2024 USBC CONVENTION

EXPERIENCE is everything

# Creation of Precision Measurement Systems

Equipment Specifications

# YOUR
# Equipment Specs Team

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Tech I

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Mechanic

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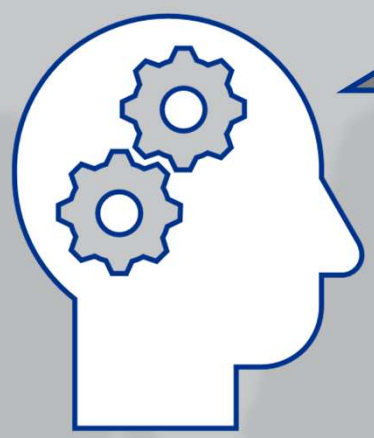
Research Engineer

# Key Points



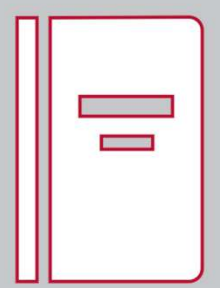
- Your equipment specifications team is working for you.
- If something needs to be measured, we're going to measure it.
- You can be confident we have followed our process and our results are accurate and precise.

# What We Do

**USBC Promise**

Our promise is to celebrate the past, be mindful of the present and ensure bowling's future through thoughtful research, planning and delivery.

