



Case Study: Using JMP to Reduce Variation in a Manufacturing Process

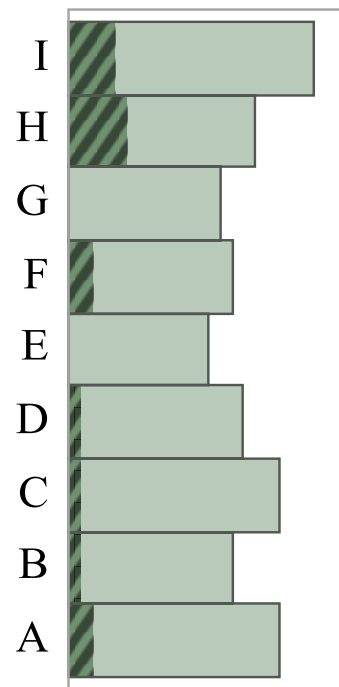
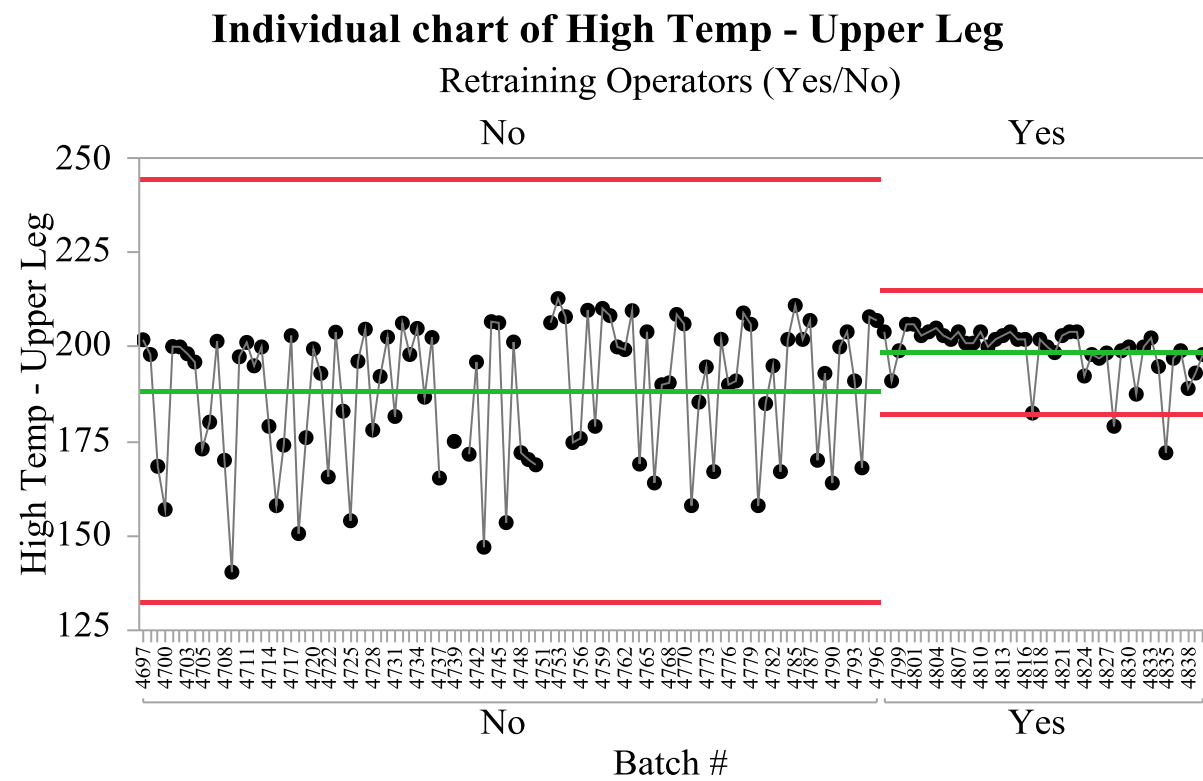
