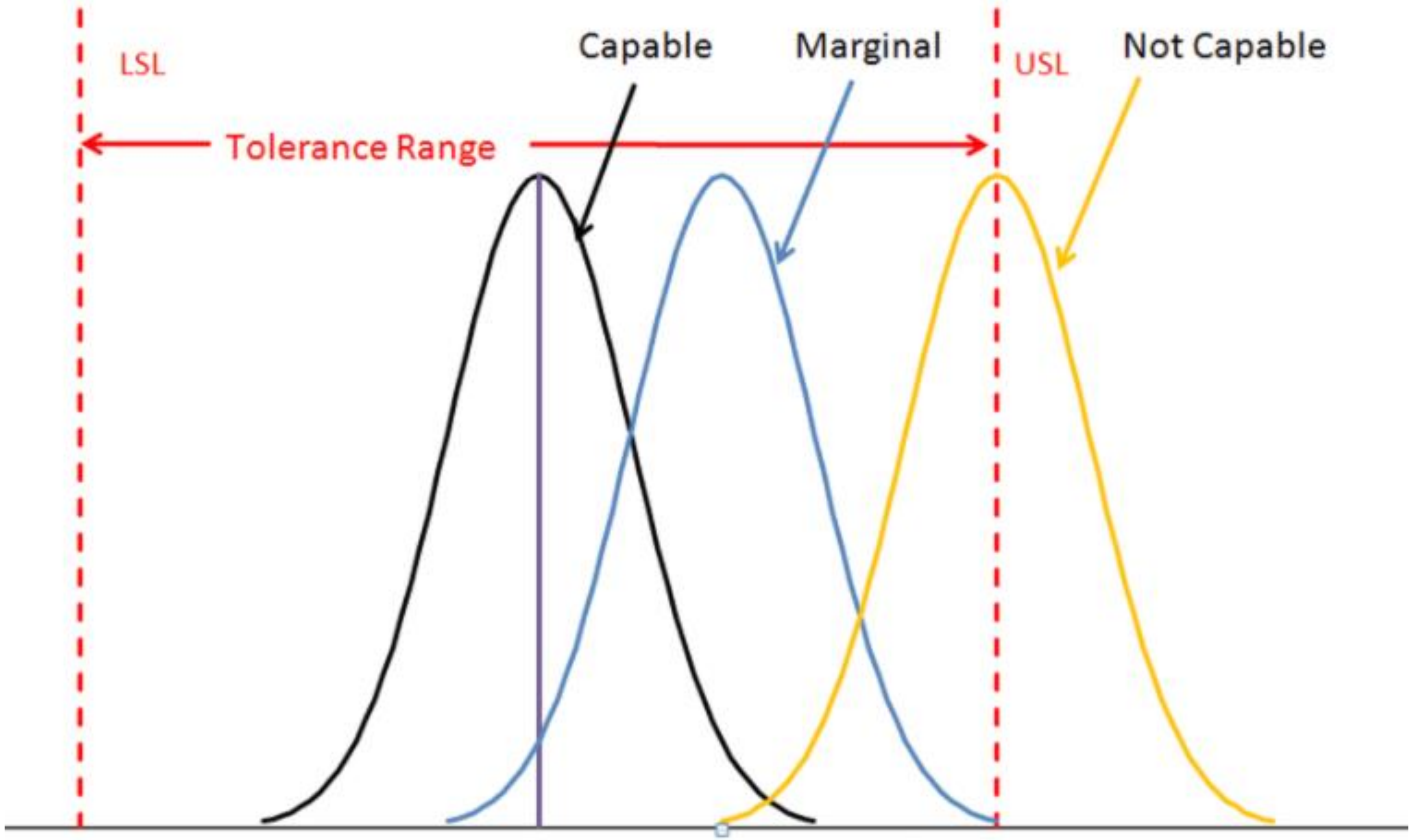




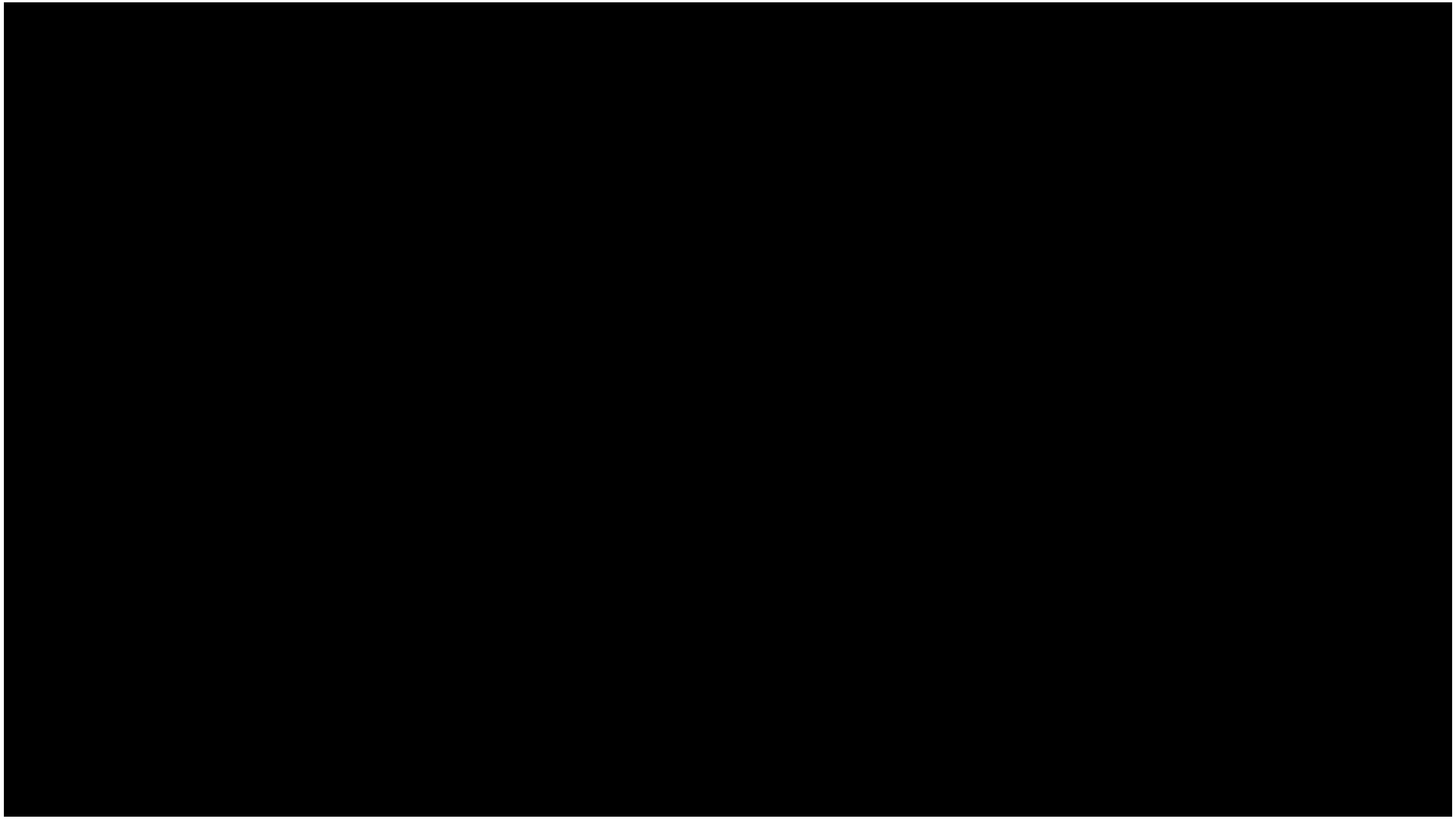
Cp and Cpk


PROCESS CAPABILITY INDICES
play
stop
step
rew
Cp = USL - LSL / 6 x σ
Summarize process potential to meet two-sided specification limits.
Cp
1.2
1.1
1.0
0.9
0.8
0.7
LSL
USL
© The Red Road