# What We Do

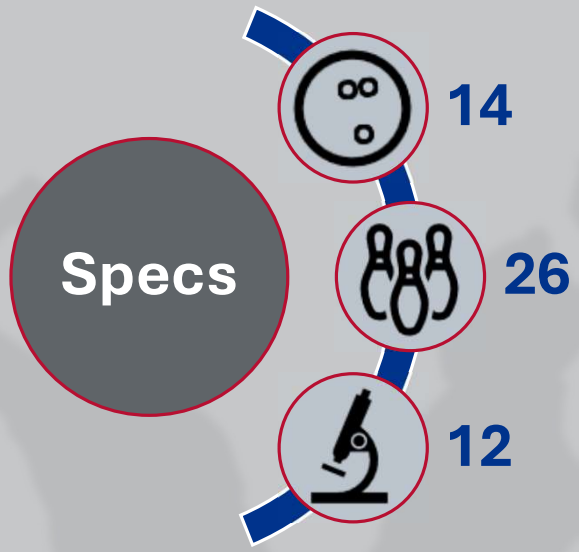


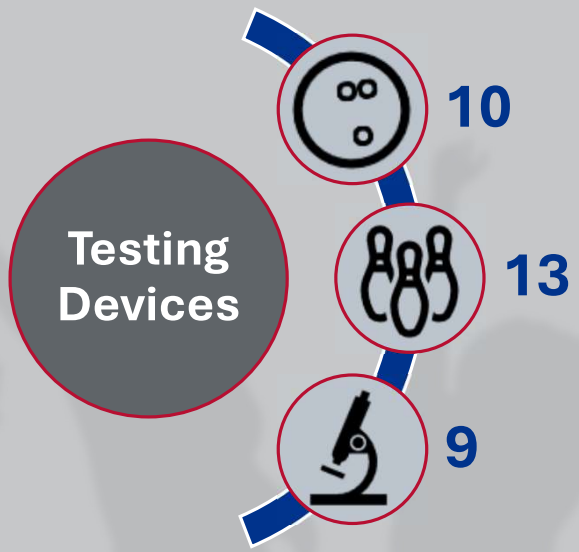
Equipment Specifications Manual

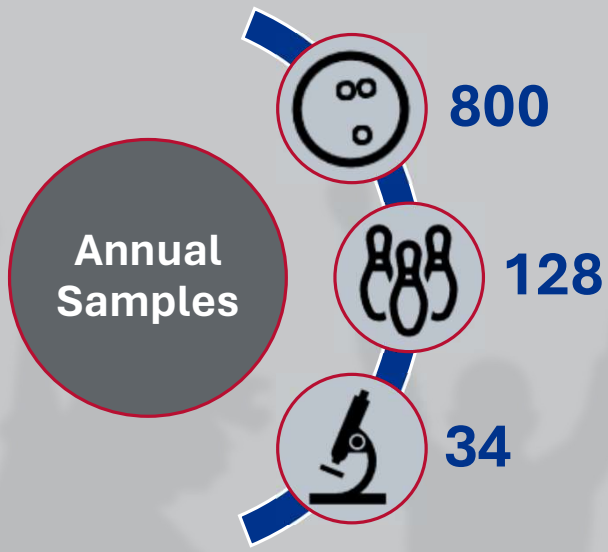
Standard Operating Procedures

BOWL.com/equipment-specifications

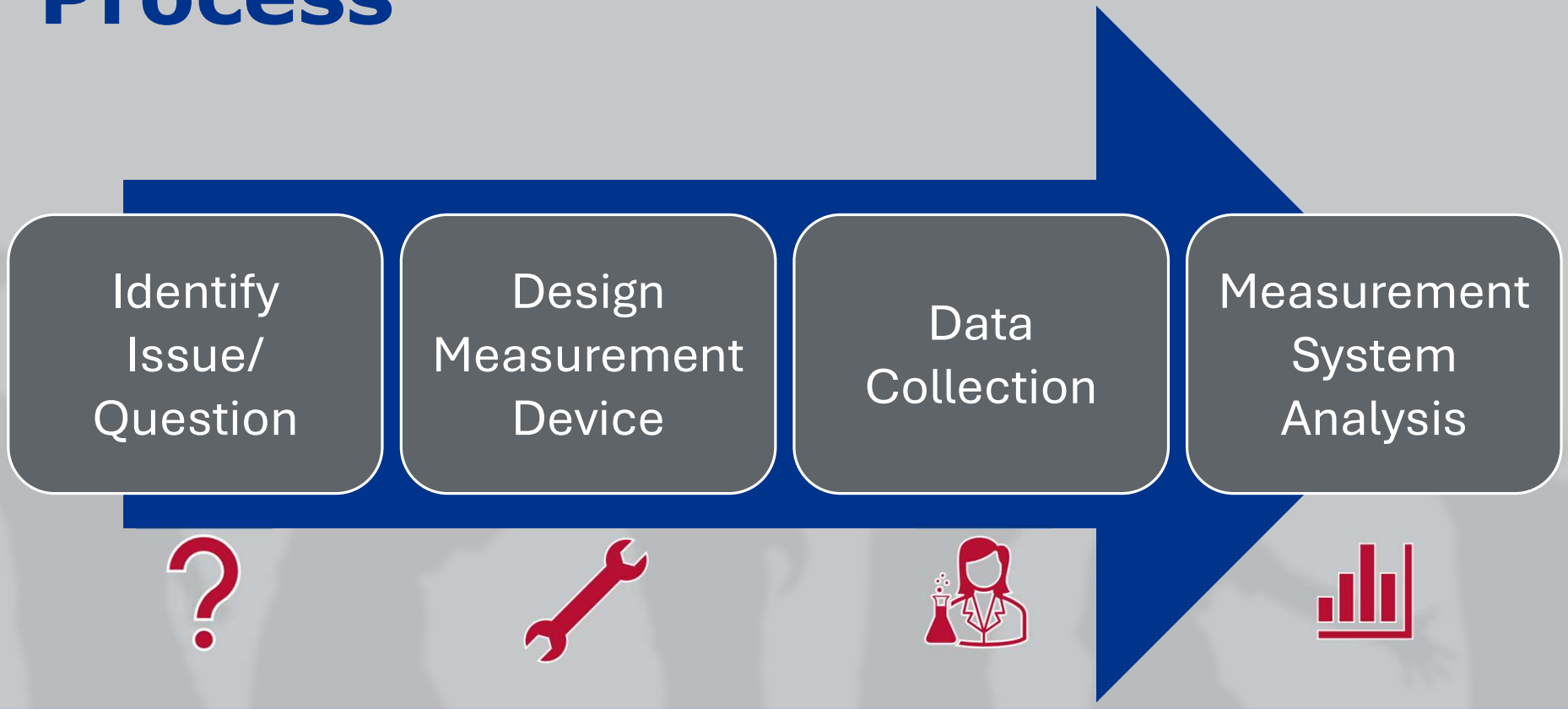
# What We Do


Specs
14
26
12


Testing Devices
10
13
9

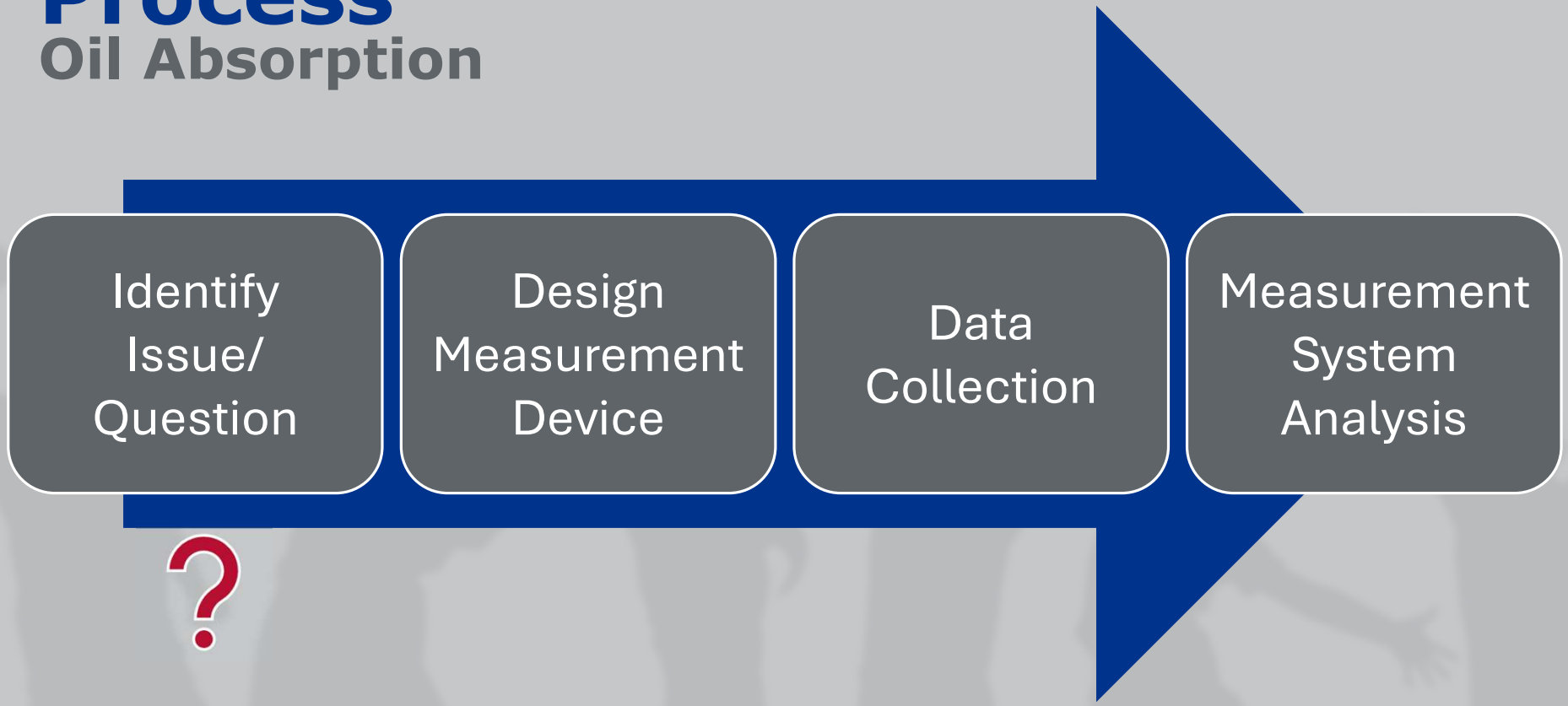

Annual Samples
800
128
34

# Measurement Development Process



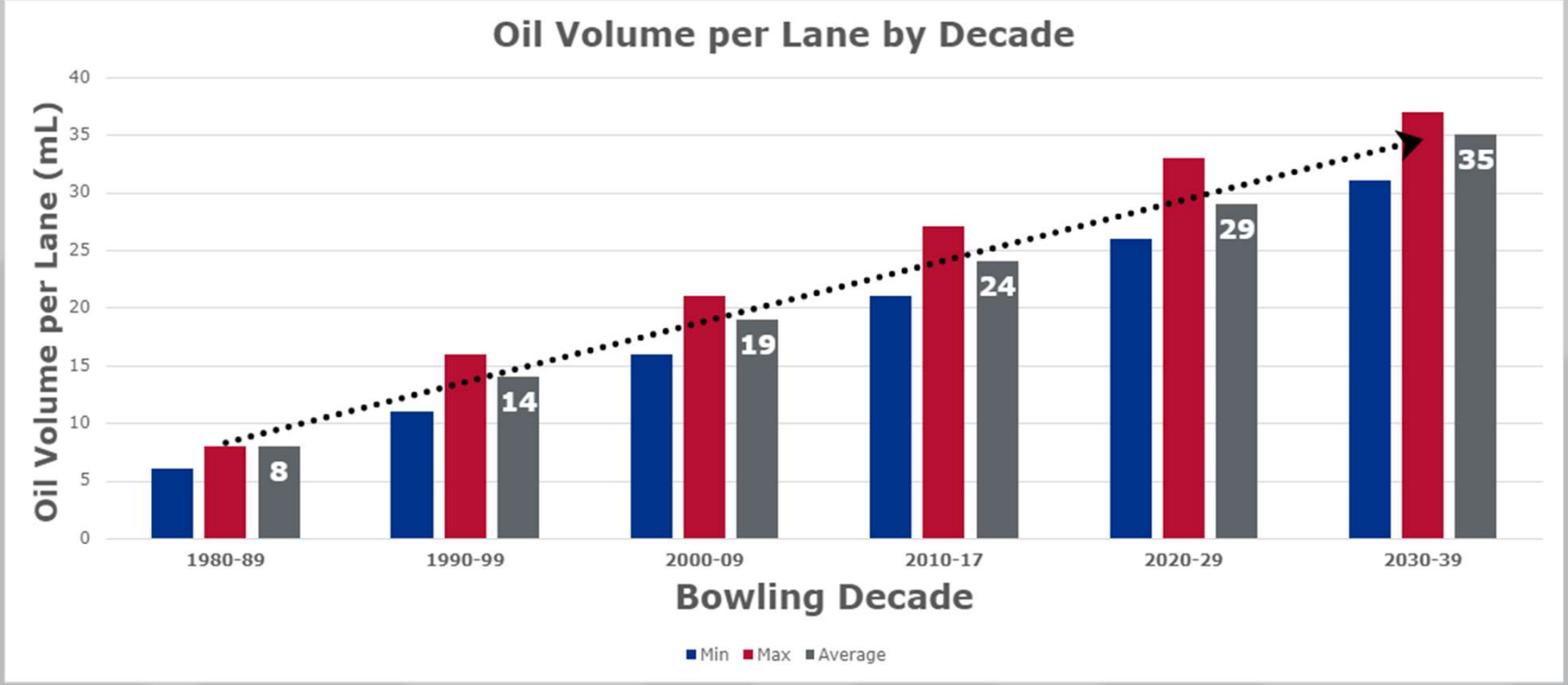
# Measurement Development Process

## Oil Absorption



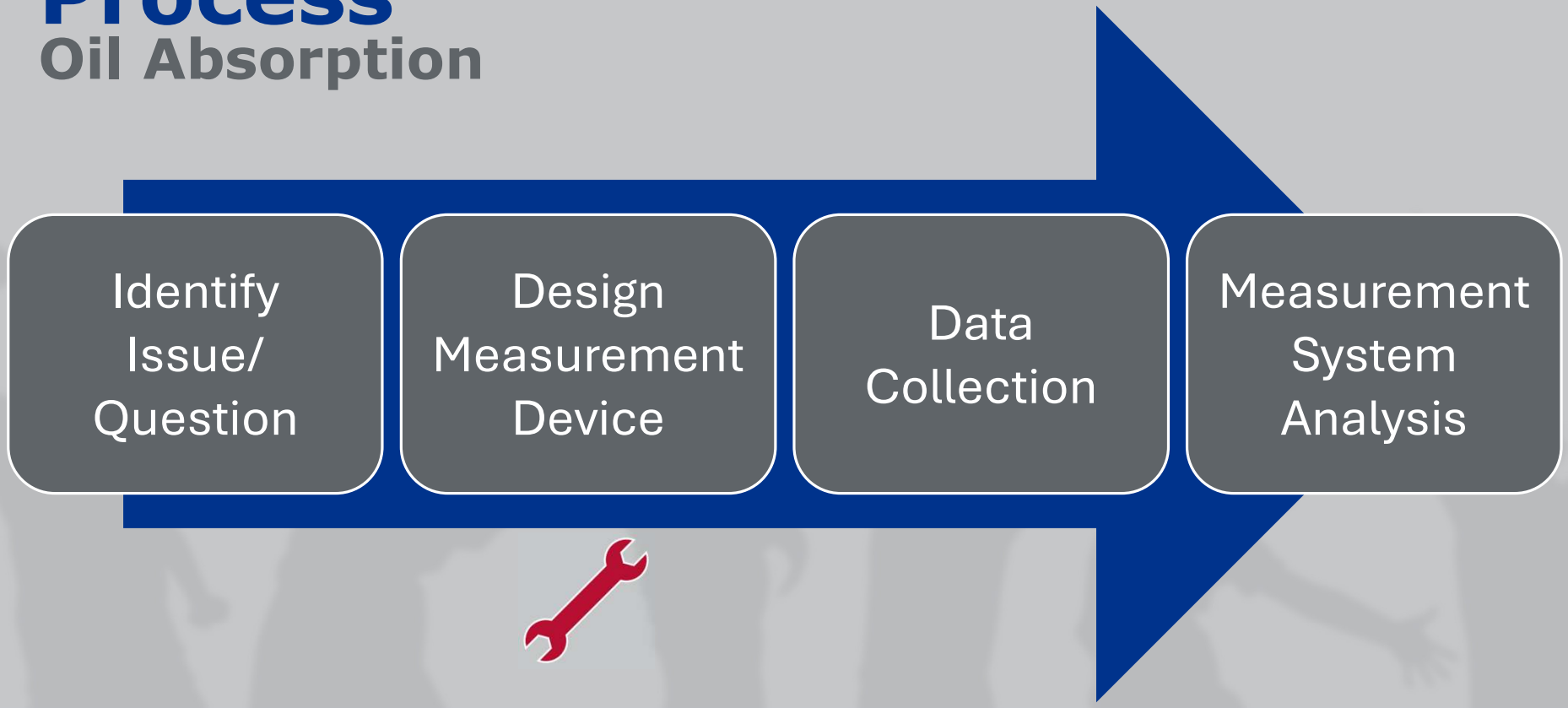
# Identify Issue or Question

## Oil Absorption



# Measurement Development Process

## Oil Absorption



# Design Measurement Device

## Oil Absorption

# Measurement Development Process

## Oil Absorption

Identify Issue/ Question

