SNS COLLEGE OF TECHNOLOGY

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF MECHANICAL ENGINEERING

COURSE NAME : 16MEOE2 NEW PRODUCT DEVELOPMENT

III YEAR /V SEMESTER

Unit 2 – Concept Generation and selection

Topic : Design for Robustness

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What is Robust?

- A system (product or process) is robust if it performs properly in a wide range of conditions

Robust products

- A pen that writes until the ink is empty
- A car that starts at -20°
- A vacuum cleaner that maintains suction levels
- A TV that lasts 10 years with no need for repair

Products that are not robust

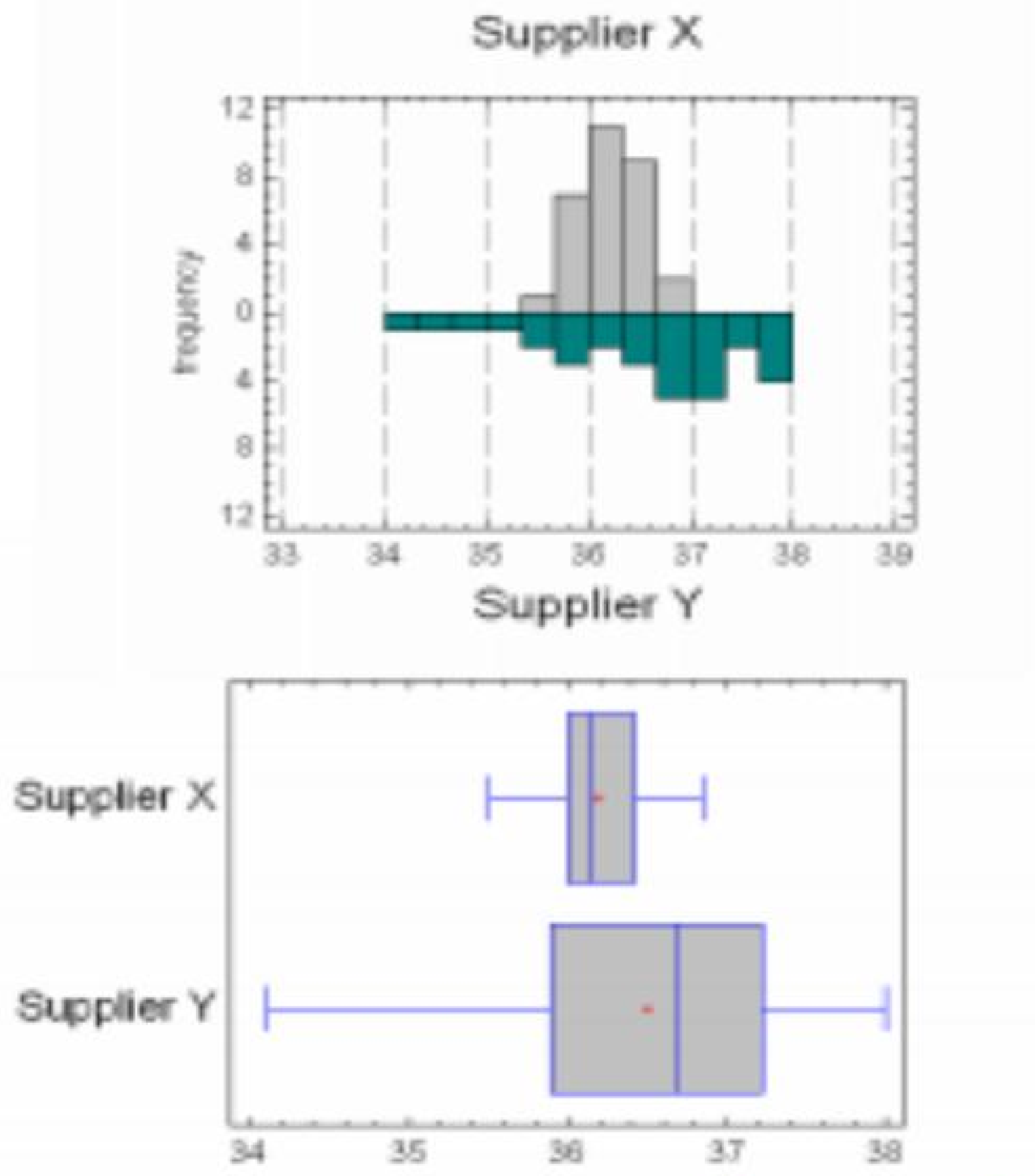
- A pen that stops writing after a few months
- A car that does not start
- A vacuum cleaner that loses suction
- A TV that needs repair after 2 years

