Lecture #22

Prof. John W. Sutherland

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Quality Engineering (MEEM 4650 / 5650)
Dept. of Mechanical Engineering - Engineering Mechanics
Michigan Technological University

Chapter 7

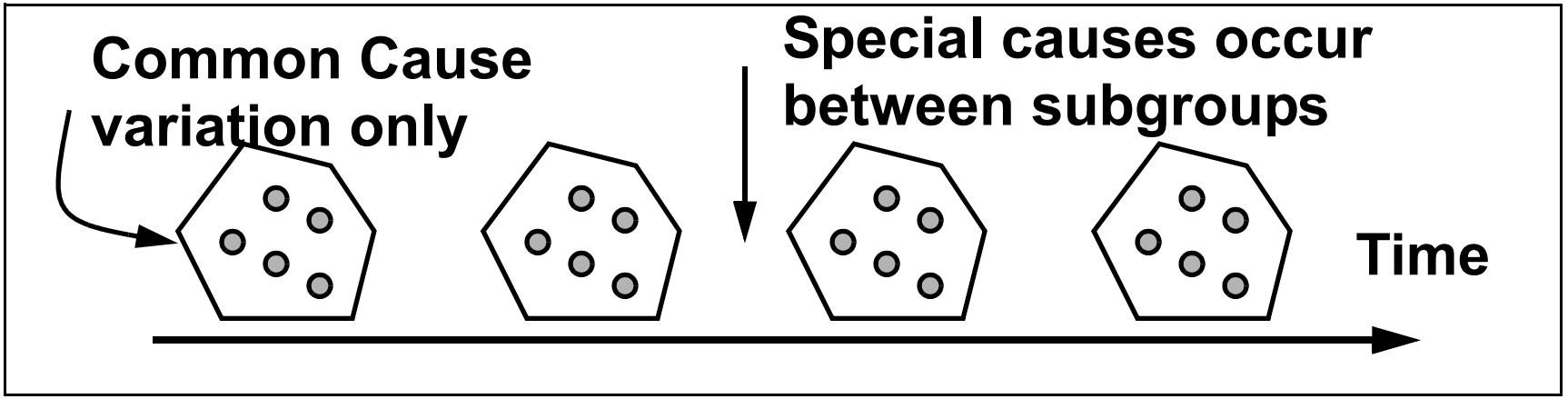
Rational Sampling