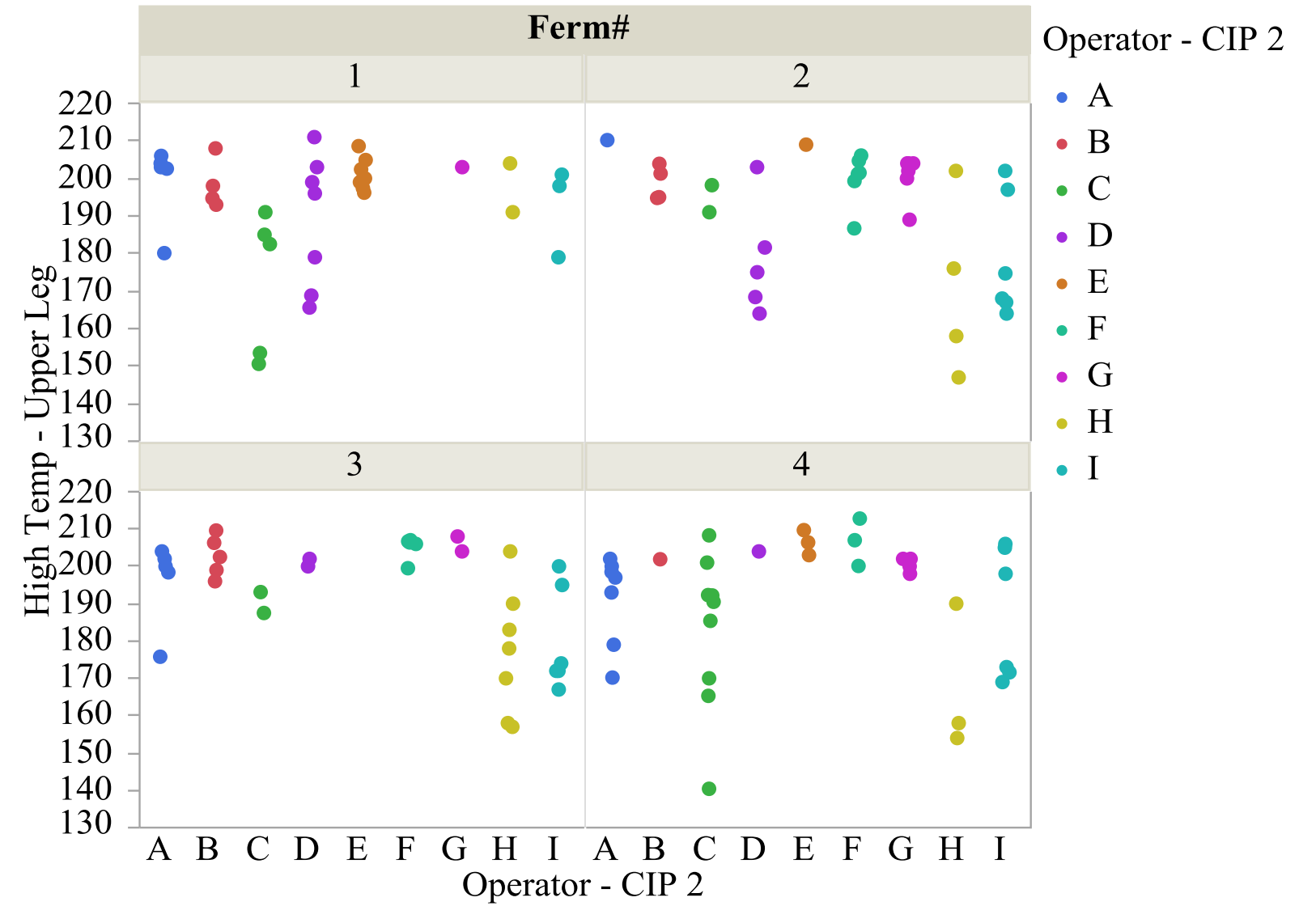
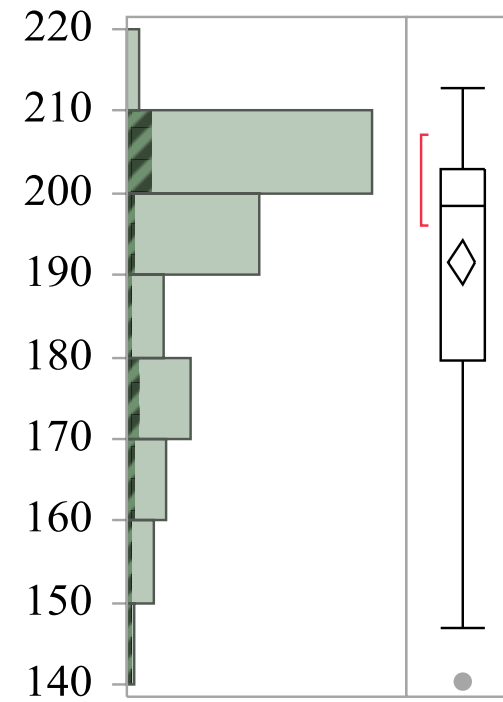
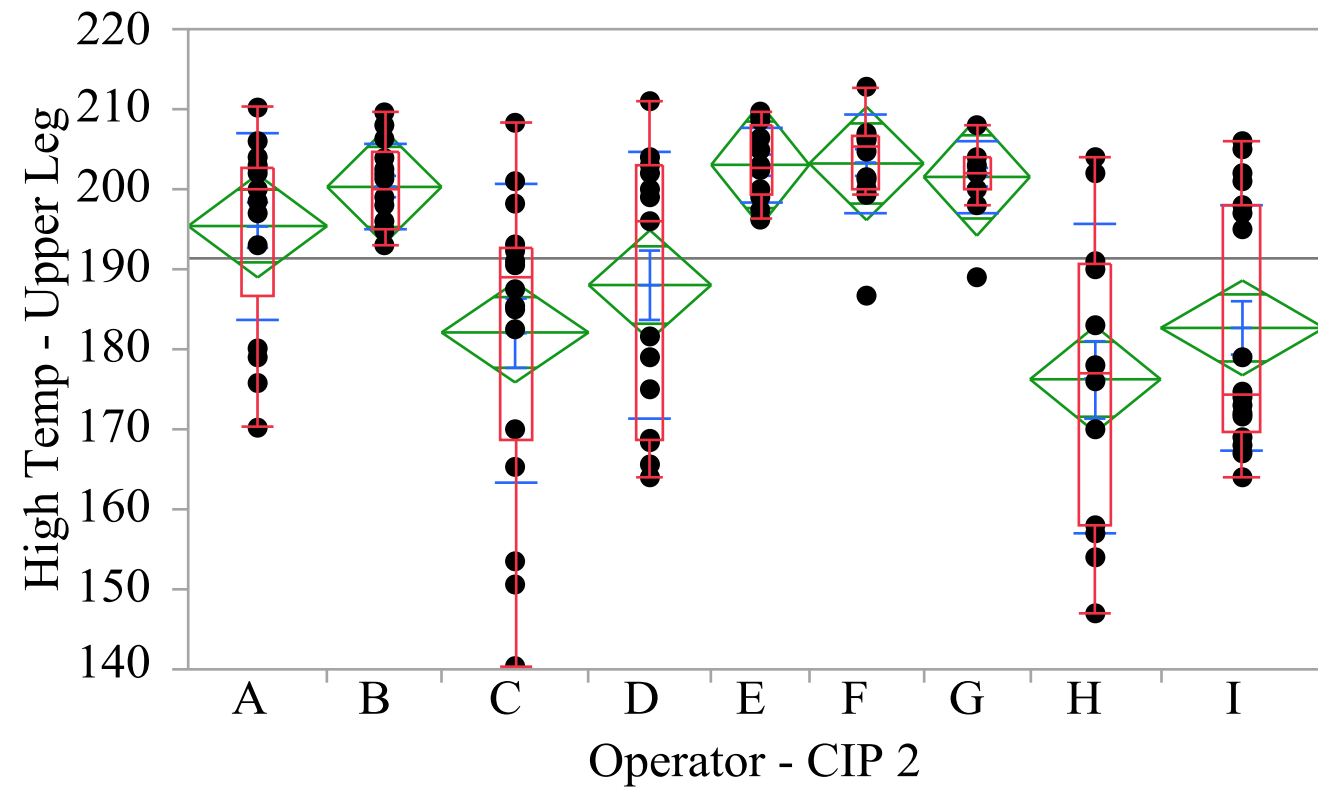
Melodie Rush
Senior Data Scientist

