



CRC

for

Premium

Quality

Wool

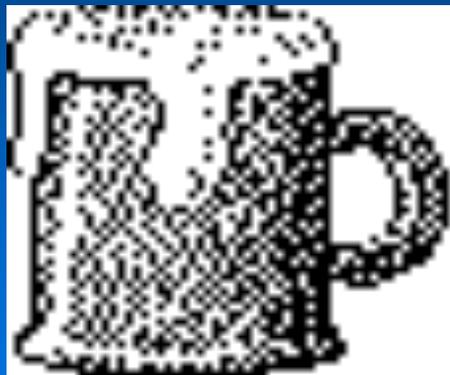
# Sampling Theory

Produced for the CRC for Premium Quality Wool undergraduate program by;  
Angus Ireland, Australian Wool Testing Authority Ltd. and  
Dr. Peter Auer, The University of New South Wales.

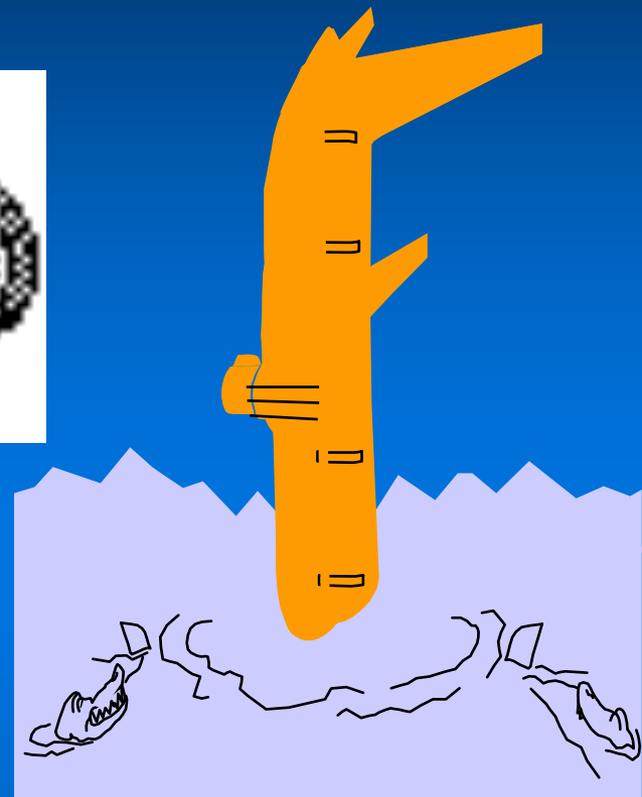


# Populations

Beers in the bar



Life jackets in aeroplanes



Diameters of wool fibres

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# Consequences of lack of confidence in test methods or results