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.**

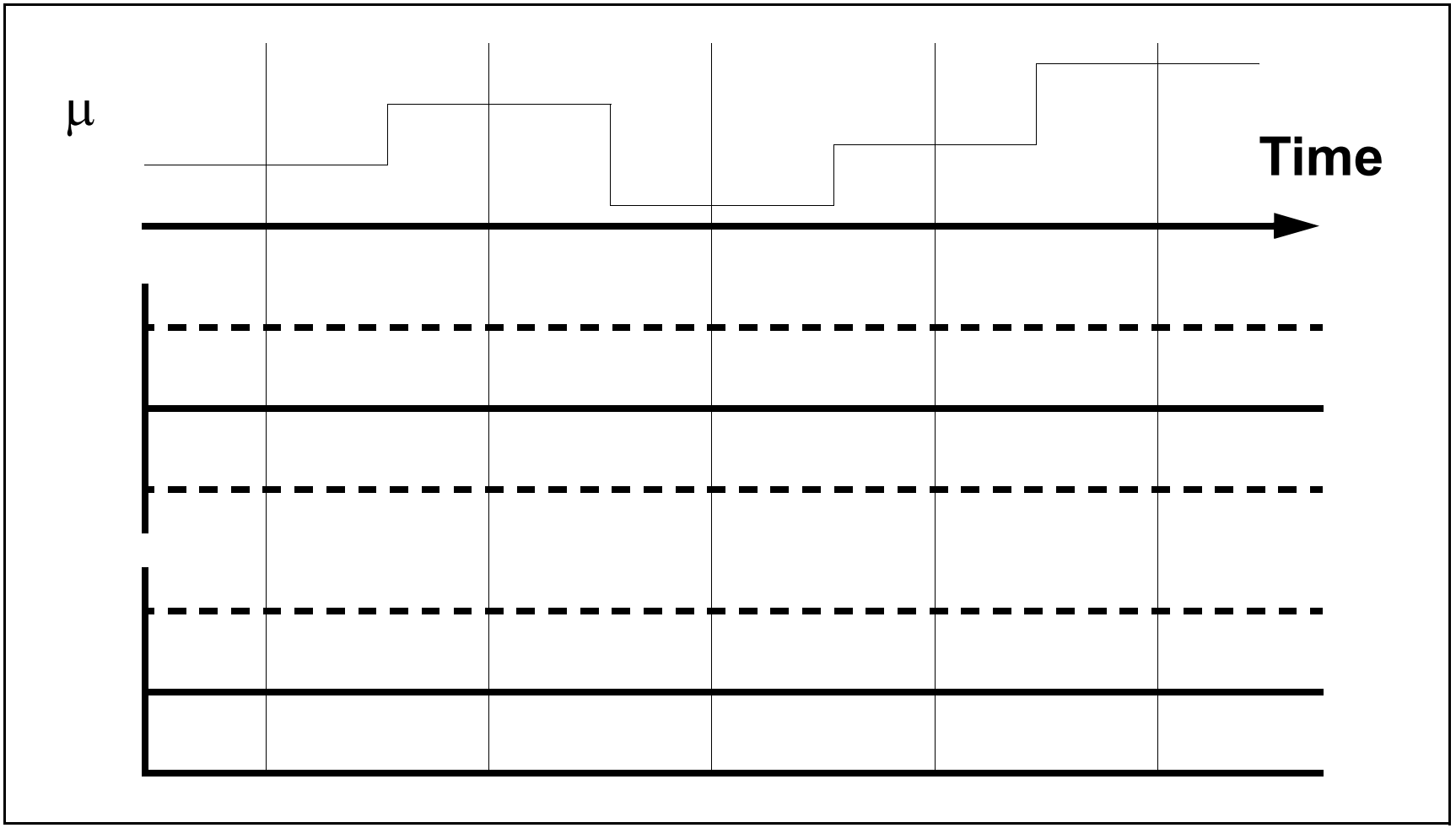
Consecutive vs. Distributed Sampling

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

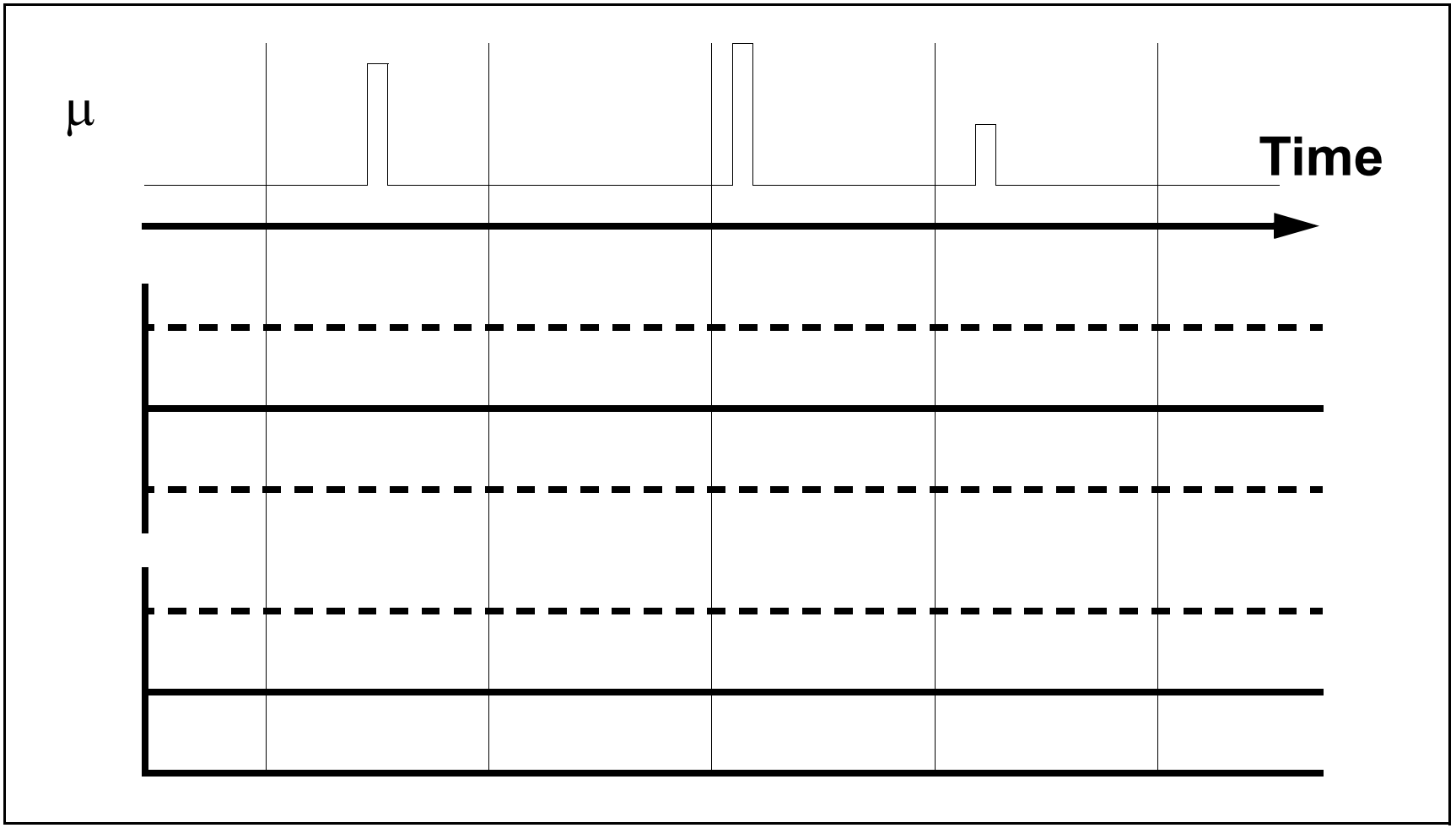
Distributed sampling: individual members in sample spread out over time