Design Measurement Device

Data Collection

Measurement System Analysis

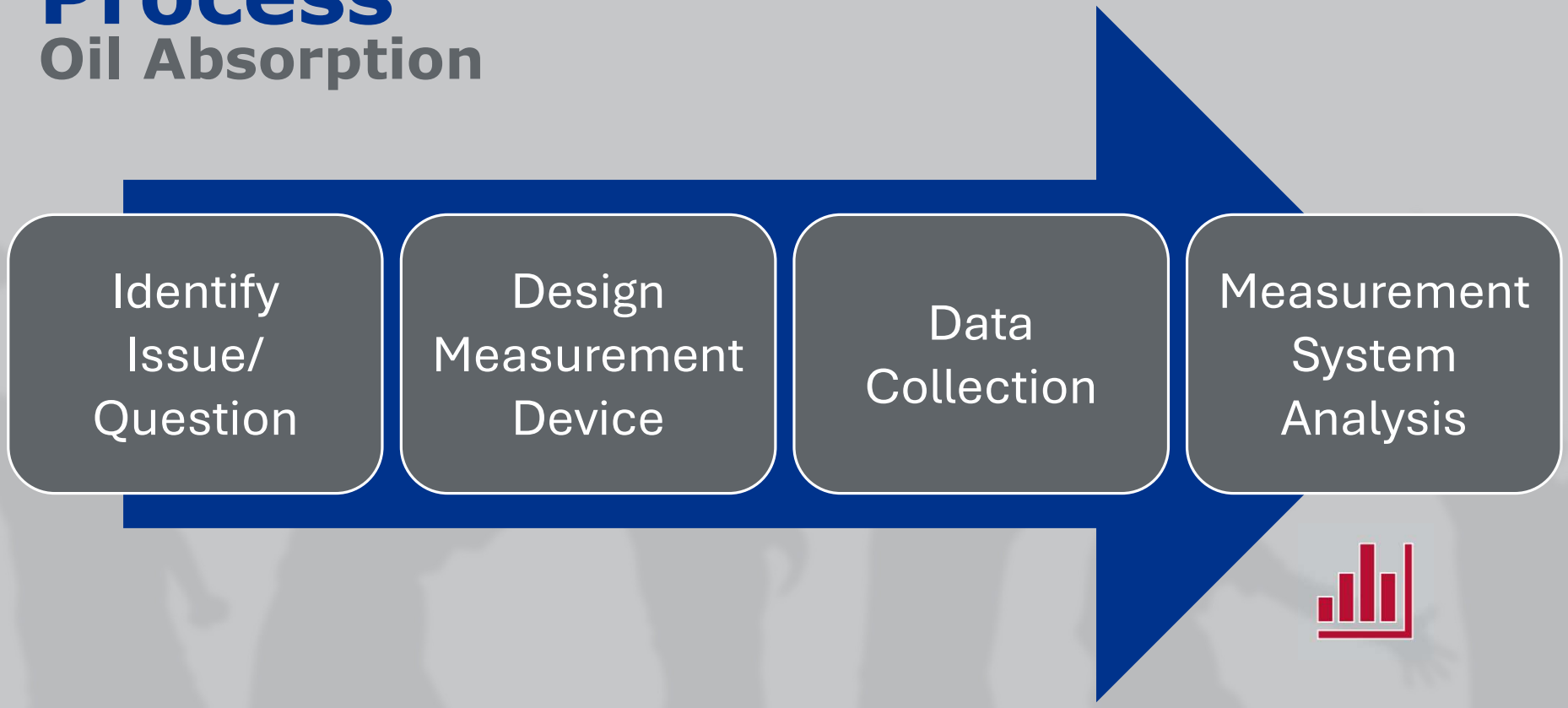
# Data Collection

## Oil Absorption

| Process Enhancements | Approval Samples | Performance Testing | Data Analysis |
|---|---|---|---|
| • Ball Temp<br>• Sanding Method<br>• Mineral Oils<br>• Time | • 500+ balls | • BowlScore<br>• EARL<br>• League Simulations<br>• Specto | • 6 fastest<br>• # drops/color<br>• Drops @ 1 time<br>• Microscope vs. DVR |

# Measurement Development Process

## Oil Absorption



# Measurement System Analysis (MSA)

- We analyze measurement systems for **Accuracy** and **Precision**
- USBC uses Gage R&R as our main MSA method.
- R&R Stands for **Repeatability** and **Reproducibility**.