What is Robust Design?

- In the design of a new system, any activity can be called robust design, if it causes the system…
  - To have longer life (higher reliability)
  - To be more consistent from use to use
  - To be more consistent from product to product
  - To perform consistently as temperature and other conditions change
- General rules for robust design
  - Always identify critical characteristics (CTQs) that quantify customer satisfaction
  - Always look for ways to reduce variation in CTQs

Example: Supplier Selection

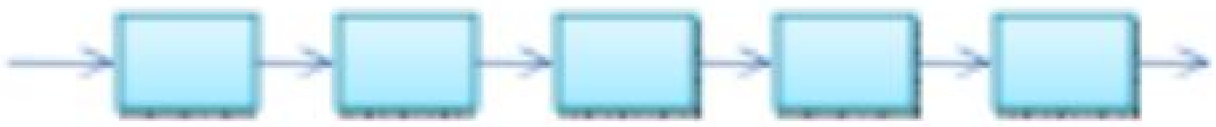
- Two suppliers, X and Y, make the same part to the same specifications
- A CTQ of the part must be within spec limits of 34.0 – 38.0
- A sample of 30 parts from each supplier are tested:
- Which supplier is the more robust design choice?



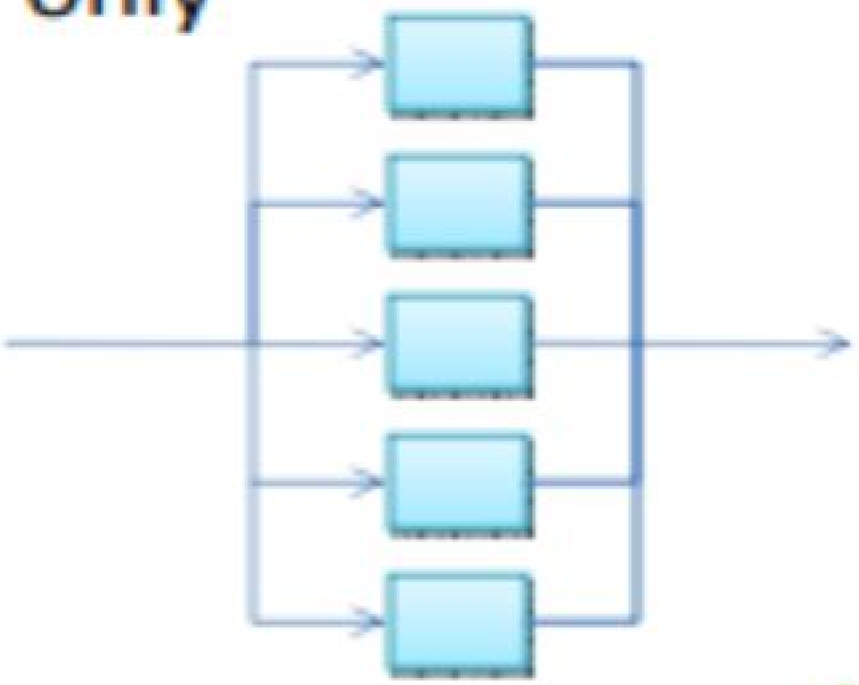
Example: Process Design

- A driver's license renewal process has five steps: data entry, skill testing, eye test, photograph, and cashier
- Customers vary widely, some requiring much more time to process than other customers
- Waiting time is CTQ
- Is a serial or parallel process the more robust design choice?