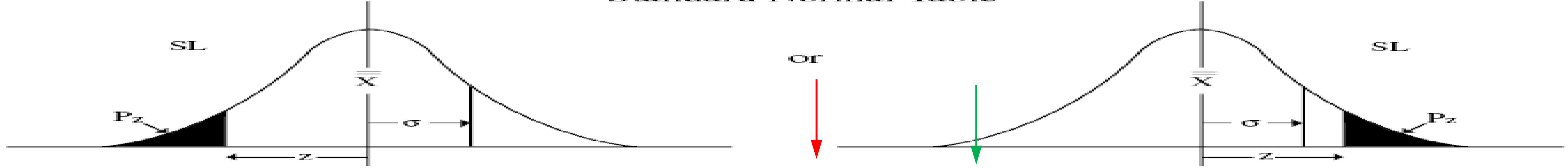

play
stop
step
rew
Cpk = |m - x̄| / 3 x σ
1. Summarize process potential to meet two-sided specification limits.
2. Cpk is a penalty factor for the process's being off nominal.
Cpk
I Process out of control
• deviation too high
• average off nominal
II Process out of control
• average off nominal
1.2
1.0
0.8
0.6
0.4
0.2
LSL
USL
LSL
USL
© The Red Road


LSL
Capable
Marginal
USL
Not Capable
Tolerance Range

Calculate Capability



Standard Normal Table



z	x.x0	x.x1	x.x2	x.x3	x.x4	x.x5	x.x6	x.x7	x.x8	x.x9
4.0	.00003									
3.9	.00005	.00005	.00004	.00004	.00004	.00004	.00004	.00004	.00003	.00003
3.8	.00007	.00007	.00007	.00006	.00006	.00006	.00006	.00005	.00005	.00005
3.7	.00011	.00010	.00010	.00010	.00009	.00009	.00008	.00008	.00008	.00008
3.6	.00016	.00015	.00015	.00014	.00014	.00013	.00013	.00012	.00012	.00011
3.5	.00023	.00022	.00022	.00021	.00020	.00019	.00019	.00018	.00017	.00017
3.4	.00034	.00032	.00031	.00030	.00029	.00028	.00027	.00026	.00025	.00024
3.3	.00048	.00047	.00045	.00043	.00042	.00040	.00039	.00038	.00036	.00035
3.2	.00069	.00066	.00064	.00062	.00060	.00058	.00056	.00054	.00052	.00050
3.1	.00097	.00094	.00090	.00087	.00084	.00082	.00079	.00076	.00074	.00071
3.0	.00135	.00131	.00126	.00122	.00118	.00114	.00111	.00107	.00104	.00100
2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
0.7	.2420	.2389	.2358	.2327	.2297	.2266	.2236	.2206	.2177	.2148
0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
0.3	.3281	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

What do we learn?