DEFINE THE PROBLEM

1. An ethanol manufacturer was having large batch to batch variation
2. The large variation was causing low yield batches
3. The variation was also hurting the effectiveness of DOEs
4. Ultimately hurting the bottom line

Need to Improve and stabilize the process!

KEY GRAPHS AND CHARTS



PIONEER OF SPC— WALTER SHEWHART



Bell Laboratories— Early 1920's

CONCEPTS TO APPLY TO THE PROBLEM

1. Analysis of variation over the 6Ms
 - Machines
 - Methods
 - Materials
 - Measurements
 - Mother Nature (Environment)
 - People (Manpower)
2. Determining if variation is from “common” or “special” causes
3. Emphasis on early detection

GOALS

- Reduce waste
- Increase production rate
- Emphasis on early detection helps prevent problems or detect changes in the process
- Have a stable process
- Determine the effect a given change has on your process

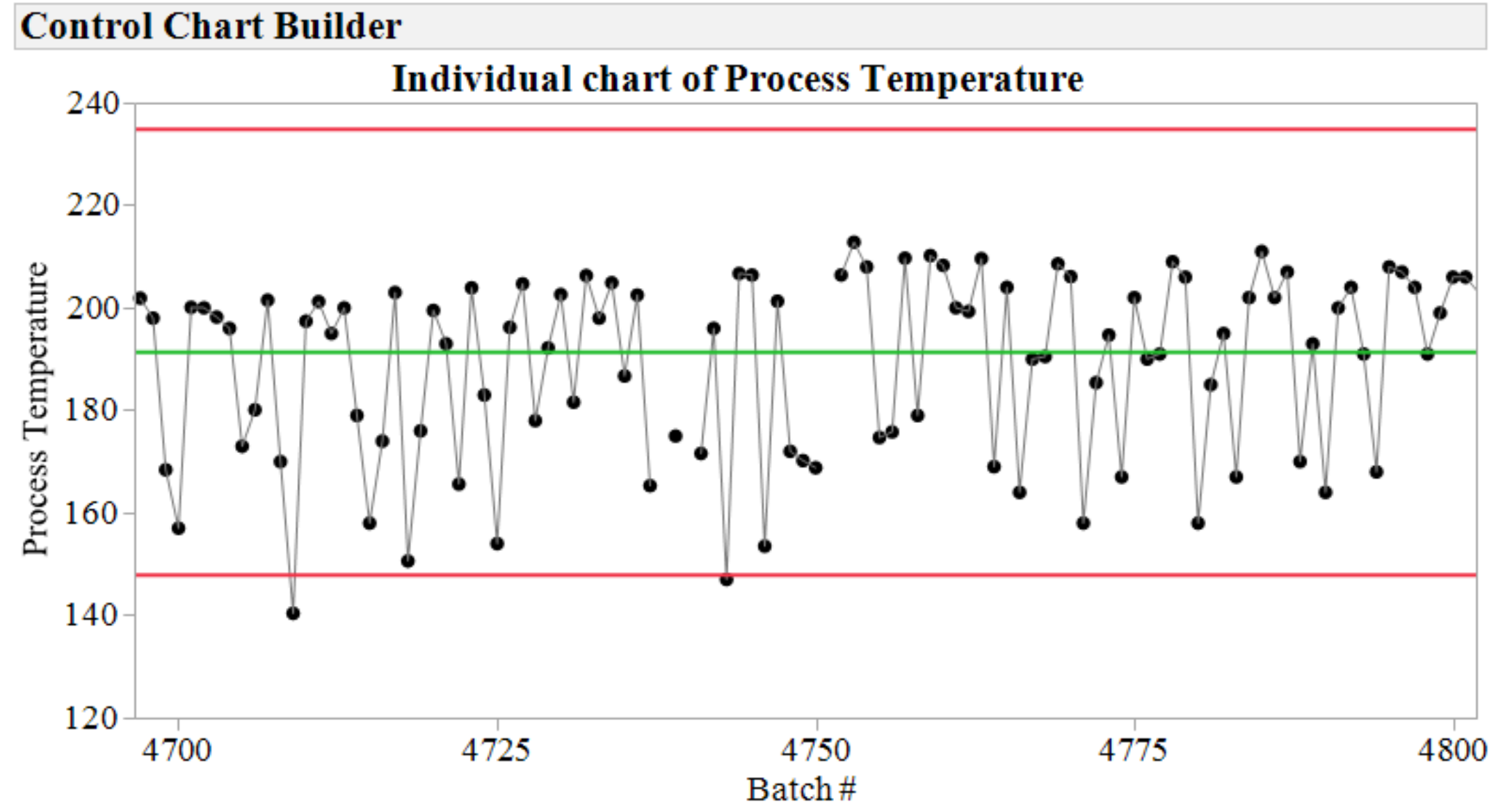
IMPLEMENTATION

- Understanding the current process
- Reduce assignable “special” sources of variation to increase process stability
- Continuously monitor process to aid in early detection of significant changes to the mean or variation in the process