- Series process – each worker handles one task only



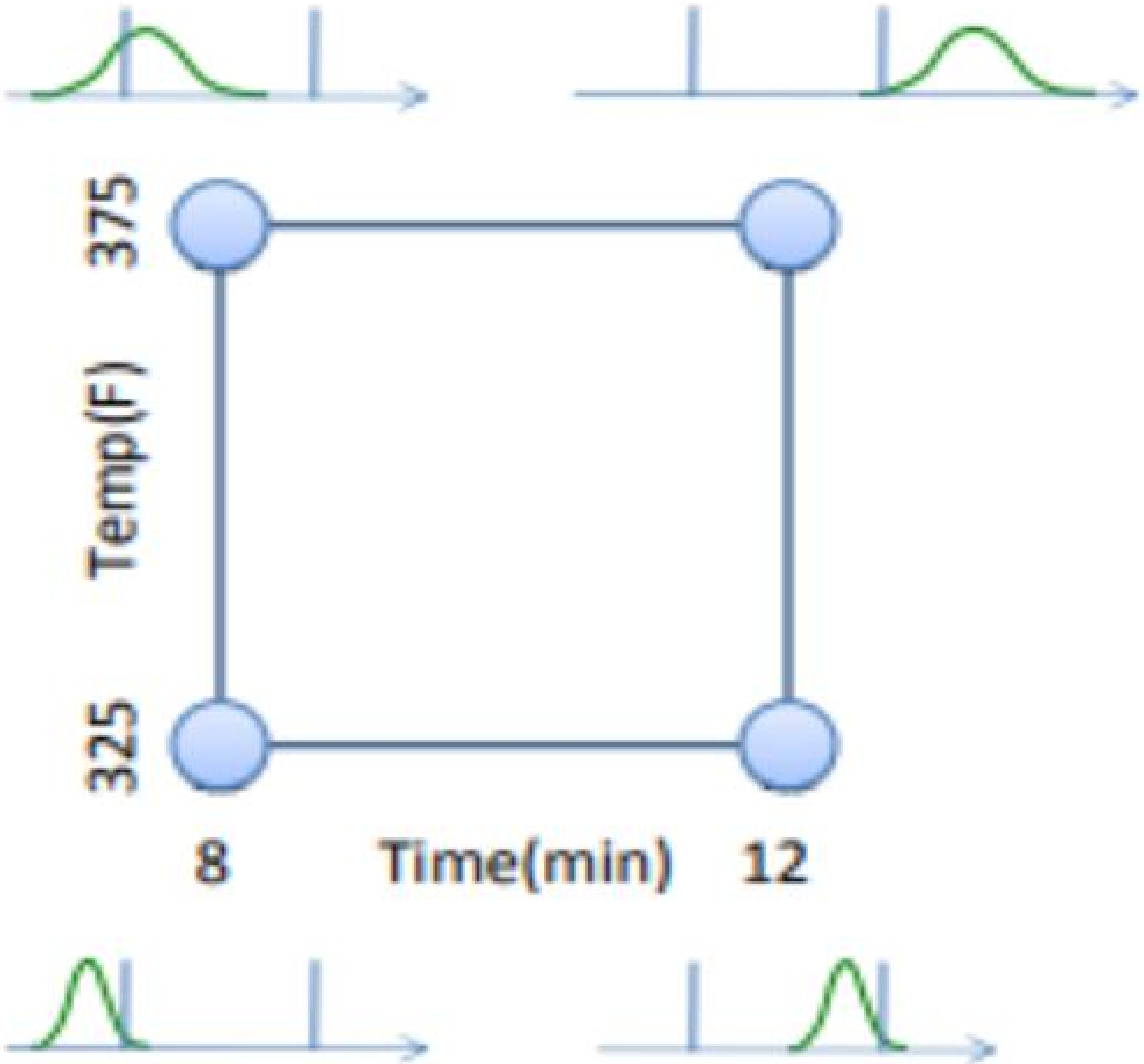
- Parallel process – each customer sees one worker only