**Brokers:** Check each sample

**Buyers:** Call up bales  
Carry risk

**Processors:** Repeat testing  
Financial claim

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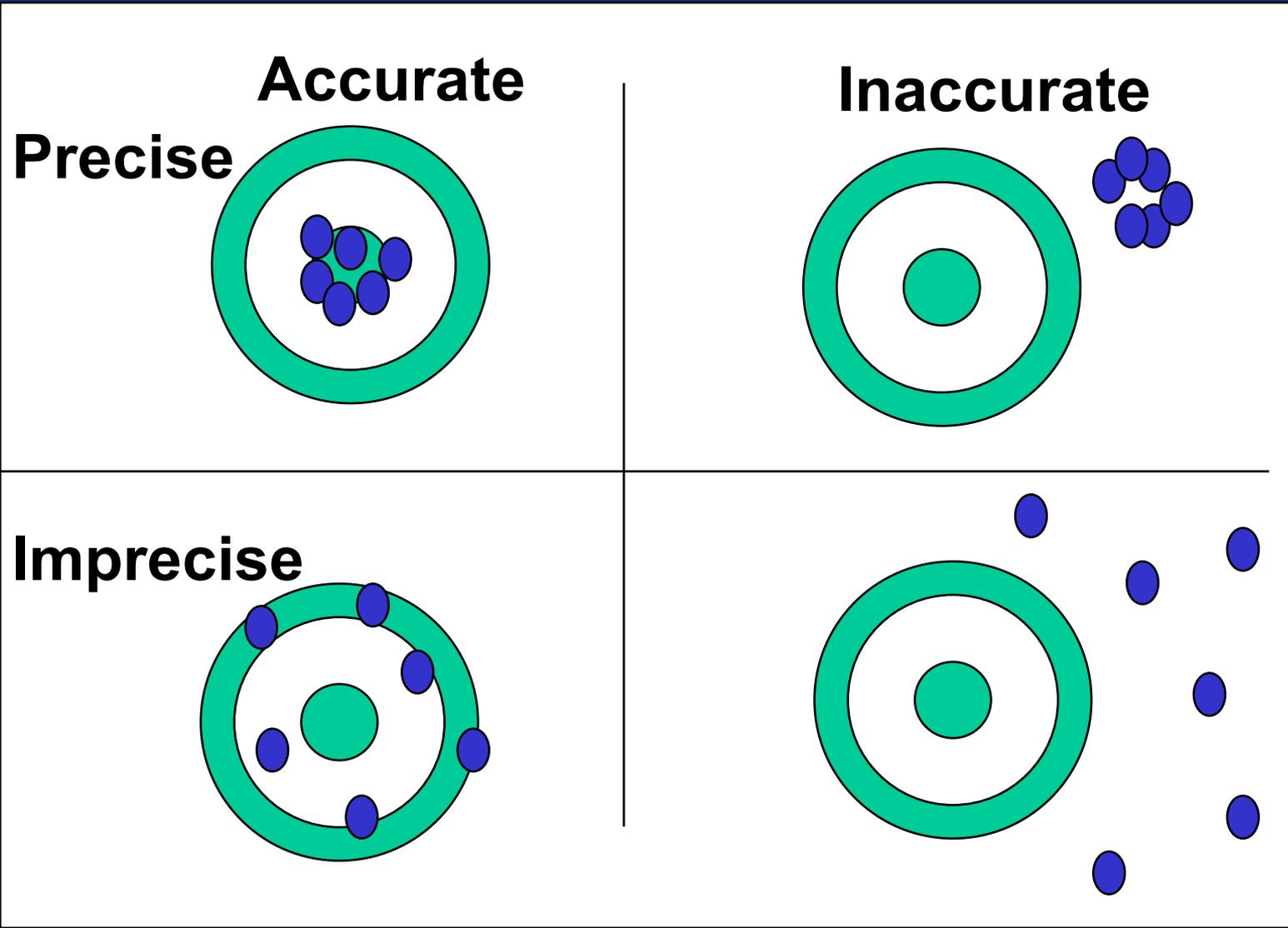
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# There are a HUGE number of fibres in a sale lot.

- 7 bales per sale lot
- 7 bales \* 40 fleeces = 280 fleeces / lot
- 280 fleeces \* 54,000,000 fibres/fleece
- 15,120,000,000 fibres/lot (rough estimate)
- How do we get a **REPRESENTATIVE** sample?

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# Principles of Sampling

- **sample**
  - unbiased (representative)
- **achieved by design**
  - equal chance
    - design
  - free from manipulation
    - machines more consistent
  - sufficient sample size
    - dependent on population variability