SPC CHART

Chart tracks a process
Over time or batch

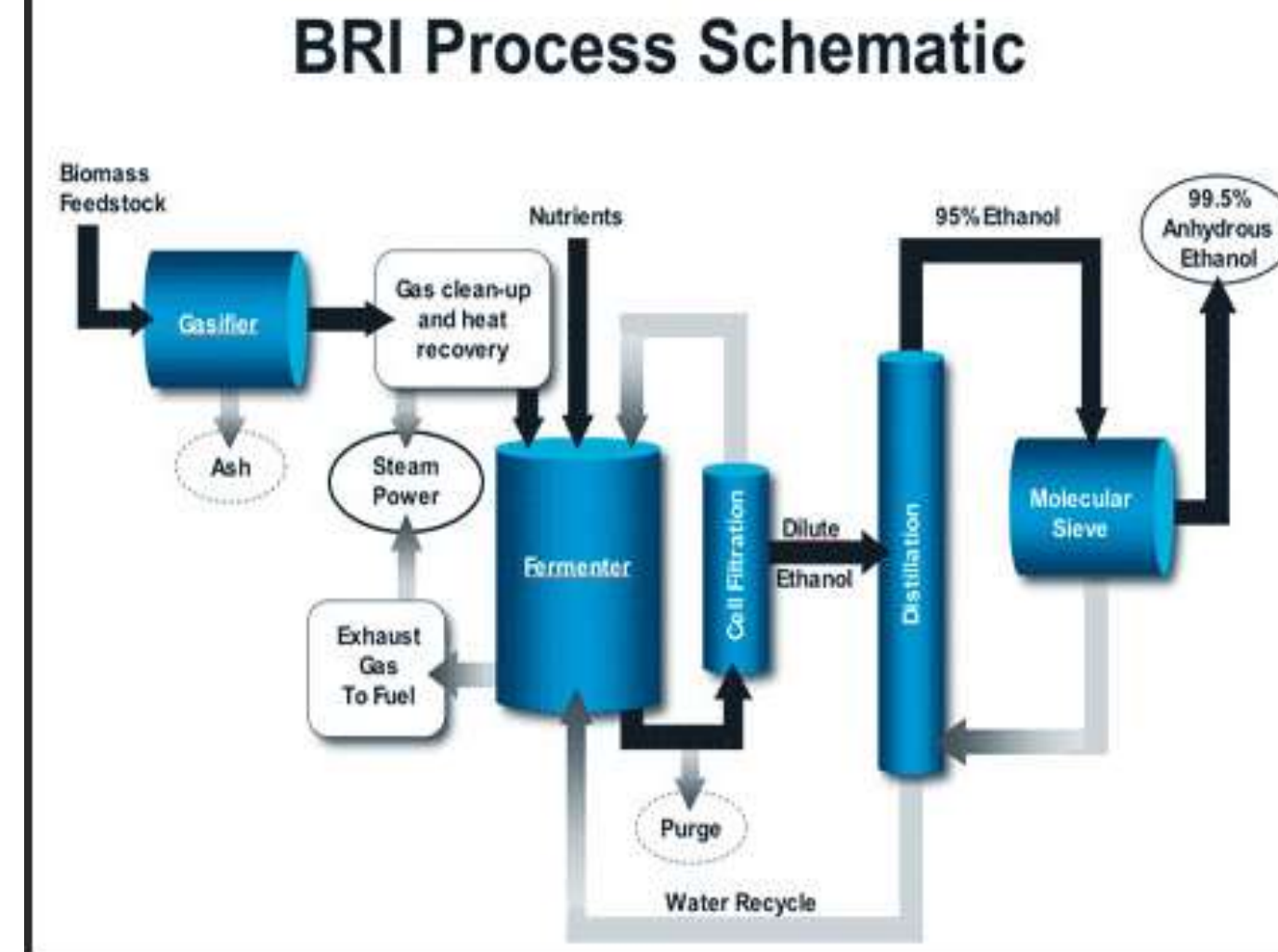
The red lines are +/-
3 Sigma from the mean
Which is the green line



SITUATION

- Ethanol Plant was trying to improve process stability
- They want to review the process data and determined which processes are causing additional variation
- Specifically looking for “special” causes

Bio-ethanol is made by converting fermentable sugars from corn or other biomass feedstock into ethanol