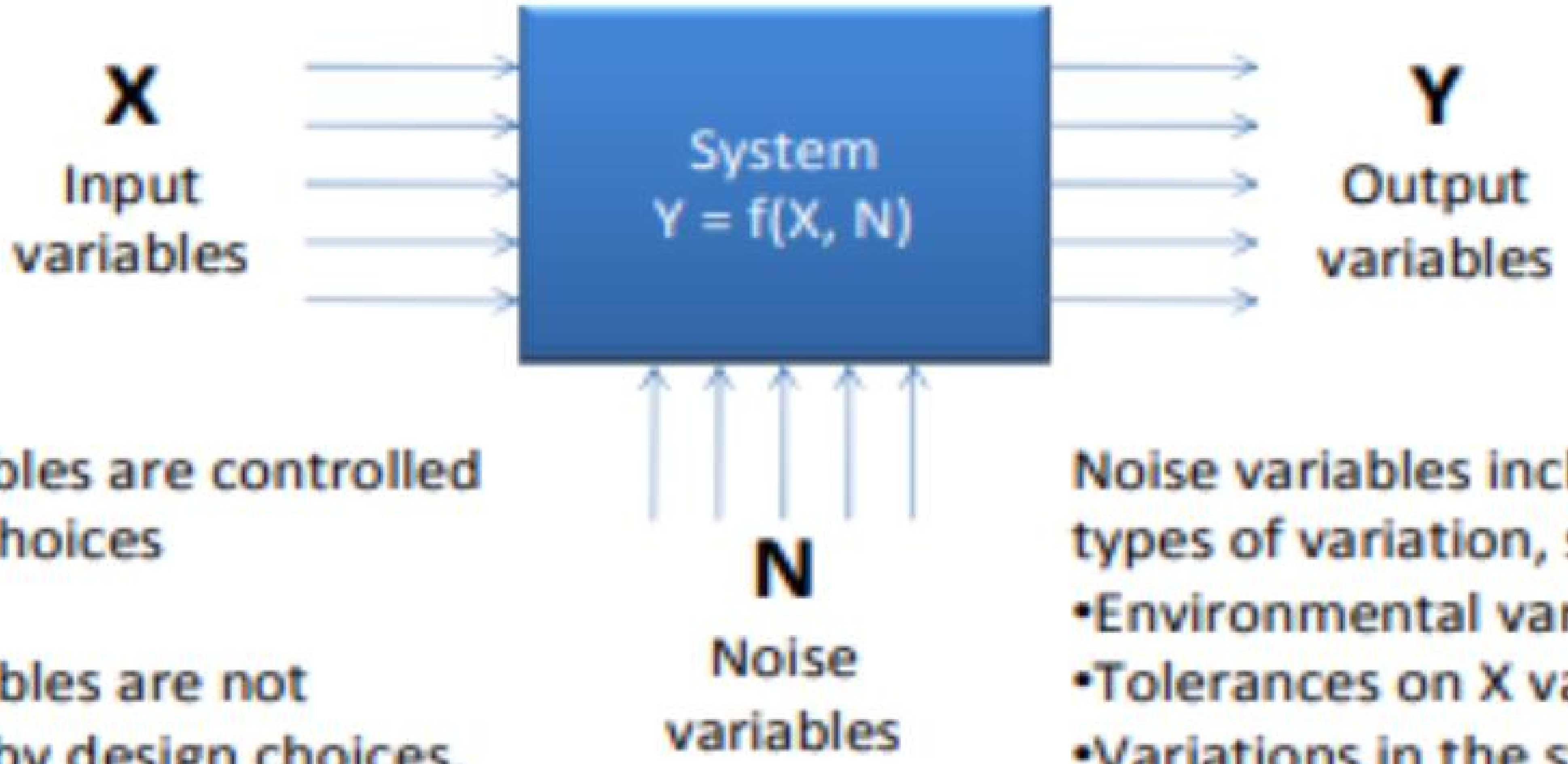
Example: Baking Cookies

- In an experiment to find the best recipe for baking cookies, several batches are made at 2 levels each of time and temperature
- Batches are graded by tasters on a Likert scale

- Based on the distributions shown, what is the best time and temperature?