- **In the absence of specialized knowledge, use consecutive sampling - default choice.**
- **For certain process behaviors, distributed sampling is preferred.**

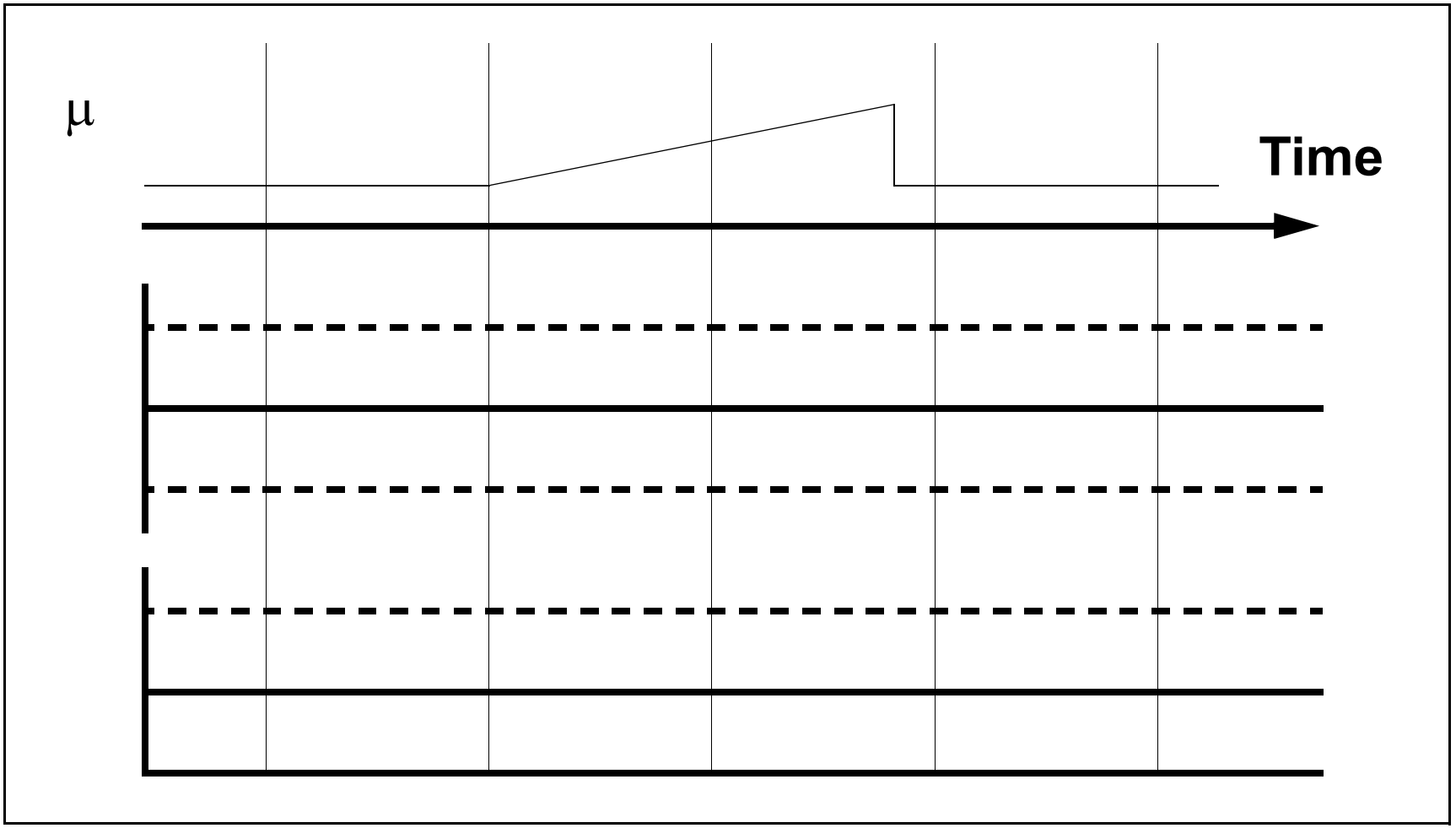
Consecutive Sampling



Distributed Sampling