LOOKING FOR SOURCES OF VARIANCE IN ETHANOL PLANT

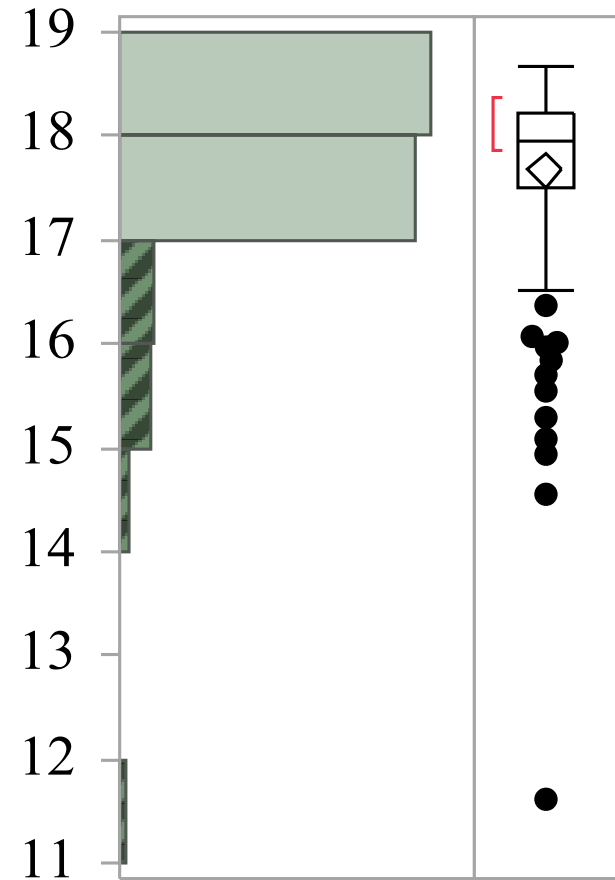
- Exploring the pre-existing data
- Looking at the 6Ms
 1. Machines
 2. Methods
 3. Materials
 4. Measurements
 5. Mother Nature (Environment)
 6. People (Manpower)

“SPECIAL” VARIATION FOUND

- It was found that people (manpower) was a major source of variance
- Operators where having a large impact on process temperature used in a cleaning step
- This is a form of “special” variation that can be reduced or eliminated

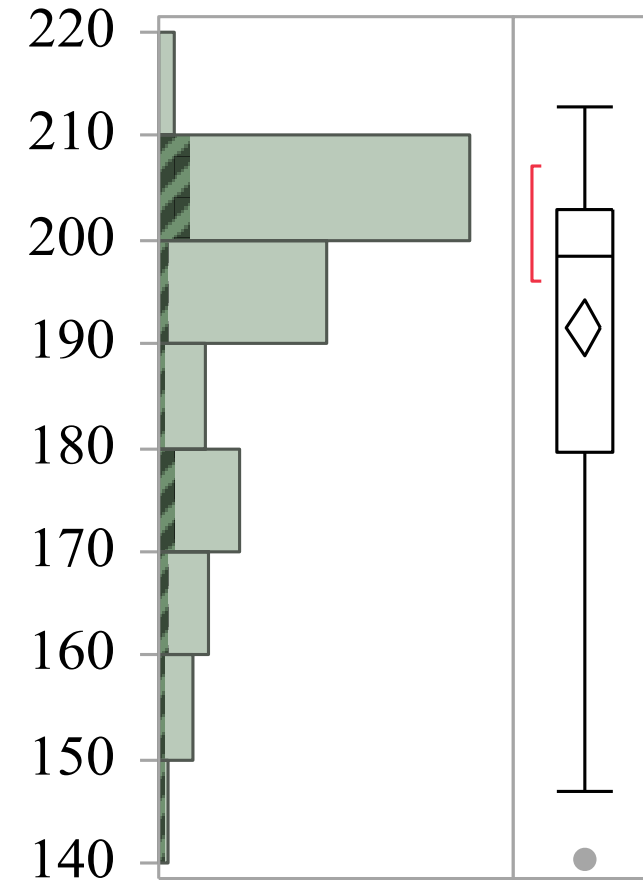
DISTRIBUTION

40 Hours-Ethanol



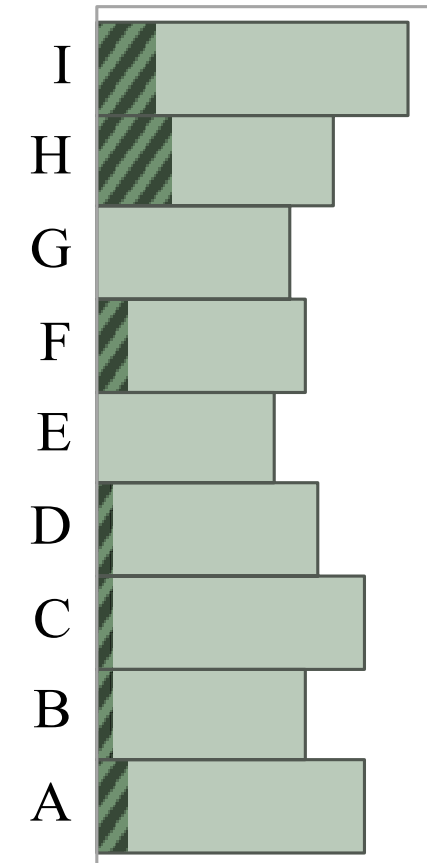
Mean	17.667999
Std Dev	0.9237996
Std Err Mean	0.0783557
Upper 95% Mean	17.822931
Lower 95% Mean	17.513066
N	139