Where Does Variation Come From?



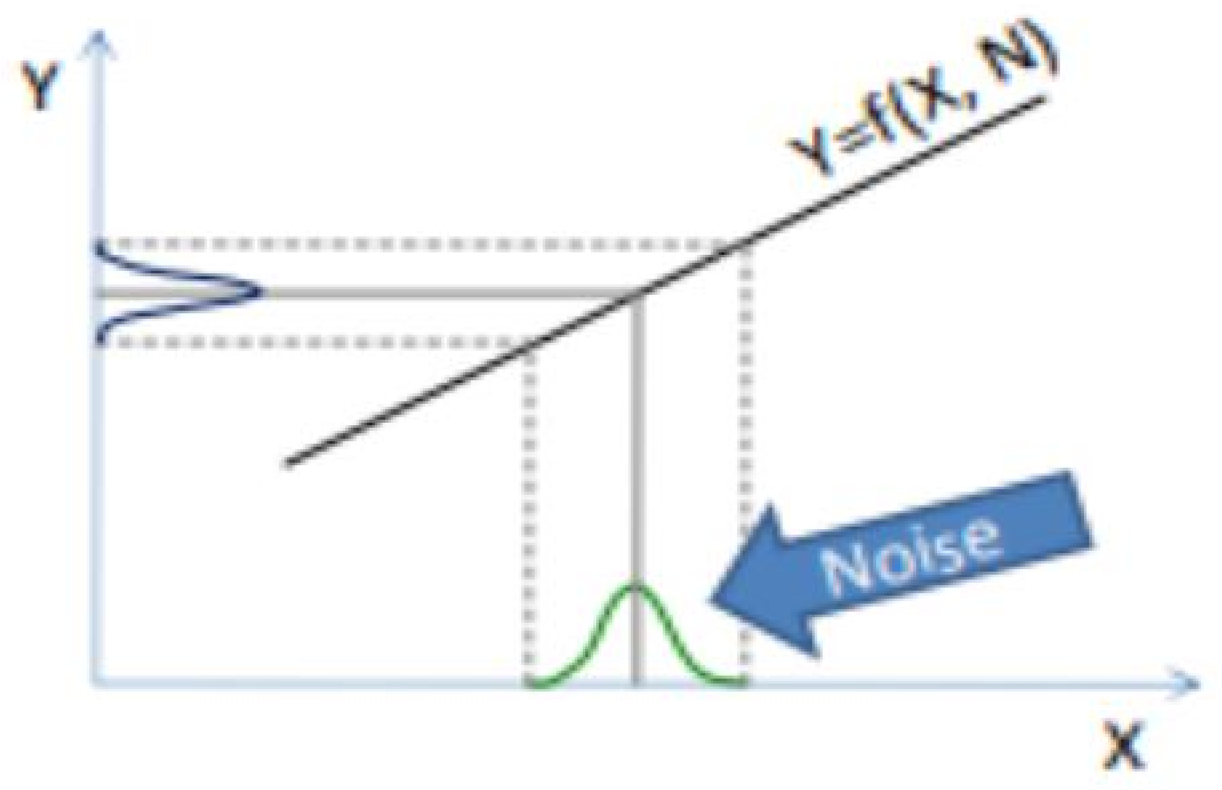
Input variables are controlled by design choices

Noise variables are not controlled by design choices, and will vary randomly

Noise variables include many types of variation, such as
- Environmental variables
- Tolerances on X variables
- Variations in the system
- Noise sources we choose not to control
- Noise sources we can not control
- Unknown noise sources