# Accuracy & Precision

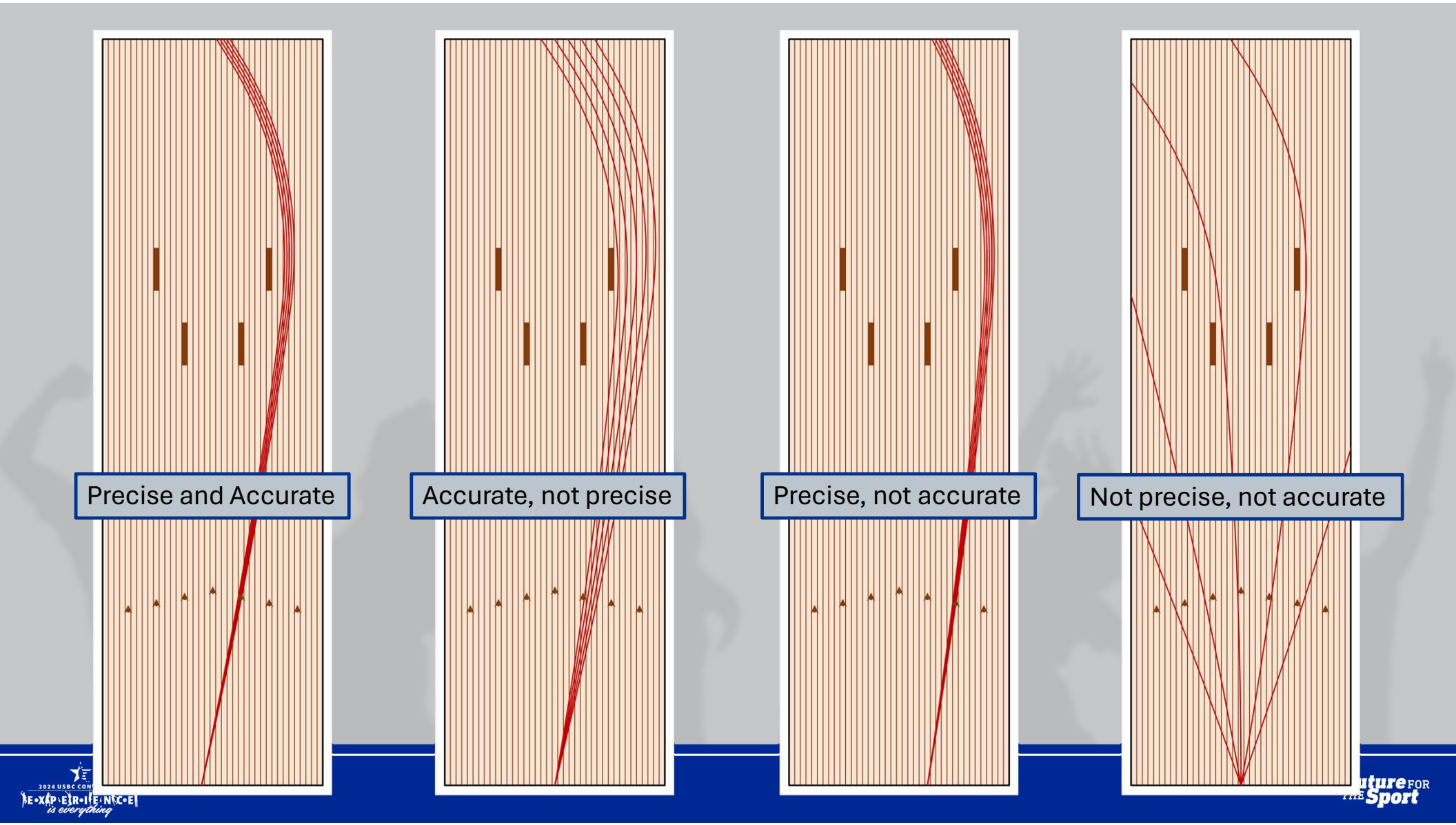
- Accuracy – Measurements are on target.
- Precision – Measurements are consistent.

Precise and Accurate

Accurate, not precise

Precise, not accurate

Not precise, not accurate


Precise and Accurate
Accurate, not precise
Precise, not accurate
Not precise, not accurate

# Repeatability

- Ability for one user to ***repeat*** their results.

- Think…
  - Bowling a 300
  - Getting a hole in one on 18 holes in a row
  - One person, doing the same thing, getting the same result.

# Reproducibility

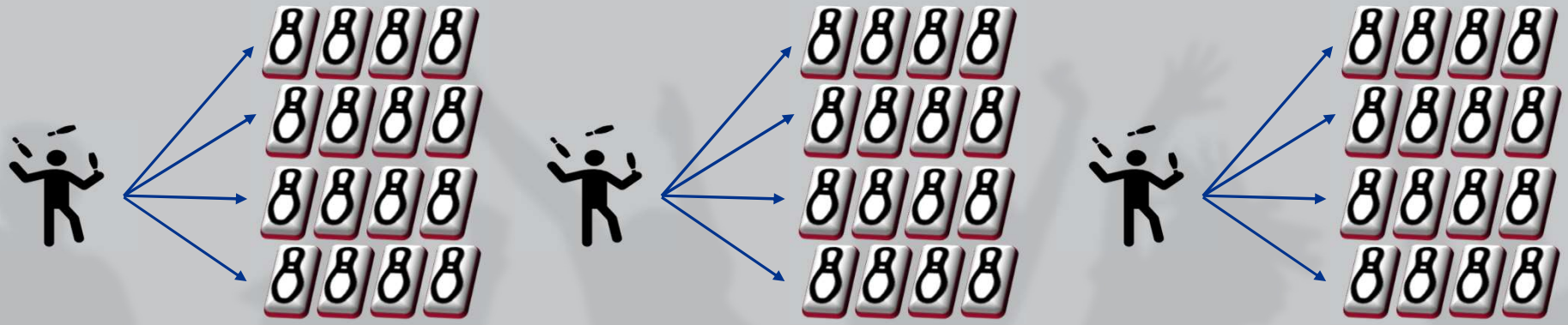
- Ability for others to ***reproduce*** your results.

- Think…
  - Everyone on the pair throwing a strike in the same frame
  - Everyone playing darts all getting a bulls-eye
  - Multiple people, trying the same thing, getting the same results.