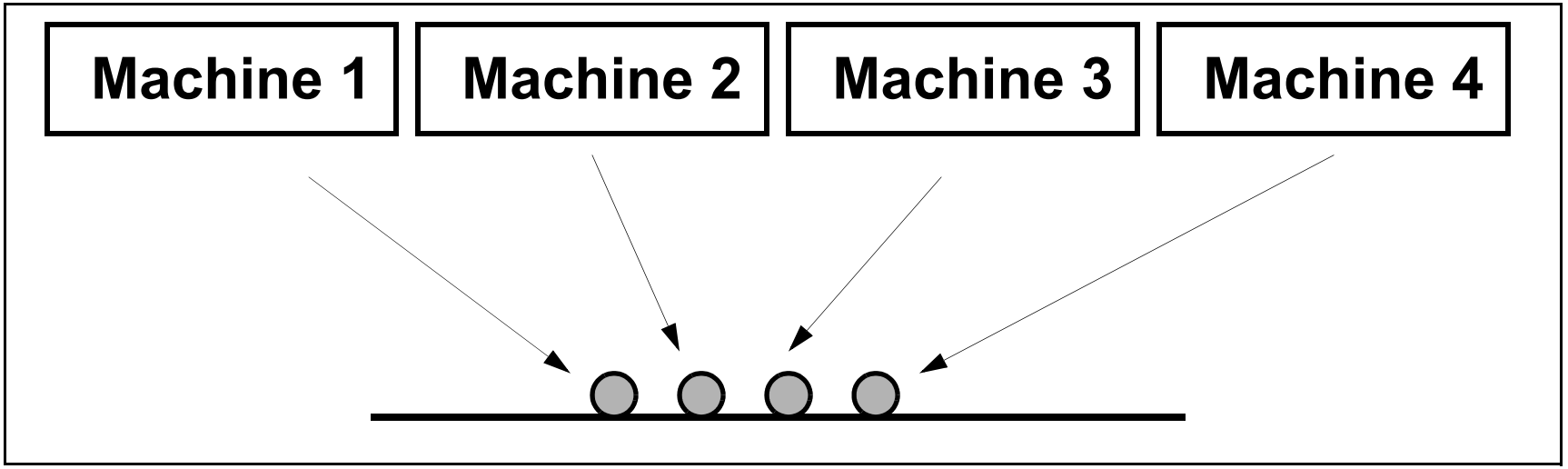
Distributed Sampling



Pitfalls in Subgroup Selection

- **Stratification**
- **Mixing**

What is Stratification??



Stratification

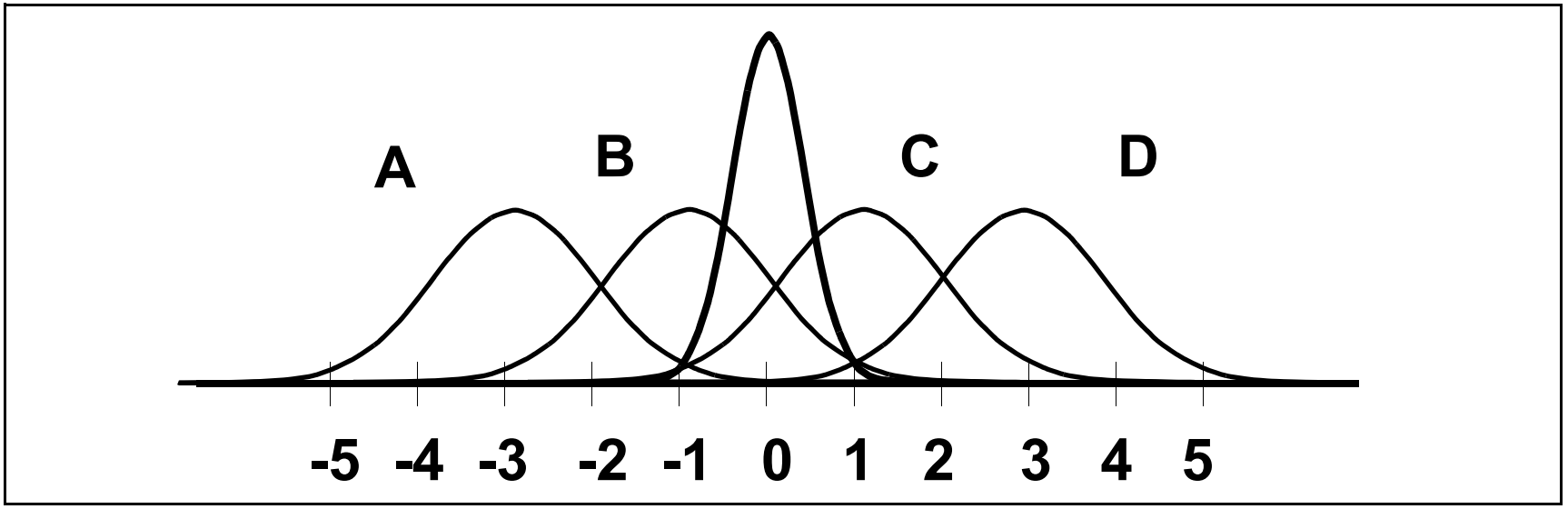
How can it occur??