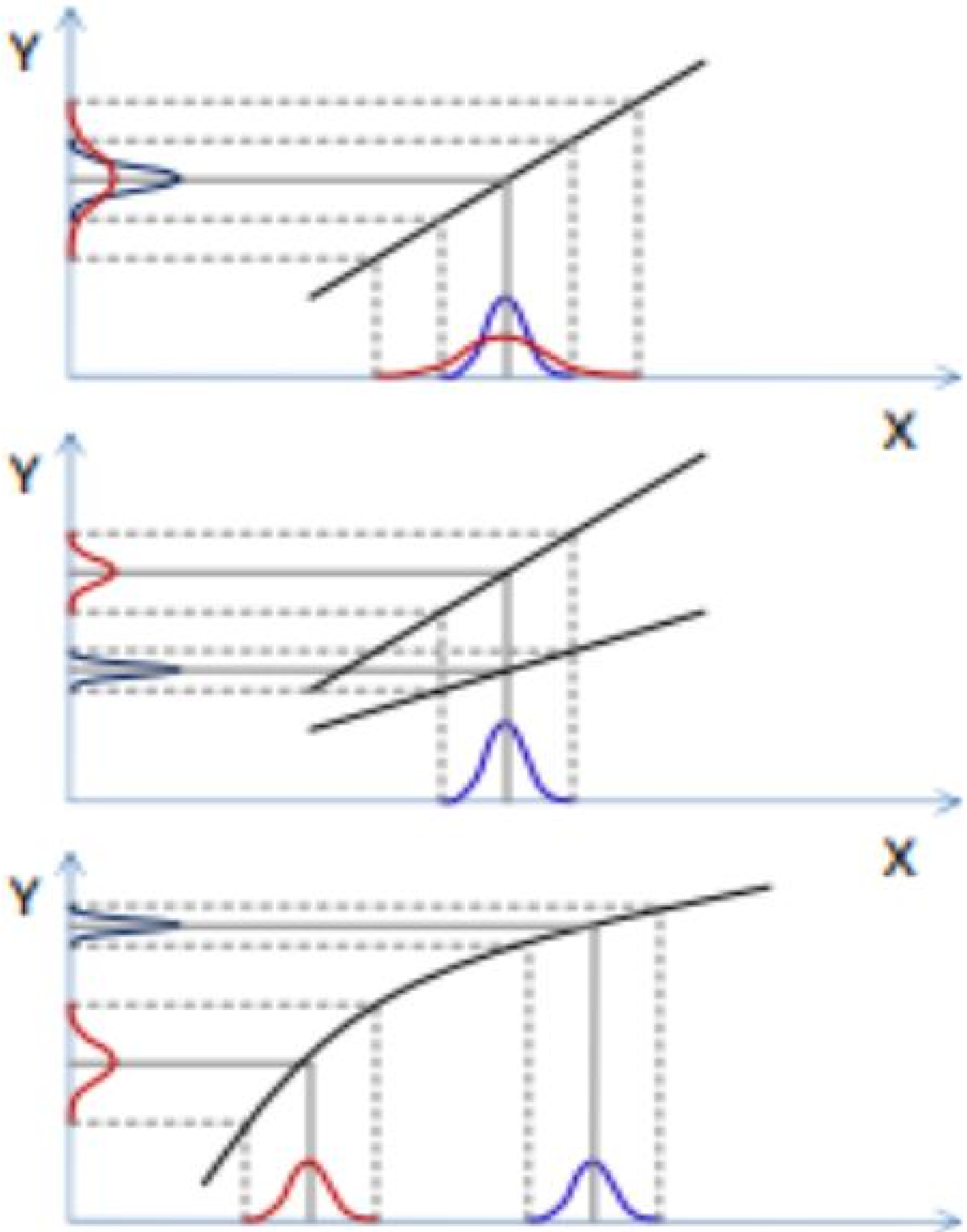
Variation Flows Through the System

- Variation caused by noise variables (N) combines with input variables (X), reflects through the transfer function f(X,N), and appears as variation in output variables (Y)
- To reduce variation in Y, our choices are either
  - Reduce the variation of noise variables
  - Change the transfer function to have a flatter slope