# Gage R&R Design

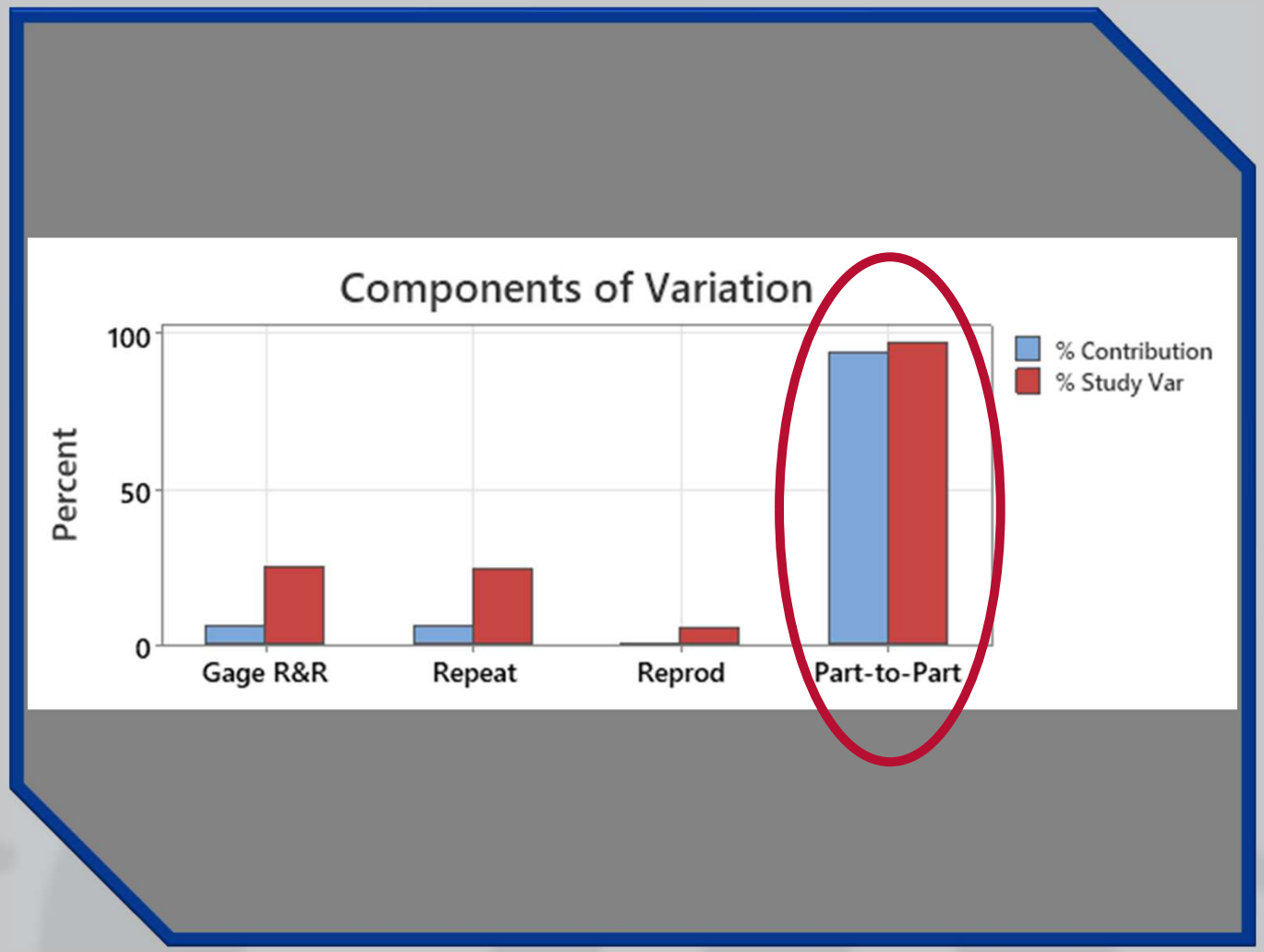
## Oil Absorption

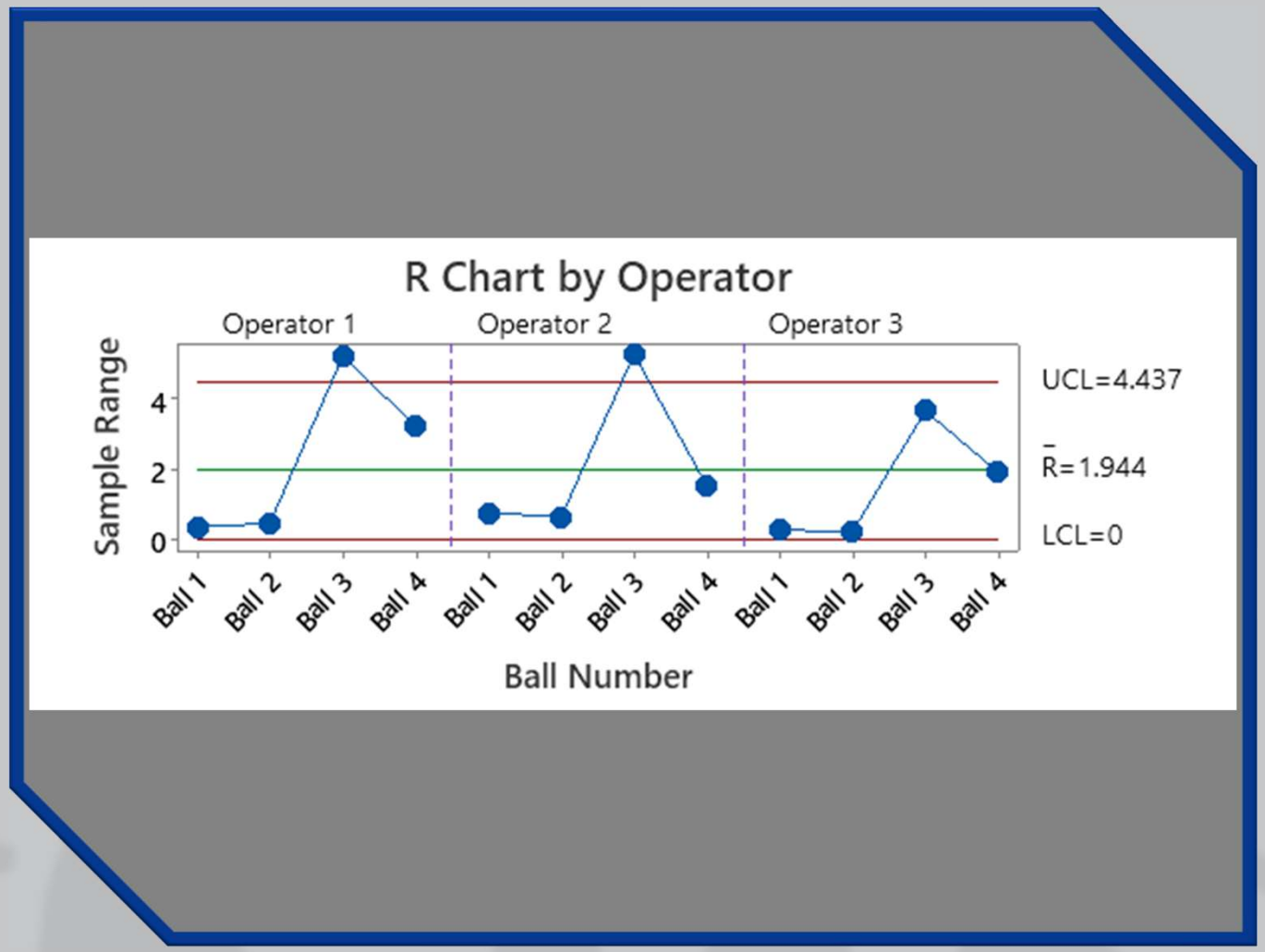
Sample Size: Operators x Parts x Trials ≥ 40

