Chapter 7

Rational Sampling

Want to collect our samples so that the differences between individuals within a subgroup is attributable only to a constant system of common causes.

Maximize opportunity for measurements within a subgroup to be similar.

Maximize chance for special causes to occur between subgroups.
Rational Subgroup Selection

- How big should the sample size be??
- How frequently should we collect samples??
- What method should be employed for subgroup selection??
Sample Size Considerations

What sample size should we use??

- Subgroups should be subject to common-cause variation
- Subgroups should ensure that sample means are normal
- Subgroups should ensure good sensitivity to detection of special causes
- Subgroups small enough to be economically viable
Sampling Frequency

How frequently should we collect samples??

- Must consider the general nature of the process stability.
- Must consider frequency of process events
- Cost of sampling??
Method of Subgroup Selection

- The individuals within a sample -- comprised of measurements taken at approximately the same time. Consecutive sampling.

Rational sampling: variation due only to common causes.

- While we may collect samples at periodic intervals, we want to vary the interval length so that samples are not collected at the same time as periodic events.
Consecutive vs. Distributed Sampling

Consecutive sampling: individual members taken as close as possible in time to one another

Distributed sampling: individual members in sample spread out over time

- In the absence of specialized knowledge, use consecutive sampling - default choice.

- For certain process behaviors, distributed sampling is preferred.
Consecutive Sampling

\[ \mu \]

Time
Distributed Sampling

\[ \mu \]

Time
Distributed Sampling

\[ \mu \]

Time

\[ \mu \]

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Pitfalls in Subgroup Selection

- Stratification
- Mixing

What is Stratification??
Stratification

How can it occur??

1. Process produces a characteristic - natural multiple occurrence of an item, e.g., mold cavities, multihead filling maching, turret

2. Conscious effort to distribute "sampling points" in an orderly fashion, e.g., measure a sheet, shaft dimensions, dimension of a cast part as it cools

3. Shortcut SPC application by taking representative sample across several machines
Stratification Example

From the figure  \( \sigma_X = 1 \)

Based on ranges,  \( \hat{\sigma}_X = \frac{\bar{R}}{d_2} = \frac{6}{2.059} \approx 3 \)
Mixing

What is Mixing??

Machine 1  Machine 2  Machine 3  Machine 4
Summary

Stratification: sample has representation from each distribution; (A,B,C,D), (A,B,C,D), . . . , (A,B,C,D)

Mixing: sample extracted from "mix" that is composed all the output from the different distributions; (A,A,C,D), (B,D,A,B), . . . , (C,D,D,C)
Overcontrol

Variations due to Common Cause sources are wrongly interpreted as being due to special causes