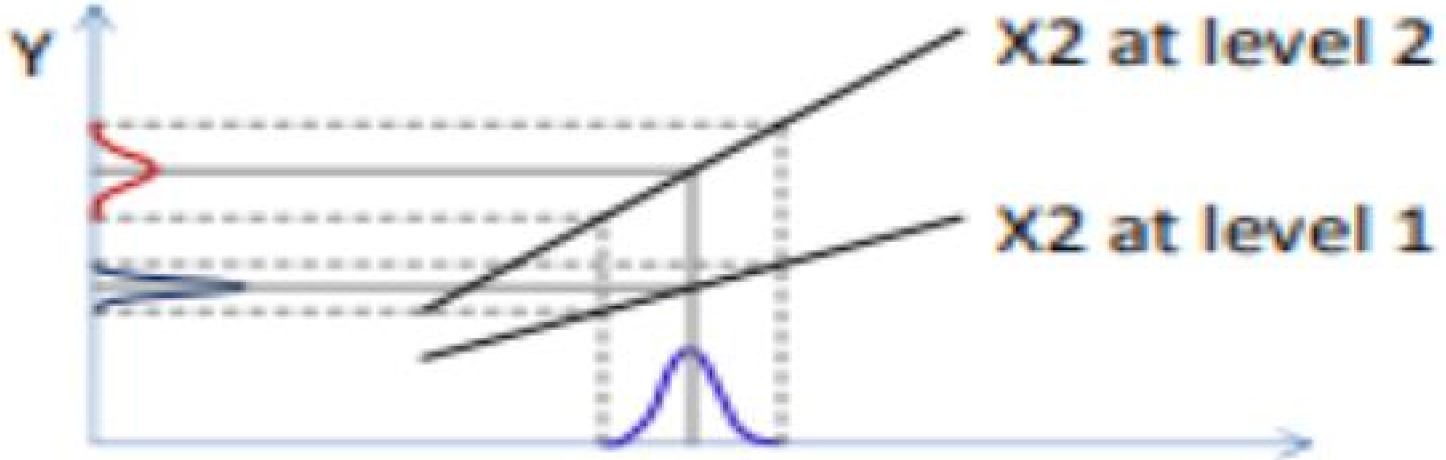
Three Ways to Reduce Variation in Y

- There are only three ways to reduce variation in Y:
- Noise reducers: design choices that reduce the variation of noise
- Interactions: design choices that reduce the slope of the transfer function
- Nonlinear effects: when the transfer function is curved, use a flatter portion of the curve