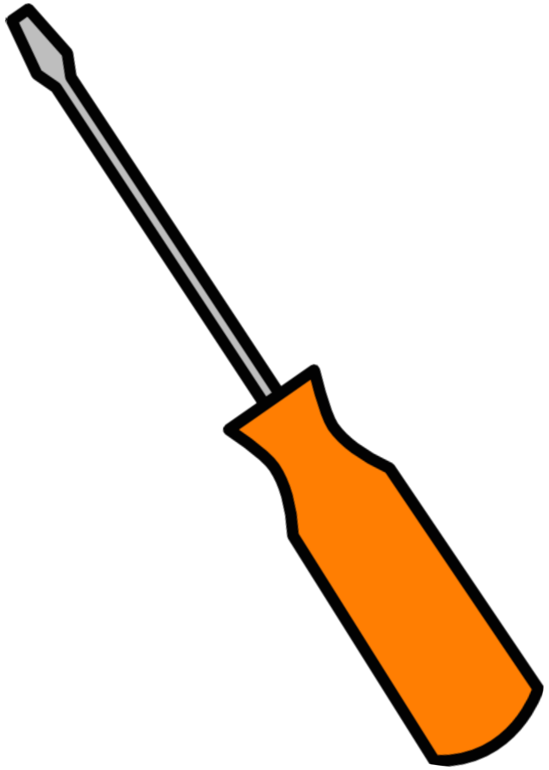
- Calculate Z_{upper} and Z_{lower}

Z_{upper} = 2.65 → 0.0040 → 0.4%

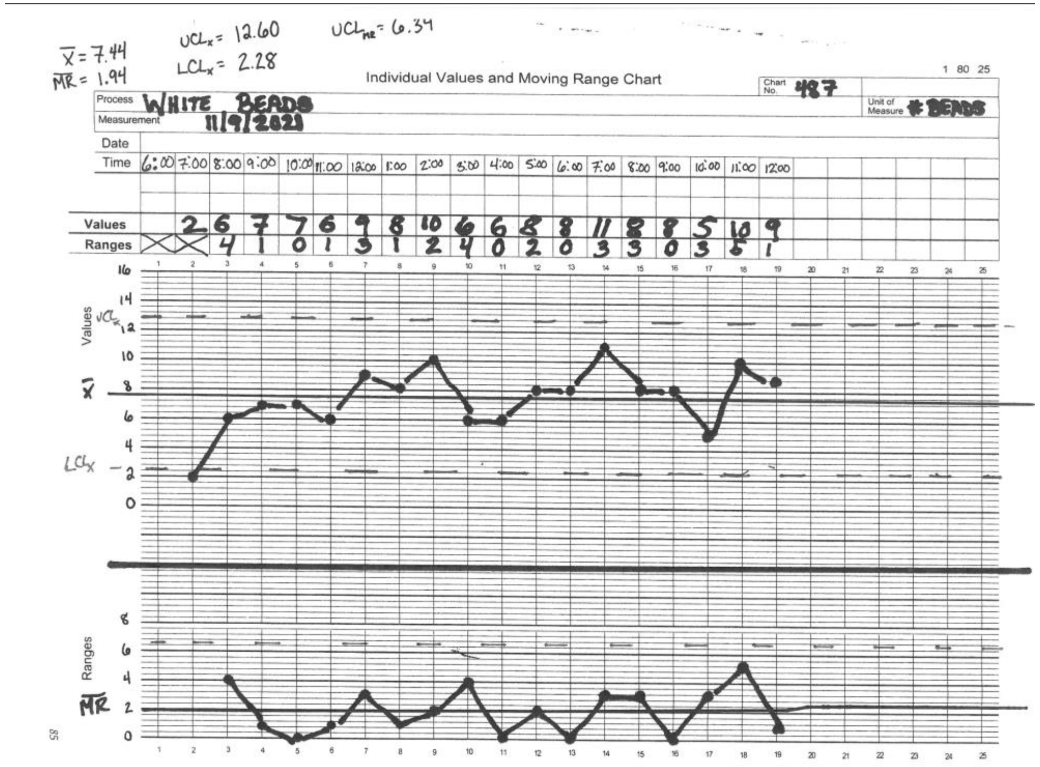
Z_{lower} = 3.16 → 0.00079 → 0.08%

We expect 0.4% + 0.08% of data to be outside the specification limits.