High-Temp Upper Leg



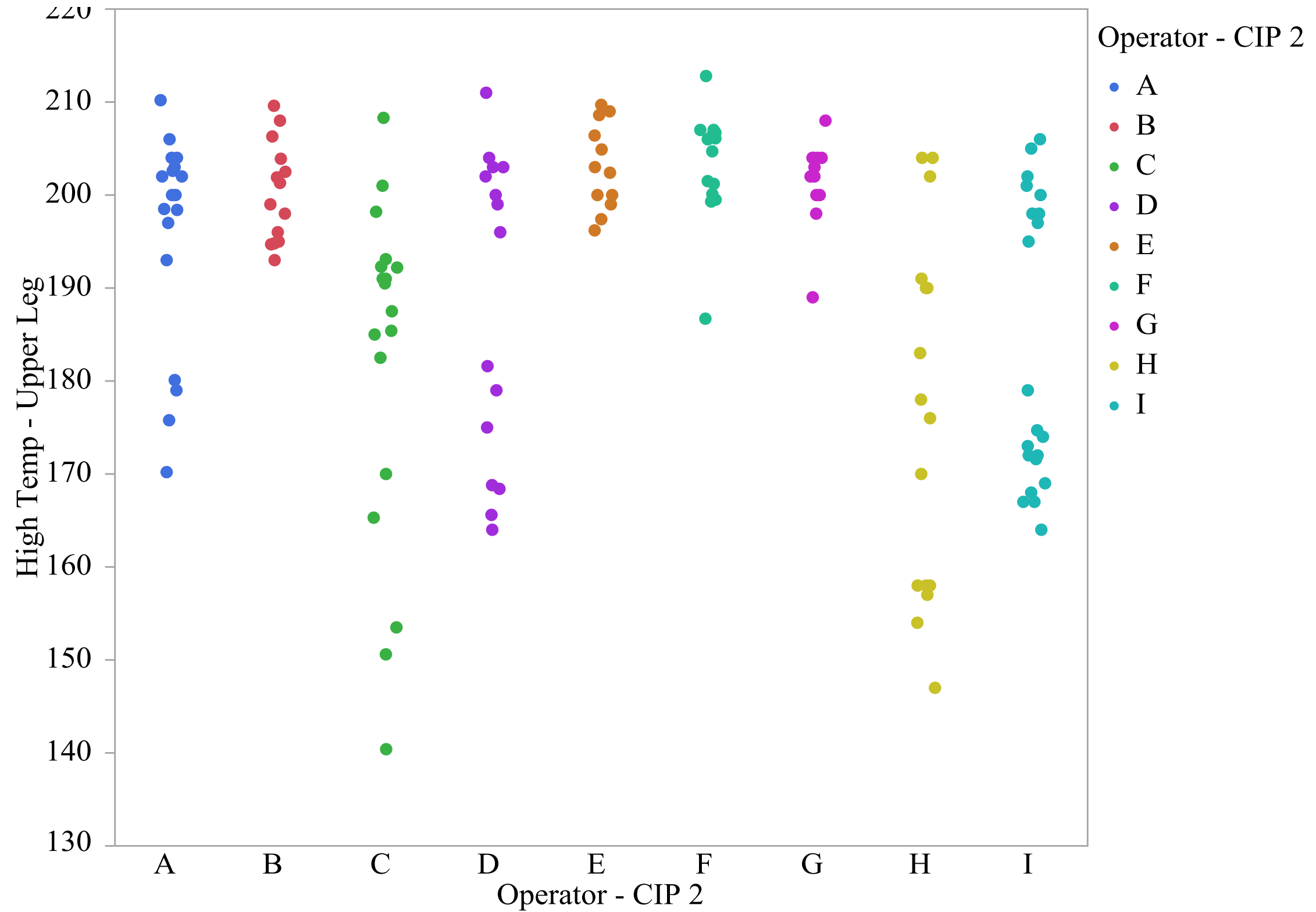
Mean	191.50979
Std Dev	16.206858
Std Err Mean	1.3648637
Upper 95% Mean	194.2082
Lower 95% Mean	188.81138
N	141