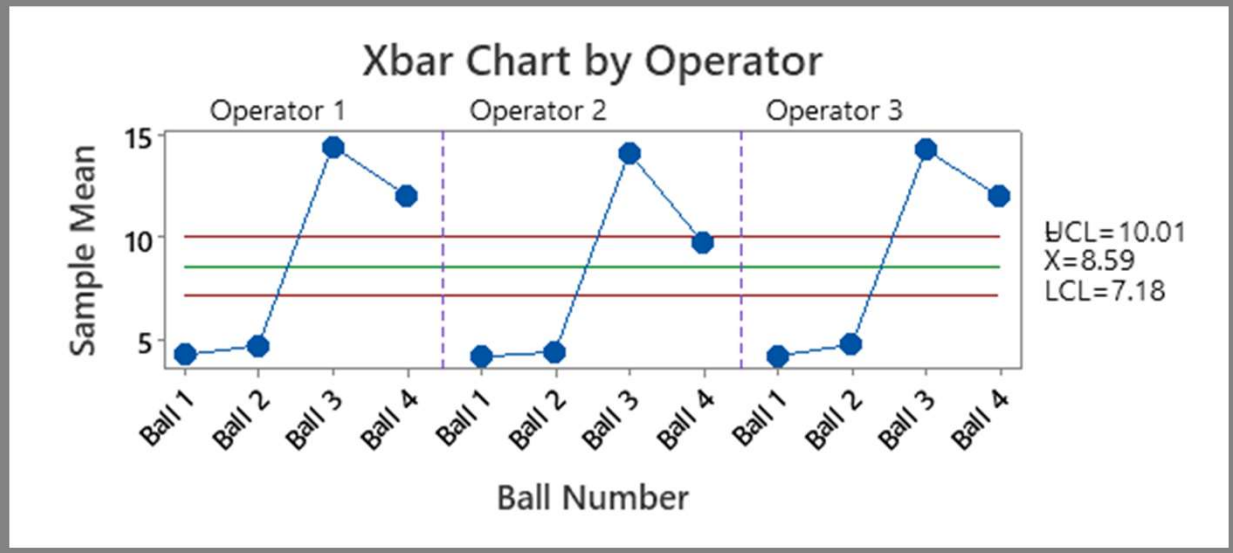


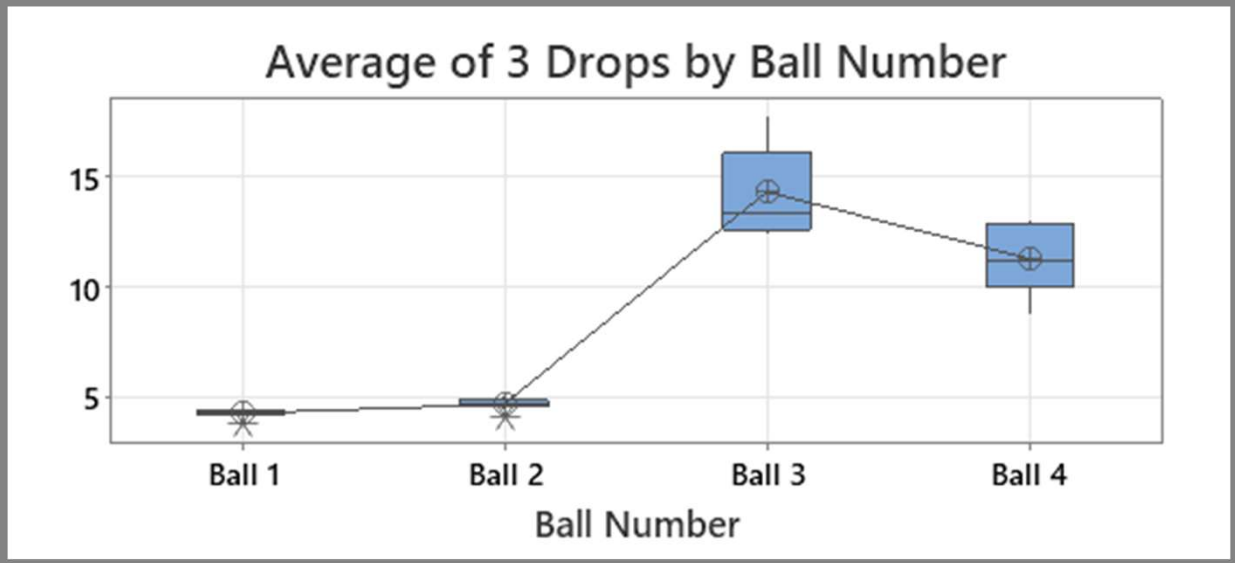
Appropriate range of values across parts

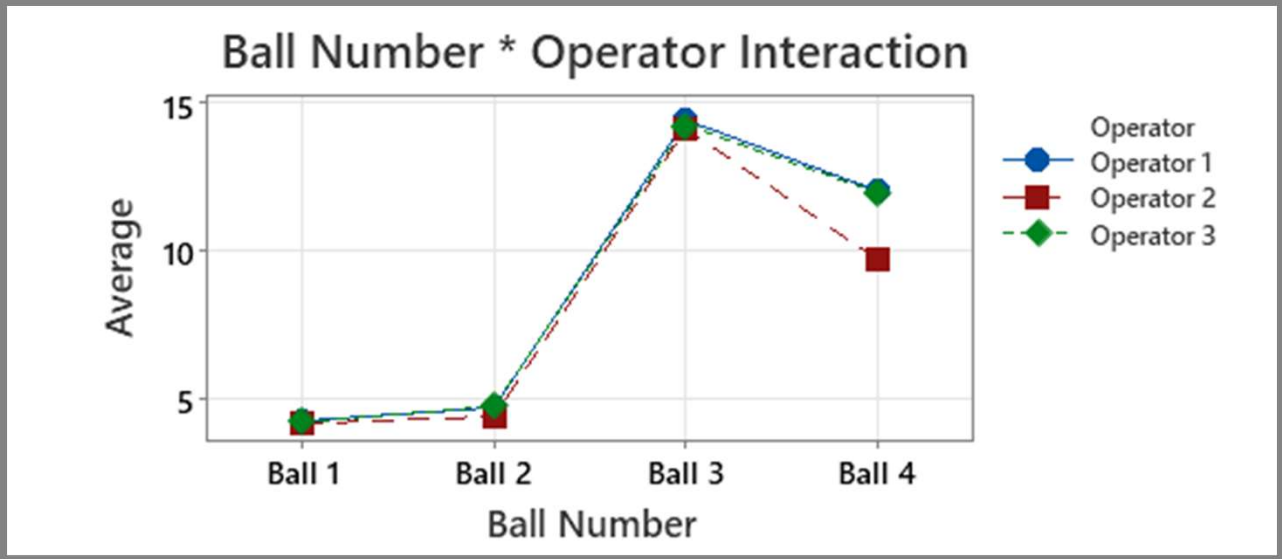
- 3 Manufacturers
- Range of Expected Times


Components of Variation
Percent
100
50
0
Gage R&R
Repeat
Reprod
Part-to-Part
% Contribution
% Study Var


R Chart by Operator
Operator 1
Operator 2
Operator 3
Sample Range
0
2
4
UCL=4.437
R=1.944
LCL=0
Ball 1
Ball 2
Ball 3
Ball 4
Ball Number


Xbar Chart by Operator
Operator 1
Operator 2
Operator 3
Sample Mean
15
10
5
UCL=10.01
X=8.59
LCL=7.18
Ball 1
Ball 2
Ball 3
Ball 4
Ball Number


Average of 3 Drops by Ball Number
15
10
5
Ball 1
Ball 2
Ball 3
Ball 4
Ball Number


Ball Number * Operator Interaction
Average
15
10
5
Ball 1
Ball 2
Ball 3
Ball 4
Ball Number
Operator
Operator 1
Operator 2
Operator 3