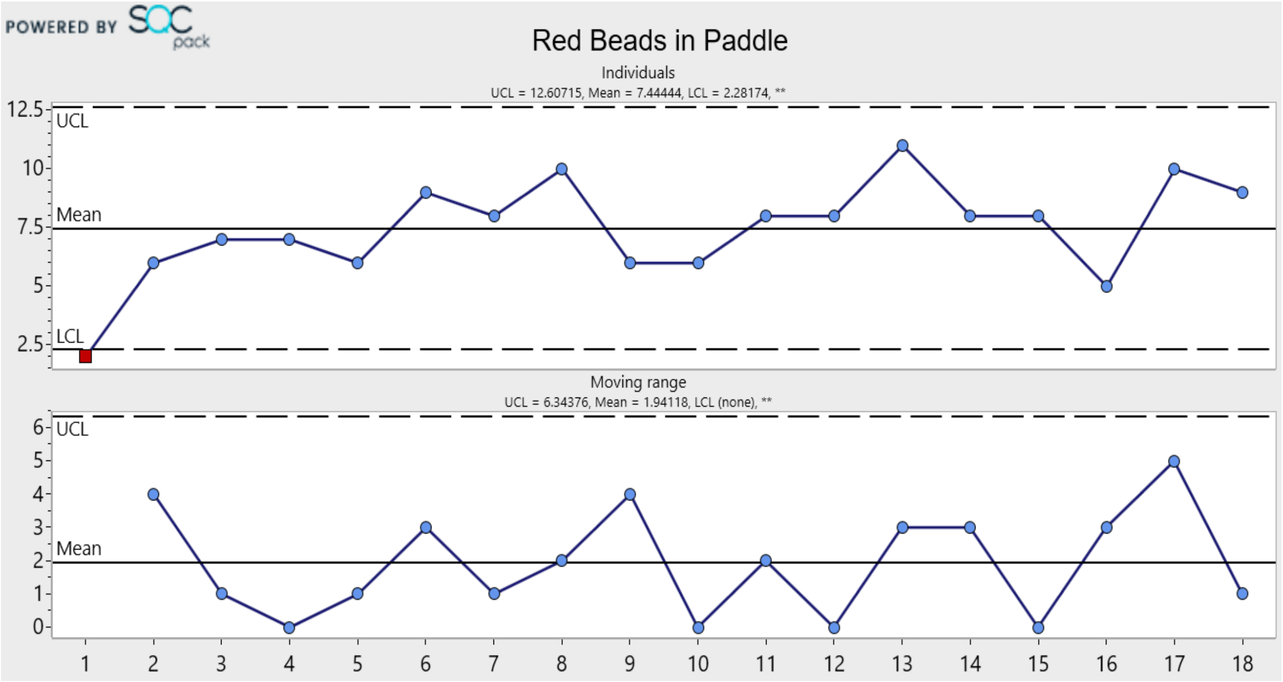
5. Efficiency & Process Improvement



Choose
One



$\bar{X}$ = 7.44
$\overline{MR}$ = 1.94
UCL_x = 12.60
LCL_x = 2.28
UCL_{MR} = 6.34
Individual Values and Moving Range Chart
Chart No. 487
Process WHITE BEADS
Measurement 11/9/2021
Unit of Measure # BEADS
Date
Time
Values
Ranges