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**

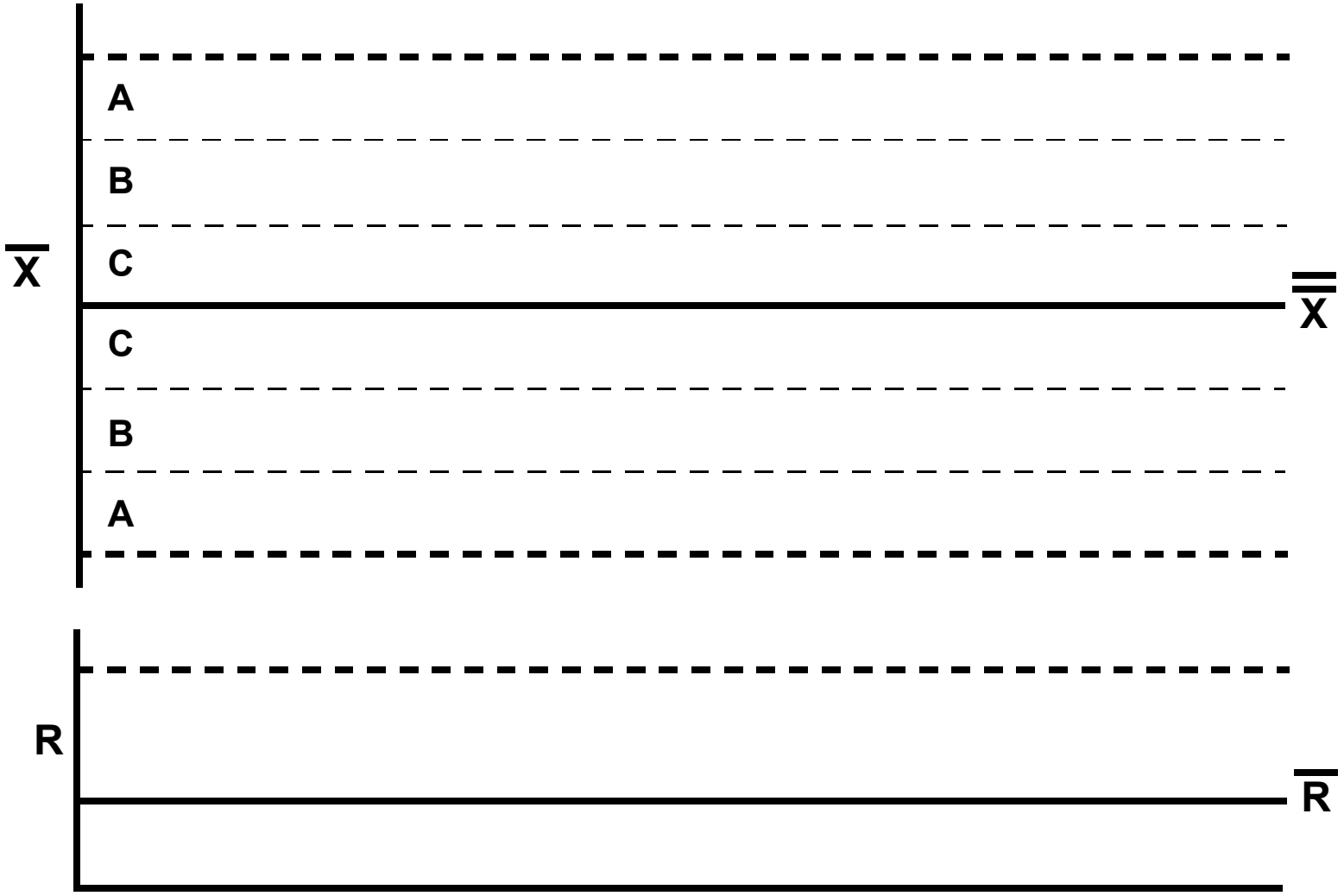
3. **Shortcut SPC application by taking representative sample across several machines**