# Gage R&R Output Values

**Gage Evaluation**

| Source | StdDev (SD) | Study Var (6 × SD) | %Study Var (%SV) |
|---|---|---|---|
| Total Gage R&R | 1.27818 | 7.6691 | 25.22 |
| Repeatability | 1.24689 | 7.4813 | 24.44 |
| Reproducibility | 0.28107 | 1.6864 | 5.51 |
| Operator | 0.28107 | 1.6864 | 5.51 |
| Part-To-Part | 4.93936 | 29.6362 | 96.87 |
| Total Variation | 5.10206 | 30.6124 | 100.00 |

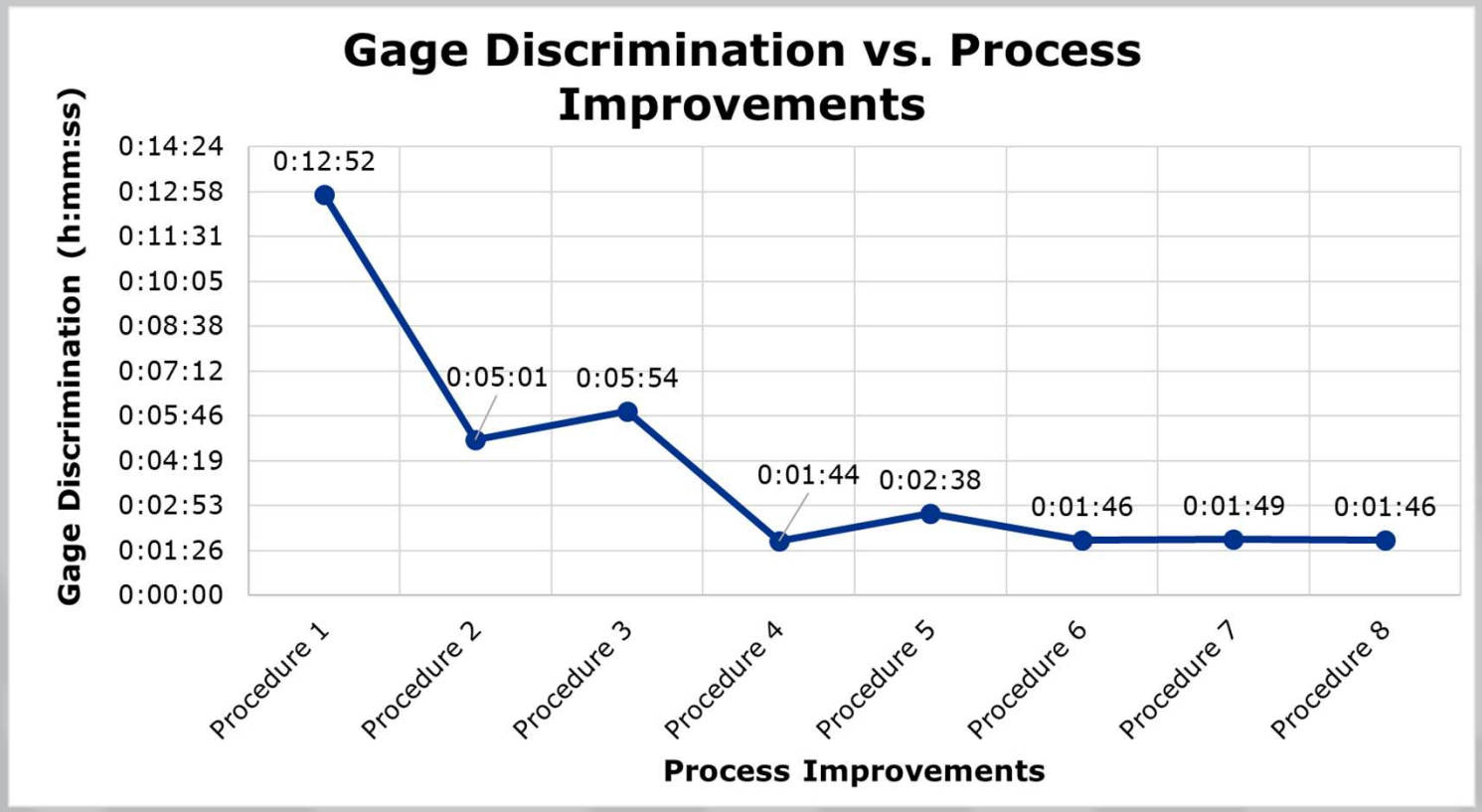
Number of Distinct Categories = 5

**Gage Discrimination**

$$\frac{Data\ Range}{\#\ Distinct\ Categories}$$

1.775 minutes
(1 minute, 46 seconds)

# Gage R&R at Different Phases



# Why measure footprint?

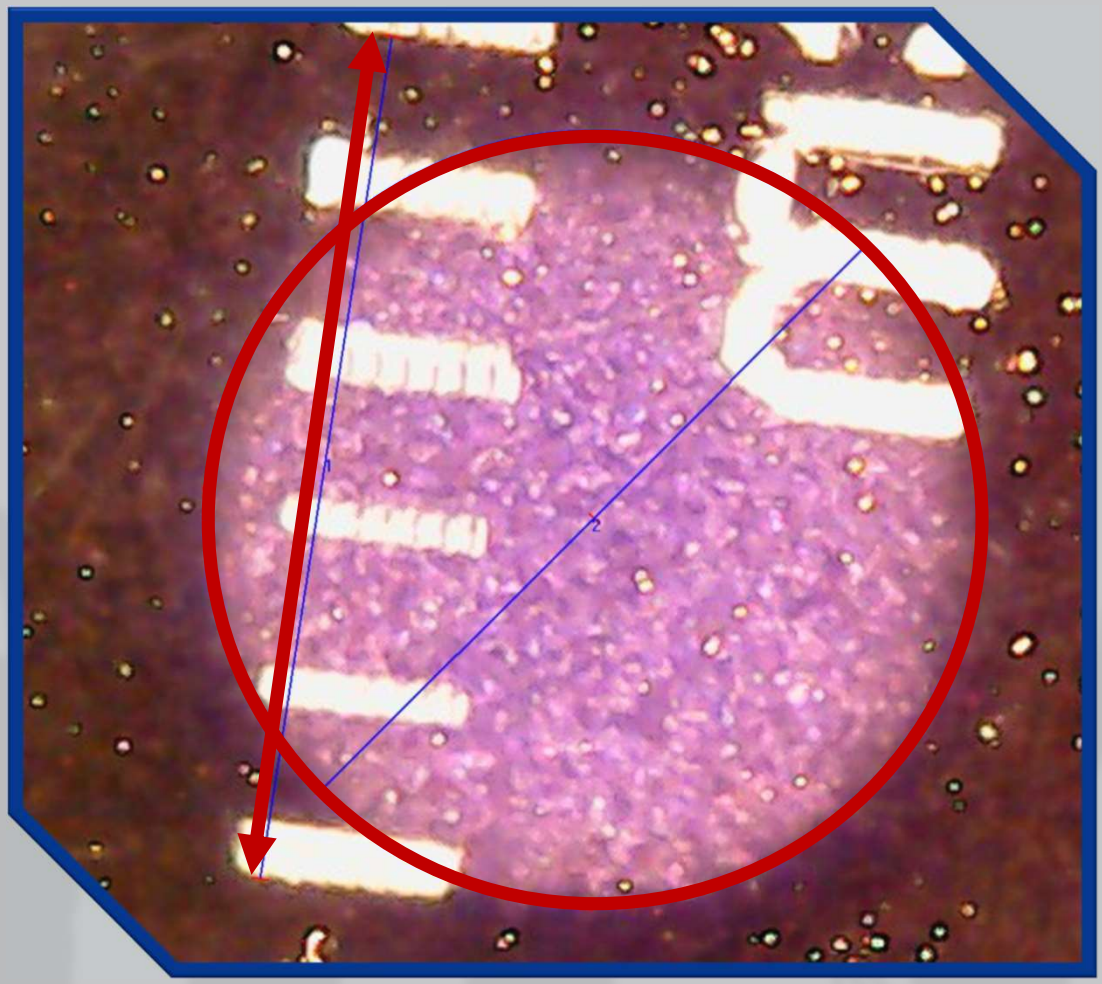
- Bowling ball hardness was first implemented in the 1970's to control "track width" due to players tampering with their equipment.
- Modern technology allowed us to measure the footprint
- Measuring footprint increased our understanding and supported earlier hardness research

# Example Image of Footprint

We measure the measurement scale, to ensure **accuracy**.