Operator

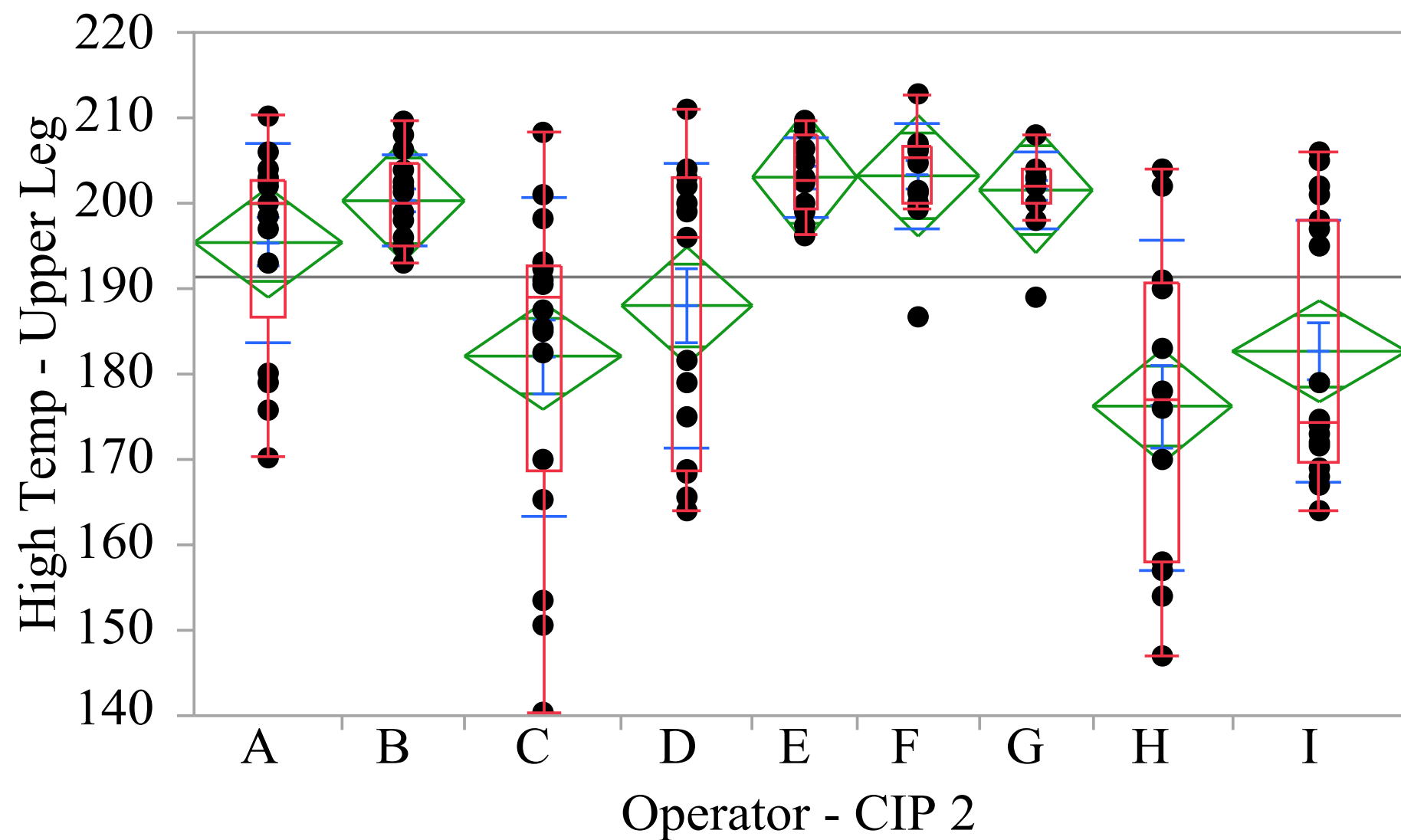


Level	Count	Prob
A	18	0.12766
B	14	0.09929
C	18	0.12766
D	15	0.10638
E	12	0.08511
F	14	0.09929
G	13	0.09220
H	16	0.11348
I	21	0.14894
Total	141	1.00000

GRAPH BUILDER



ANALYSIS OF VARIANCE



Operator	Mean	Std Dev
A	195.399	11.7110
B	200.286	5.3464
C	182.100	18.6062
D	188.027	16.6508
E	203.050	4.6647
F	203.214	6.0744
G	201.538	4.5021
H	176.250	19.3339
I	182.665	15.2481

DEMO IN SOFTWARE

- Univariate analysis (distribution)
- Graph builder
- One way analysis (compare groups)

PROBLEMS

- Creating waste by not effectively fermenting the useable sugars
- The variation added by operator to operator inconsistencies was increasing variance in ethanol yield
- The poor process control was making it difficult to determine if process changes were having an impact on ethanol yield
- Negative impact on profitability from poor batch yield

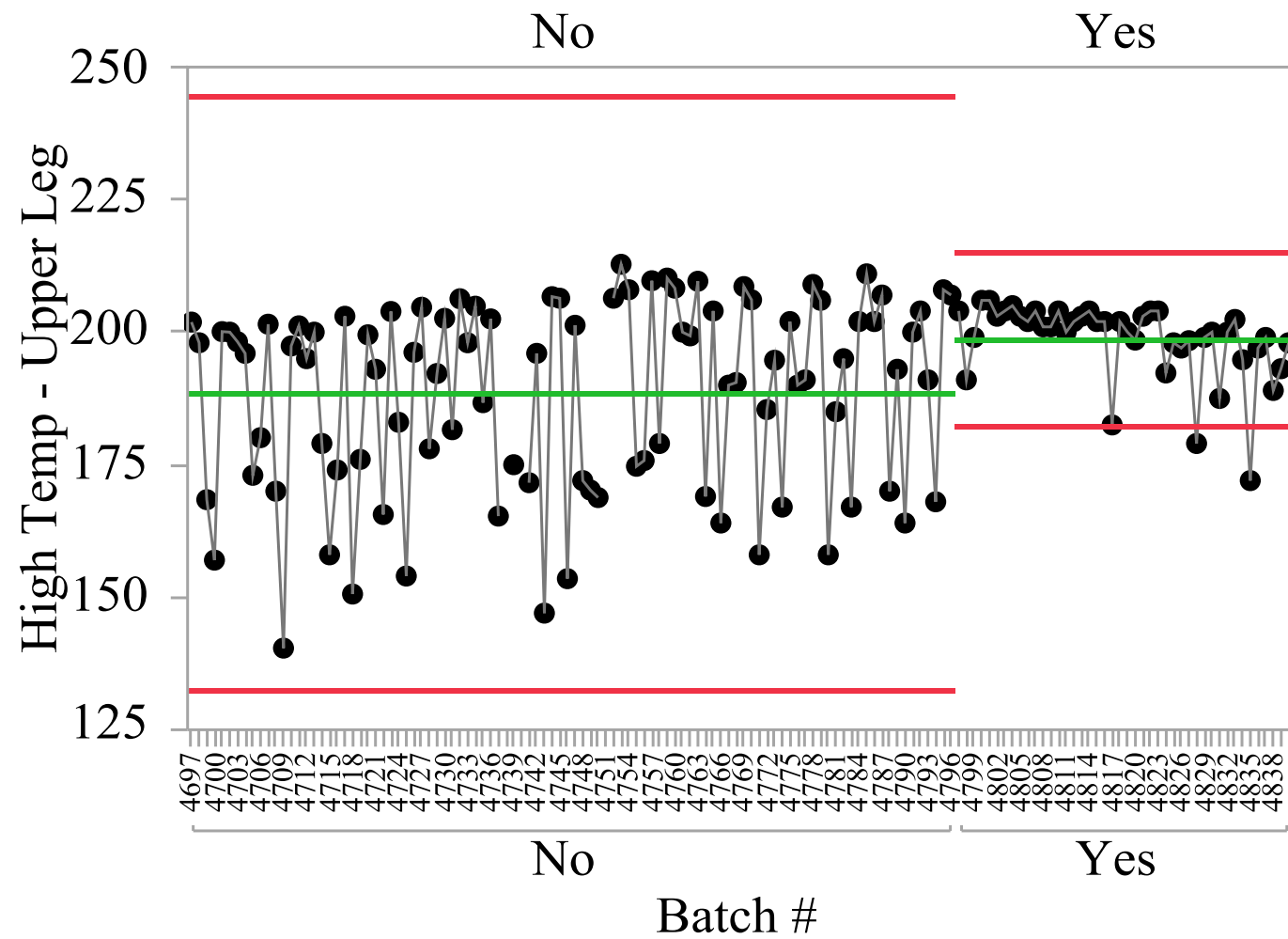
SOLUTIONS

- Retrain operators to have a more consistent performance
- Monitor process using SPC charts
- Compare process temperature SPC chart to ethanol yield SPC chart