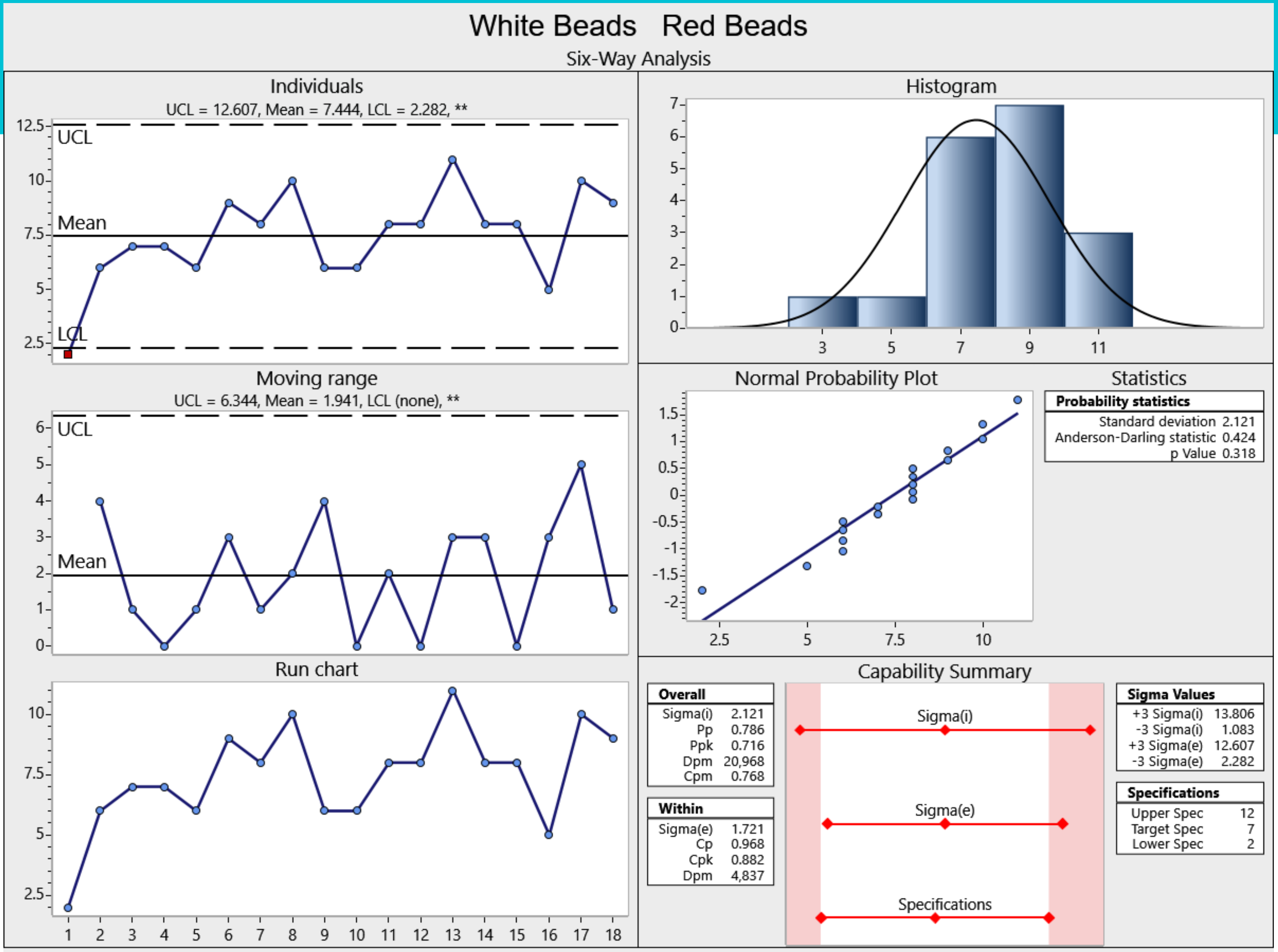


POWERED BY SQC pack
Red Beads in Paddle
Individuals
UCL = 12.60715, Mean = 7.44444, LCL = 2.28174, **
UCL
Mean
LCL
Moving range
UCL = 6.34376, Mean = 1.94118, LCL (none), **

Choose One

SYSTEMS

Oh...Now I get it



White Beads Red Beads
Six-Way Analysis
Individuals
UCL = 12.607, Mean = 7.444, LCL = 2.282, **
UCL
Mean
LCL
Moving range
UCL = 6.344, Mean = 1.941, LCL (none), **
UCL
Mean
Run chart
Histogram
Normal Probability Plot
Statistics
Probability statistics
Standard deviation 2.121
Anderson-Darling statistic 0.424
p Value 0.318
Capability Summary
Overall
Sigma(i) 2.121
Pp 0.786
Ppk 0.716
Dpm 20,968
Cpm 0.768
Within
Sigma(e) 1.721
Cp 0.968
Cpk 0.882
Dpm 4,837
Sigma(i)
Sigma(e)
Specifications
Sigma Values
+3 Sigma(i) 13.806
-3 Sigma(i) 1.083
+3 Sigma(e) 12.607
-3 Sigma(e) 2.282
Specifications
Upper Spec 12
Target Spec 7
Lower Spec 2

Describe the Process:

We have a process that is behaving predictably with only common-cause variation present.

Our Cp being ~ 1.00 means that our specification spread is about the same size as our process spread.

Based on these specs, though, our data is not perfectly centered around the target.

Therefore, our process spread bleeds beyond the specification spread. We are incapable of meeting the requirements of our customer.

How would you improve our Capability?

Option 1:

Reduce sources of variation. Invest energy in the process to find ways to more consistently pull 7 (or nearly 7) red beads.

Option 2:

Loosen the specifications.

Notice what we're not talking about?