We measure the diameter of the circle as the result.

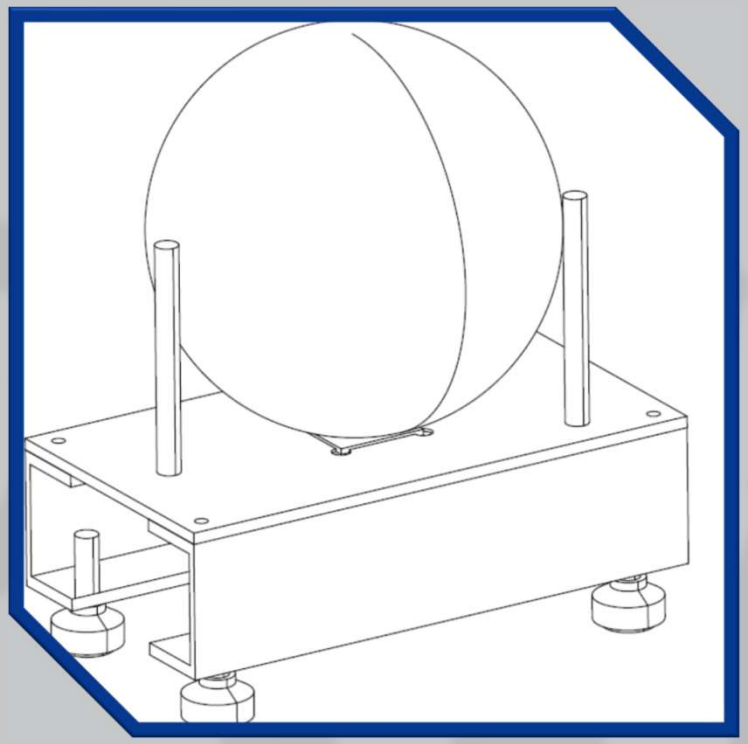
We measure ten images per ball and average the results.

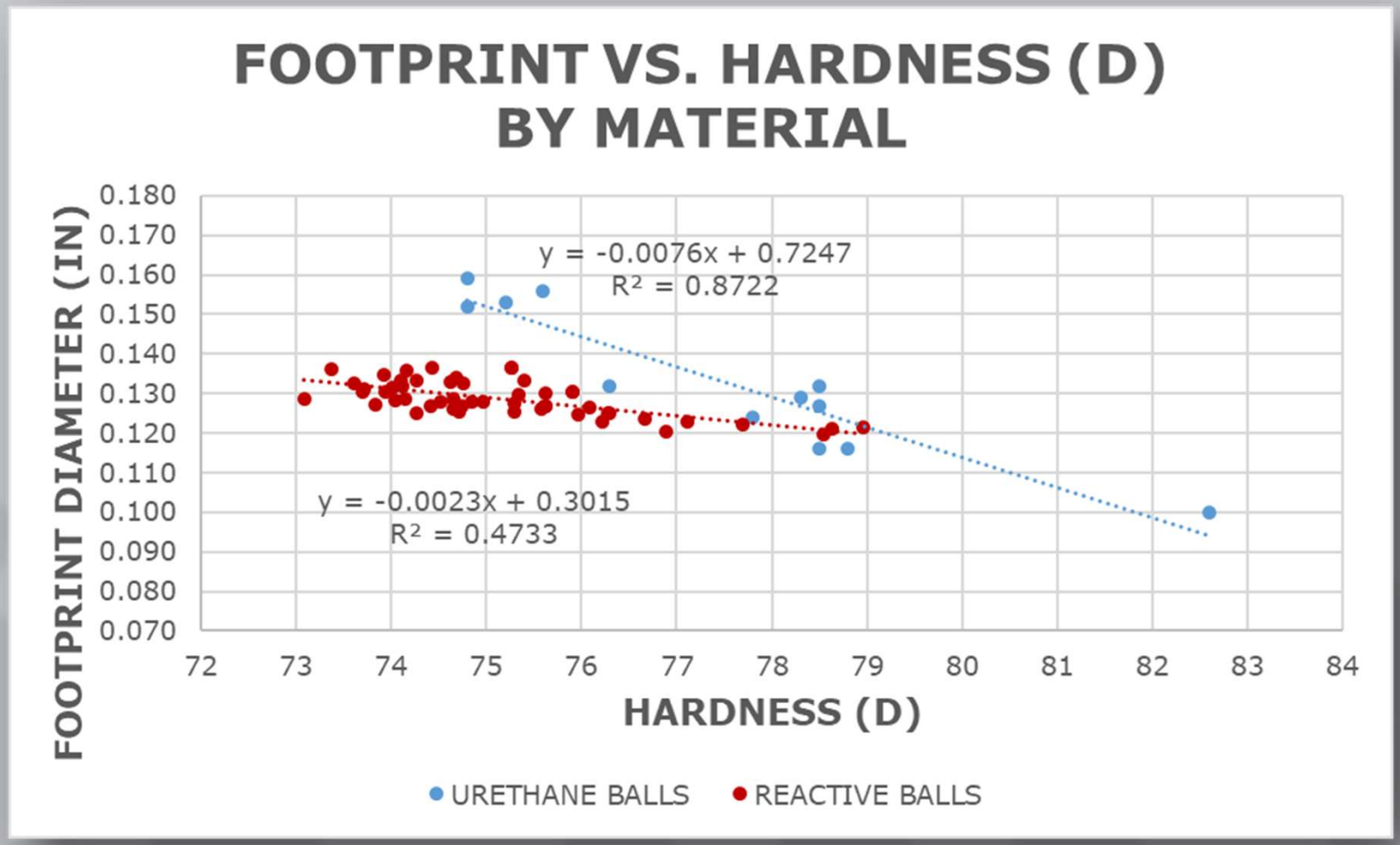


# Outcomes of Footprint Research

- Supported findings from hardness research
- Produced a **repeatable** and **reproducible** research tool
  - Results independent of operator
  - Gauge Discrimination of 0.004”
- Following our Vision:
  - …to continue to be the leading authority to the sport, servicing the needs of bowling.

# Footprint Demonstration




FOOTPRINT VS. HARDNESS (D)
BY MATERIAL
FOOTPRINT DIAMETER (IN)
0.180
0.170
0.160
0.150
0.140
0.130
0.120
0.110
0.100
0.090
0.080
0.070
y = -0.0076x + 0.7247
R² = 0.8722
y = -0.0023x + 0.3015
R² = 0.4733
72
73
74
75
76
77
78
79
80
81
82
83
84
HARDNESS (D)
URETHANE BALLS
REACTIVE BALLS

# Closing Thoughts

- Your equipment specifications team is working for you.
- If something needs to be measured, we're going to measure it.
- You can be confident we have followed our process and our results are accurate and precise.

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# Visit us at

## Bowl.com/equipment-specifications

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**Ally Stanton**