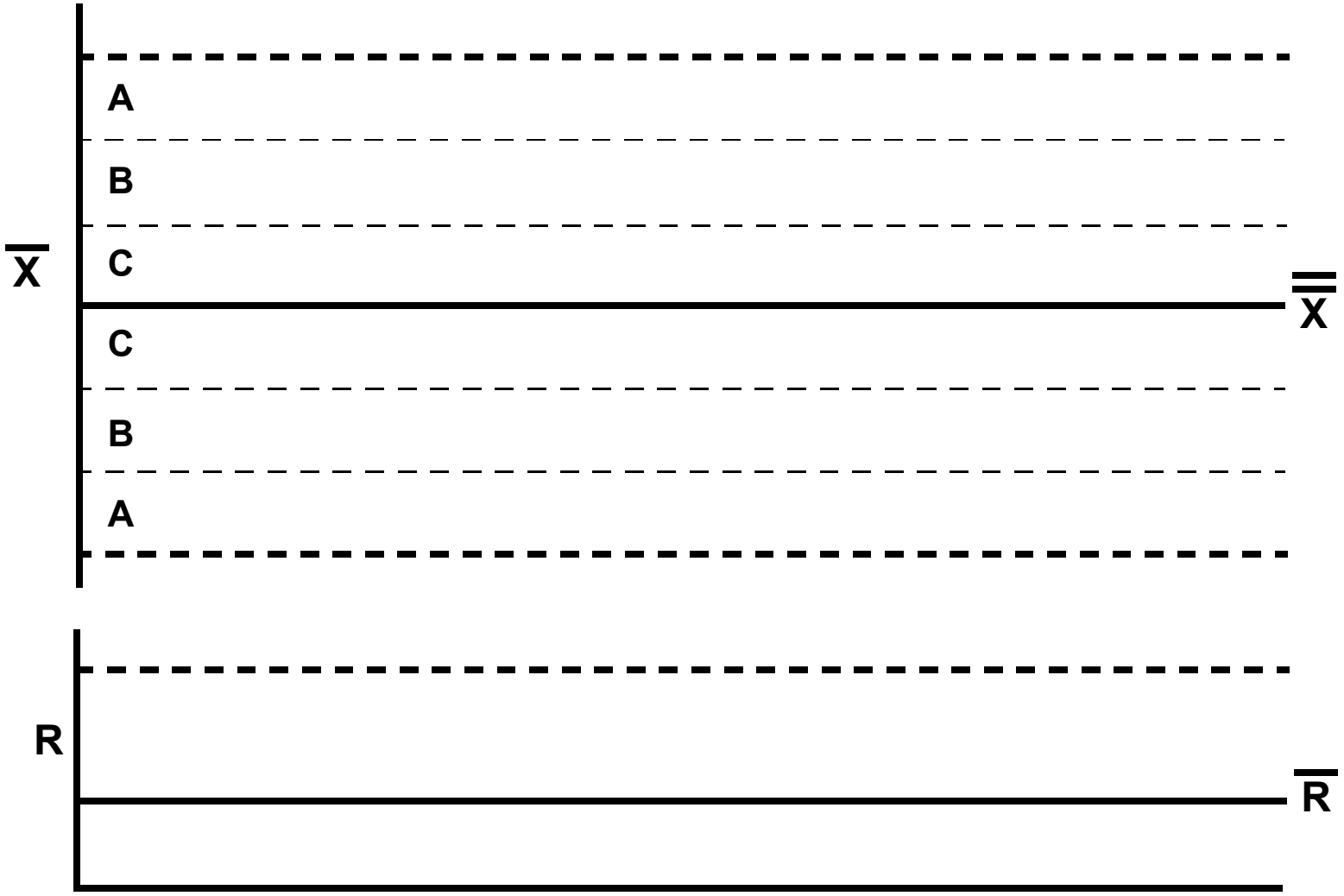
Stratification Example



From the figure $\sigma_X = 1$

Based on ranges, $\hat{\sigma}_X = \bar{R}/d_2 = 6/2.059 \approx 3$


A
B
C
$\overline{X}$