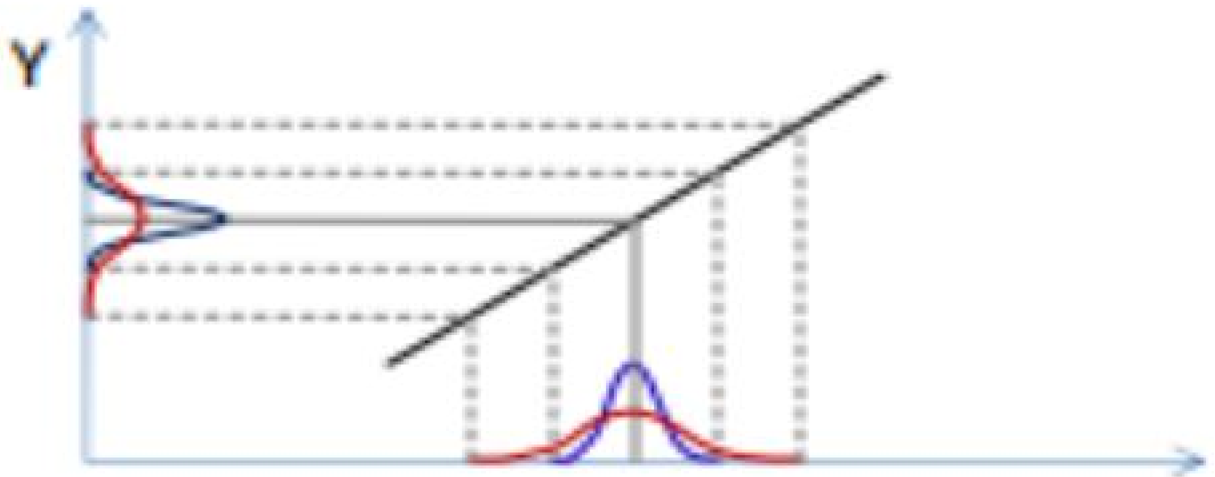
Interactions

- An interaction occurs when one factor alters the response of the system to changes in a different factor
- If an interaction makes the slope of the transfer function flatter, this is an opportunity to make the system more robust



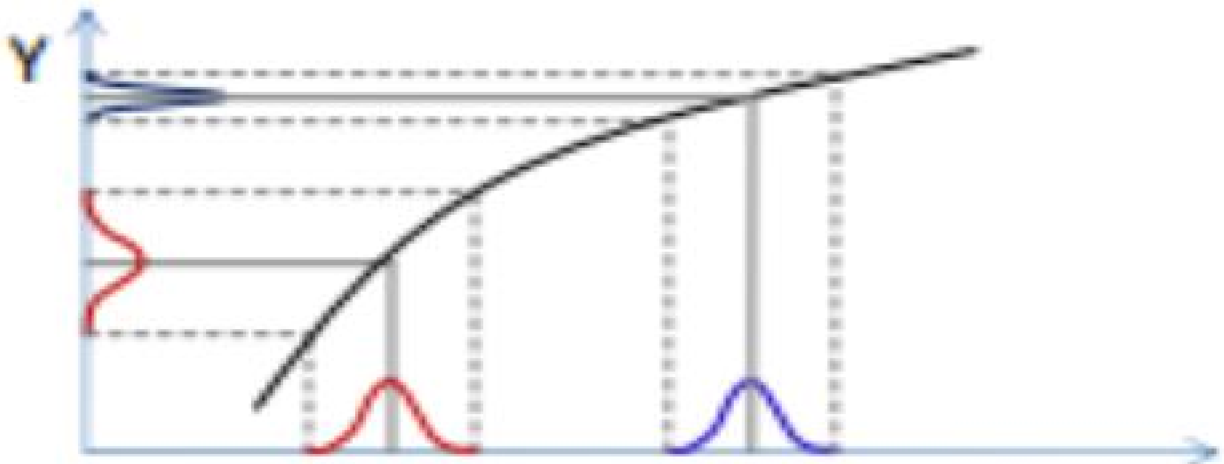
Noise Reducers

- The two-sample examples shown earlier are examples of noise reducers
  - Between suppliers X and Y, supplier X ships parts with less variation. Choosing supplier X will make our product more robust
  - In the driver's license process, my waiting time depends on the variation of customers who came before me. Having parallel paths reduces the impact of earlier customers on my waiting time
- Always examine the variation of many parts or units flowing through a process



Nonlinear Effects

- Many systems are naturally nonlinear
- If a nonlinear effect creates a flatter spot in the transfer function, this is an opportunity to make the system more robust
- Sometimes a second factor can be used to adjust the mean back to its target value



Robust Design

- Robust design can be complicated … but why?
- Measure variation at every opportunity
  - Measure quantitatively, not pass-fail
  - Replicate experiments
  - View graphs of the sample distribution, and calculate measures of variation
  - Look for opportunities to reduce variation
- Design experiments for robustness
- Look at graphs and think – don’t just rely on the optimizer
- Design systems for the flatter portions of the transfer function


Thank You