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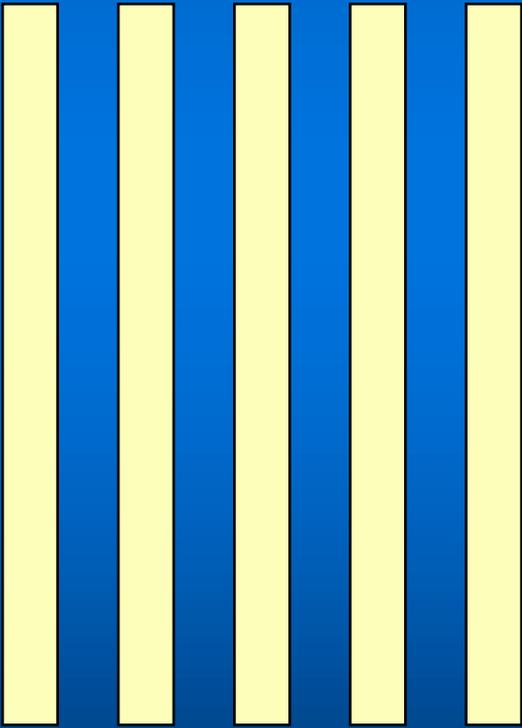
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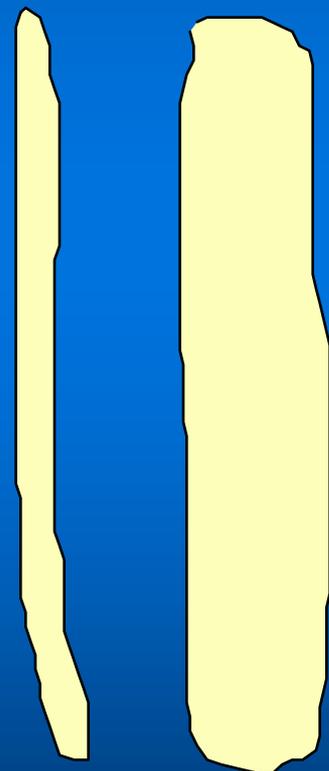


# Natural Variation: 22 micron wool fibres

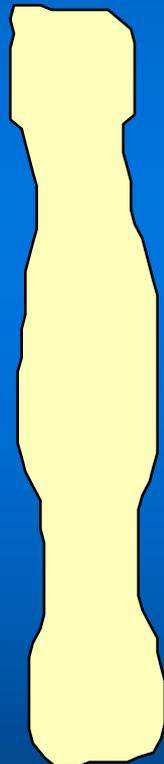
No diameter variation



Between fibre variation



Along fibre variation



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# Sources of Variation

- raw material
- sampling
- tests
- measurements
- operators
- labs

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# What is the Total Variance?

- Total Variance = variance per bale + variance per core + variance per test + variance per sample + variance per fibre etc.
  - the sum of the fractional variances
  - apply known values to the formula
- calculate precision
  - PRECISION = +/- 1.96 X  $\sqrt{\text{Total Variance}}$
  - 95% confidence

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# Example of Total Variance

Total Variance (FDA)

$$= 0.083 / 20 + 0.016 / 2 + 21.8 / 2000$$

$$= 0.00415 \quad (18.1\%) \quad \text{cores}$$
$$+ 0.008 \quad (34.7\%) \quad \text{subsamples}$$
$$+ 0.0109 \quad (47.3\%) \quad \text{fibres}$$

$$= 0.02305$$

$$\text{Precision} = 1.96 \times \sqrt{0.02305} = +/- 0.30$$

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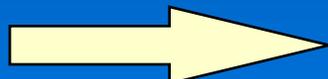
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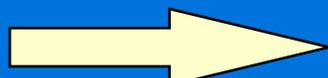
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# 95% Confidence Limit & Interval

For Example:

  $30.0\mu\text{m} \pm 0.6\mu\text{m}$  (Limit)

  $29.4\mu\text{m} - 30.6\mu\text{m}$  (Interval)

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# Improving the Precision of a Test Result

Multiple Tests	% Improvement in Precision	Effect on 95% Confidence Limits (wools > 26 $\mu$ )
1	0	0.60
2	29	0.42
4	50	0.30
10	68	0.19