$\overline{\overline{X}}$
C
B
A
R
$\overline{R}$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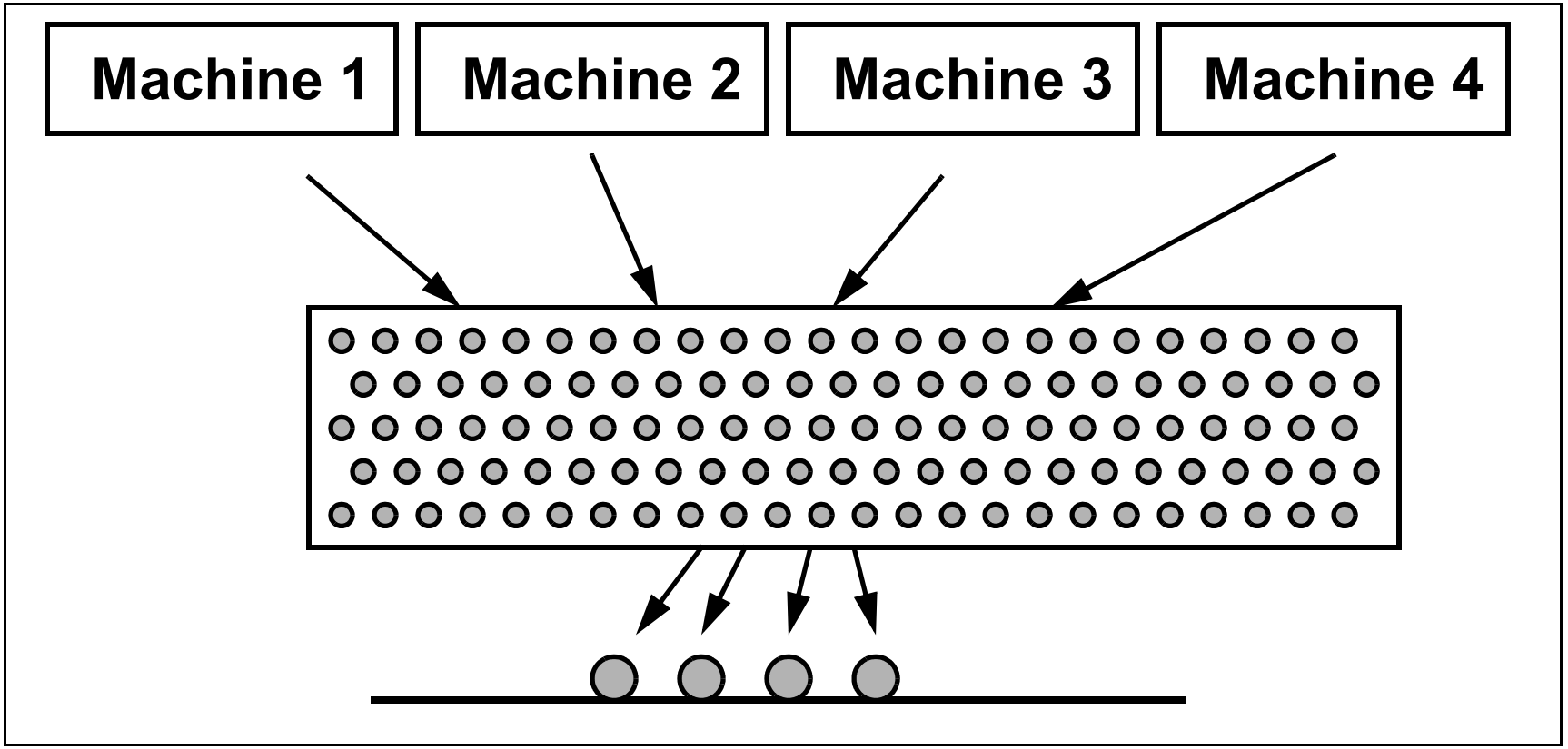
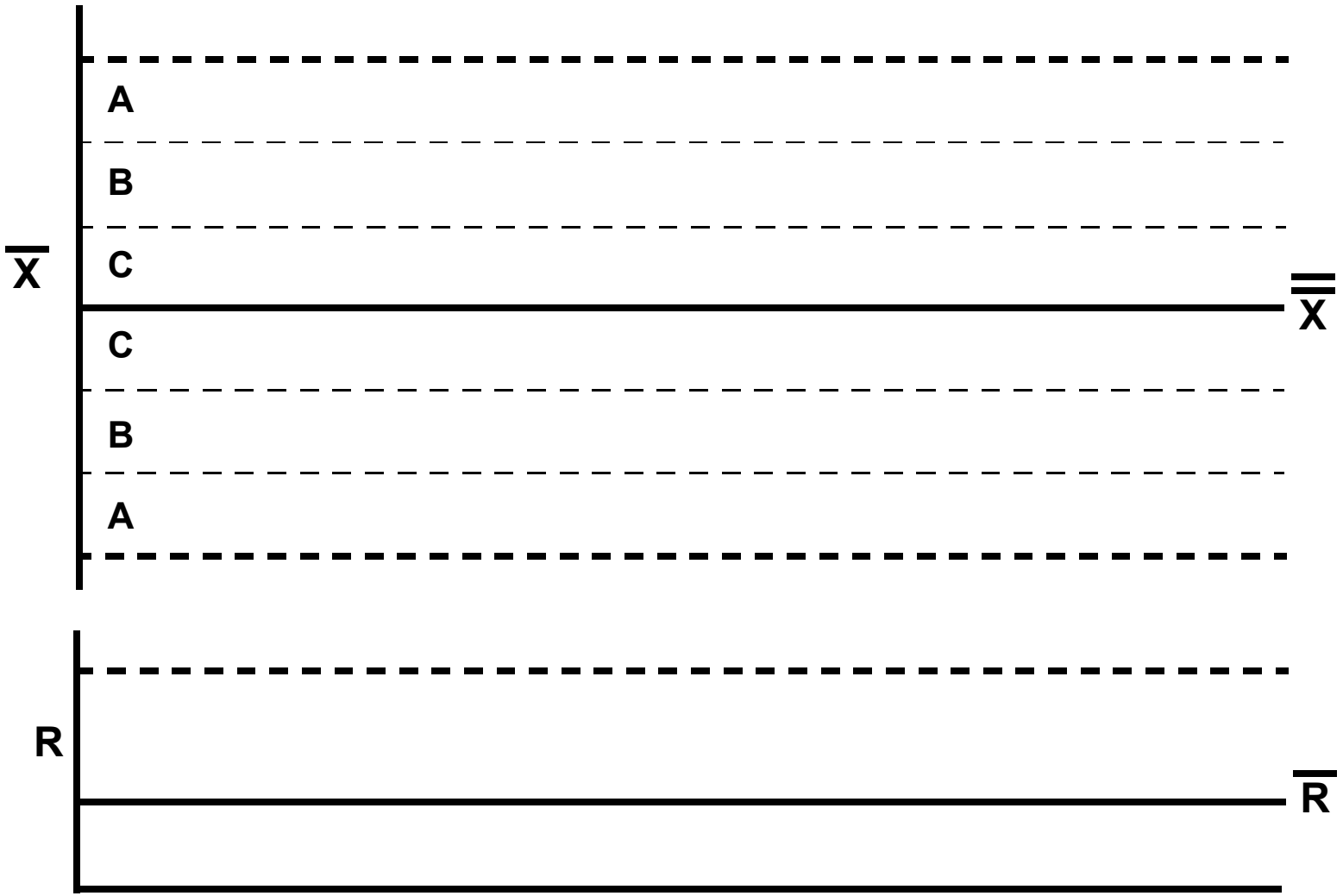
Mixing

What is Mixing??