SPC CHART OF PROCESS TEMPERATURE

Individual chart of High Temp - Upper Leg

Retraining Operators (Yes/No)



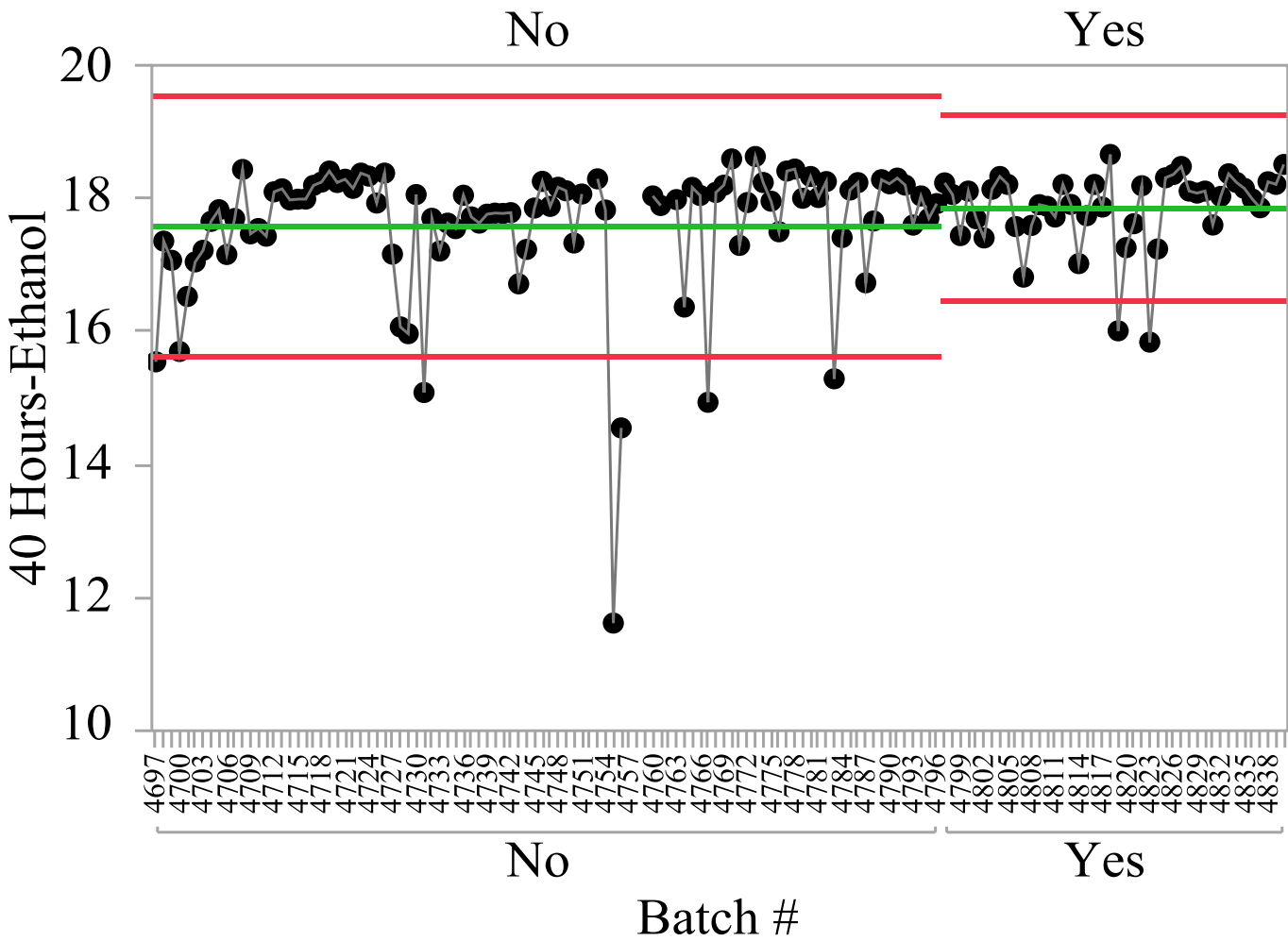
High Temp - Upper Leg Limit Summaries

Points plotted	Retraining Operators (Yes/No)	LCL	Avg	UCL	Limits	Sigma	Sample Size
Individual No	No	132.3064	188.3132	244.32	Moving Range		.
Individual Yes	Yes	182.1101	198.5568	215.0035	Moving Range		1

SPC CHART OF ETHANOL YIELD

Individual chart of 40 Hours-Ethanol

Retraining Operators (Yes/No)



40 Hours-Ethanol Limit Summaries

Points plotted	Retraining Operators (Yes/No)	LCL	Avg	UCL	Limits	Sigma	Sample Size
Individual	No	15.62372	17.58209	19.54047	Moving Range		.
Individual	Yes	16.45334	17.85348	19.25361	Moving Range		1

DEMO IN SOFTWARE

- Histograms
- Compare groups
- Graph Builder
- Control Chart builder
- Phasing with different groups

WE HAVE SHOWN YOU . . .

- A problem from an ethanol plant that was defined, analyzed and improved upon using SPC methods
- The value of utilizing SPC methods
- How SPC can be used to optimized processes saving money and resources

Connect with me:

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QUESTIONS?

Thank you for your time and attention!



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