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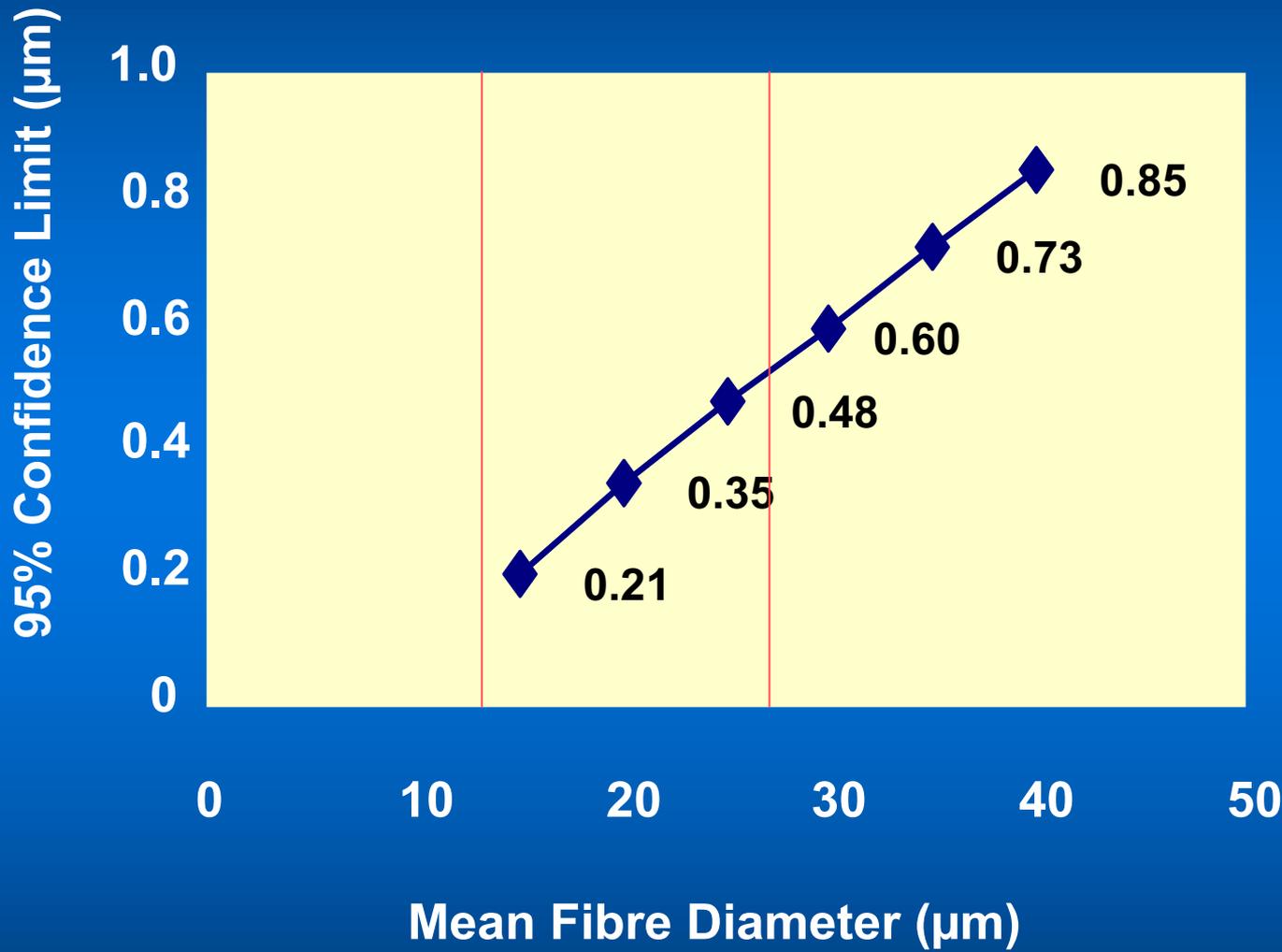
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# Precision - How it can vary

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Angus Ireland & Peter Auer  
Source: IWTO 12