A
B
C
$\overline{X}$
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C
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A
R
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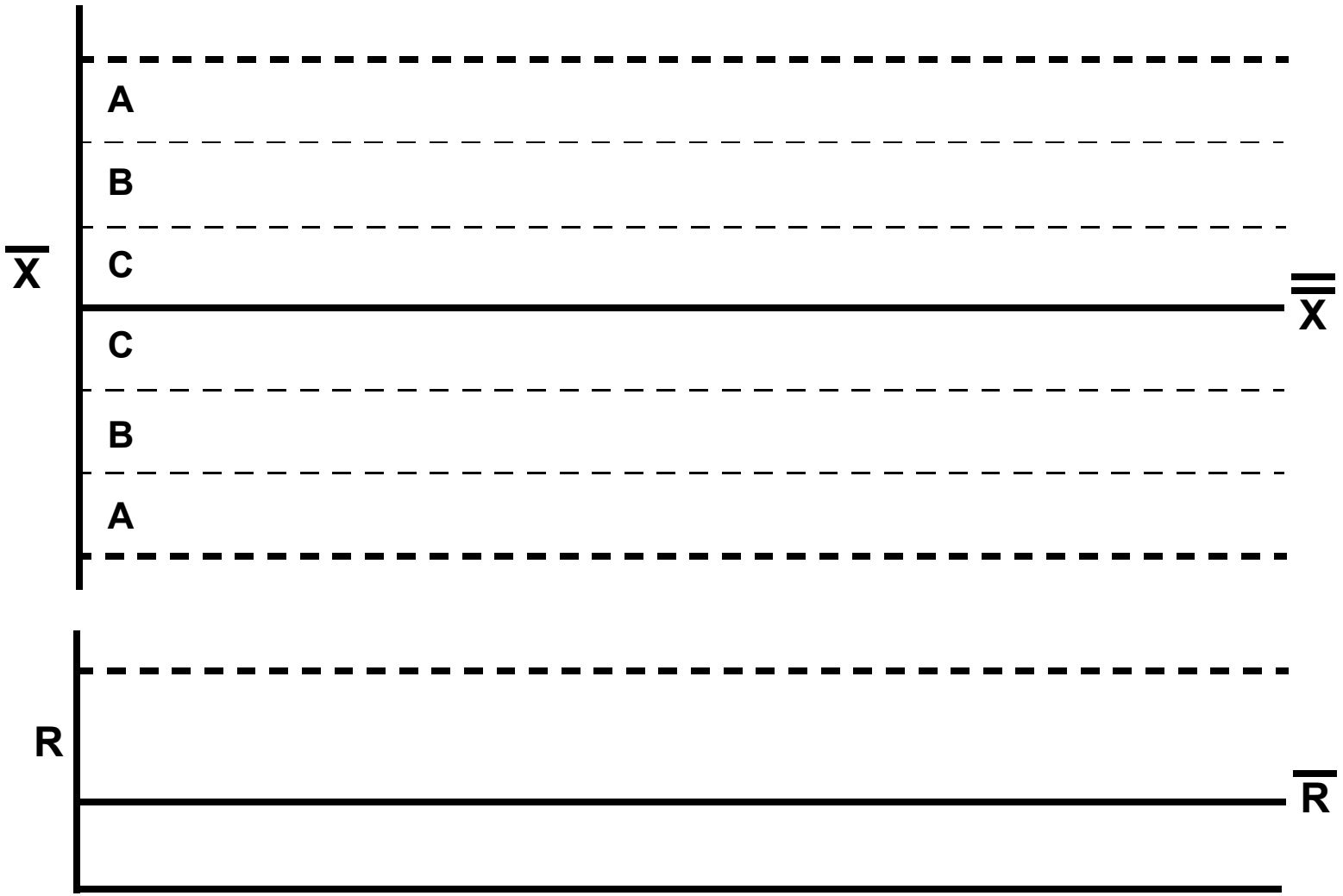
A
B
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C
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A
R
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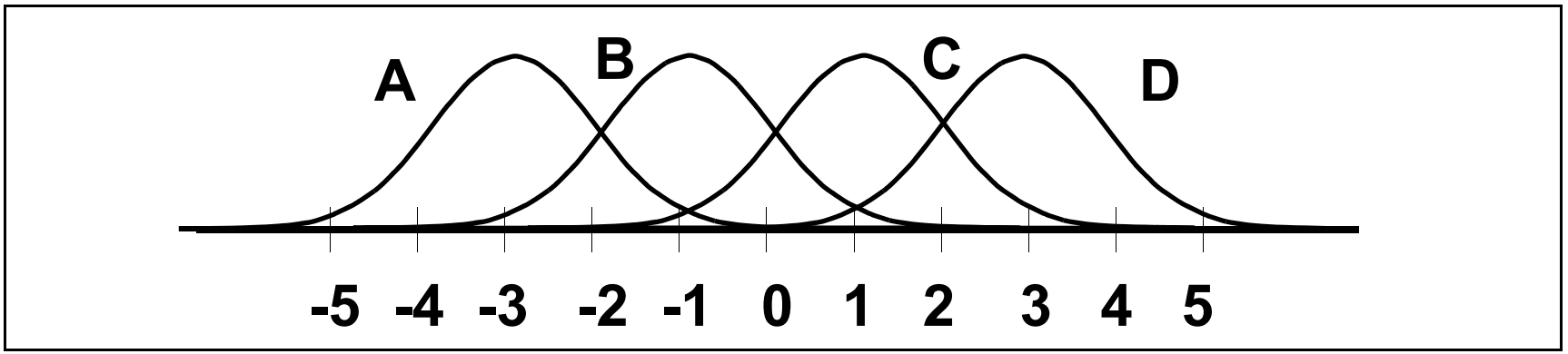
Summary

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