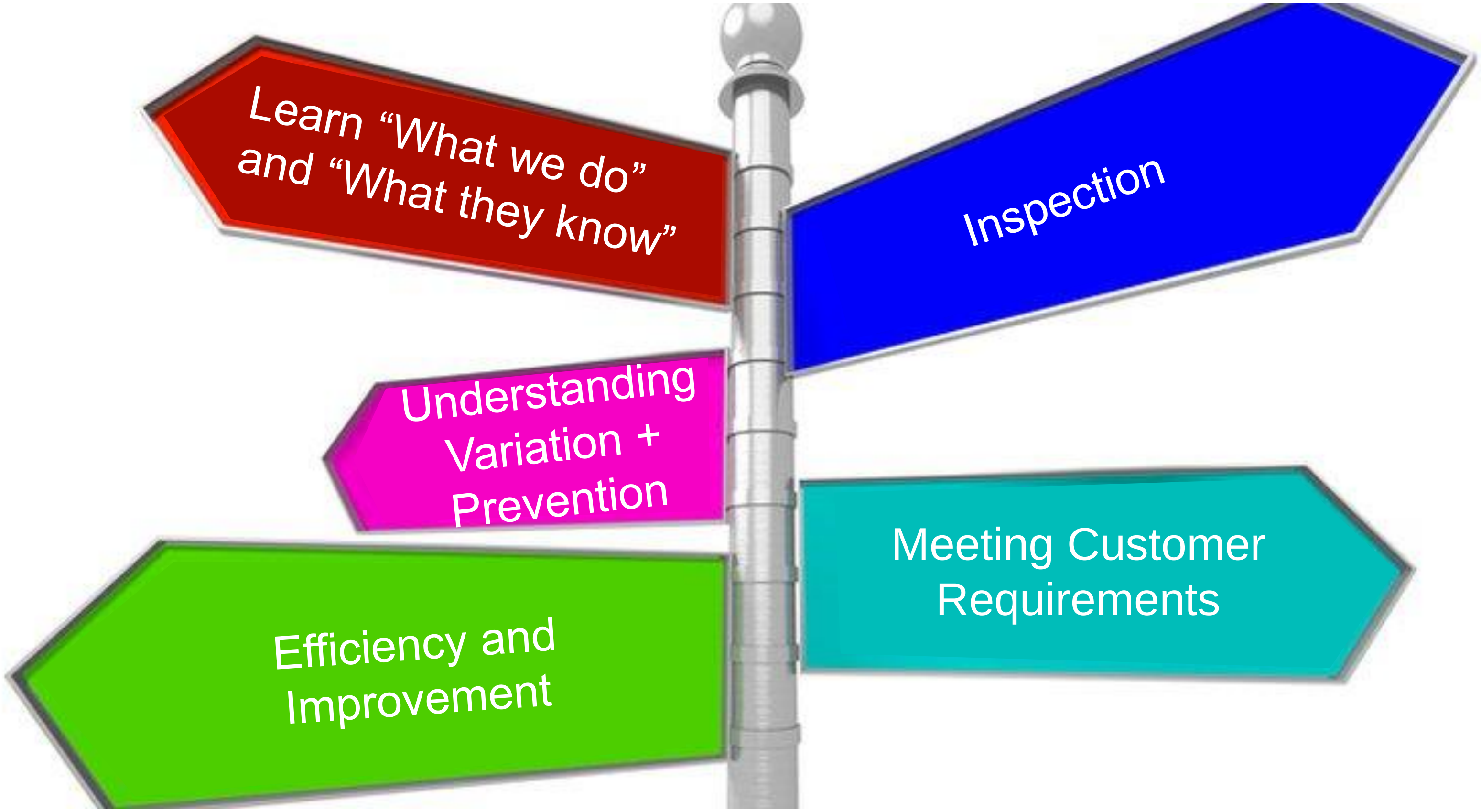
Inspect more parts

Contain the Defects

Hire more inspectors

It’s all about Prevention!

In Summary



Learn "What we do" and "What they know"
Inspection
Understanding Variation + Prevention
Meeting Customer Requirements
Efficiency and Improvement

Thank you, Quality Digest!

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