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QUALITY MANAGEMENT 444

Lecture 17 (Week 9)

Chapter 24 – Inspection, test and measurement

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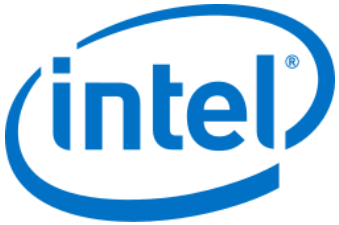
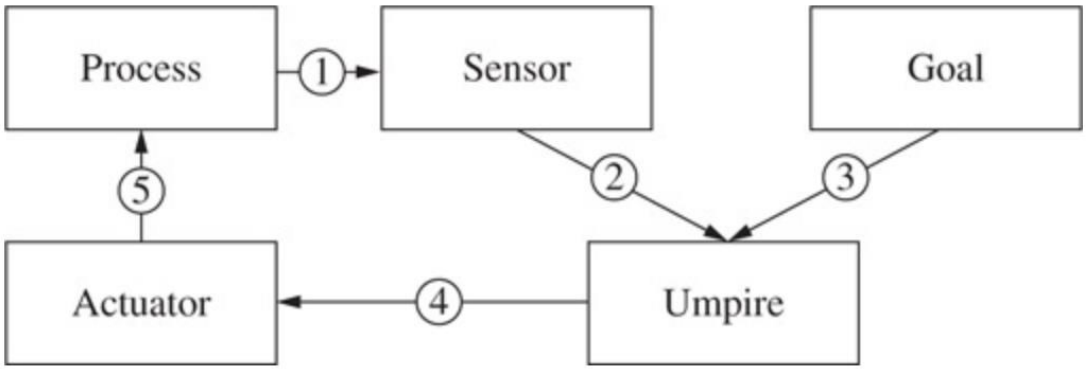
Inspection and testing



Inspection and testing

- Inspection and test typically include **measurement of an output** and **comparison to specified requirements** to **determine conformity**
- Inspection and test activities ensure that manufactured products, individual components, and multicomponent systems are **adequate for their intended purpose**
- Inspection and testing are the operational parts of **quality control**



Inspection and testing

- Distinction between **inspection** and **testing** has become blurred

- Inspection
  - Activity of ***examining the product or its components*** to determine if they meet the design standards
  - Typically under static conditions
  - Visual or destructive or series of (complex) measurements
  - Determine ***conformance to a standard*** (UCL/LCL)

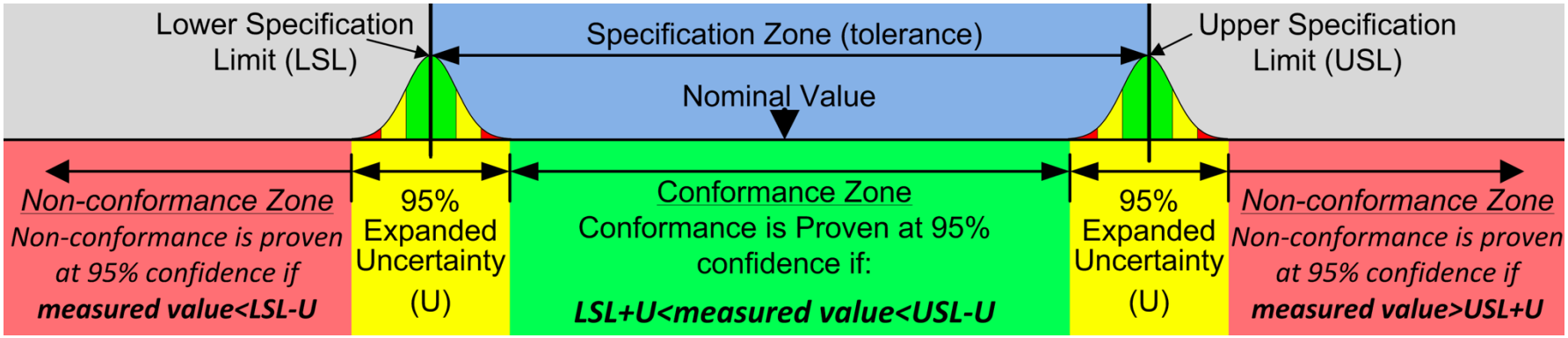
- Testing
  - Procedure in which the item is observed ***during operation*** in order to determine whether it functions properly for a reasonable period of time
  - Performed on more ***complex items*** such as subassemblies or systems
  - Determine ***conformance to functional specification***

Why do we inspect and/or test products?

- *Purpose of inspection and testing =* ***Product Acceptance***
  - 'Product' can mean discrete unit, a collection of units (a lot), a bulk product (tank of chemicals) or a complex system
  - 'Product' can also mean a service, such as bank transaction or performance of airline check-in

- ***Product acceptance*** *based on its quality, involves 3 decisions:*
  - *Conformance.* Judging whether the product conforms to specification.
  - *Fitness for use.* Deciding whether nonconforming product is fit for use.
  - *Communication.* Deciding what to communicate to insiders and outsiders.

Conformance & non conformance



Fitness-for-use decision

Who will the user be?
How will the product be used?
Are there risks to human safety or to structural integrity?
What is the urgency?
What are the company's and the users' economics?
What are the users' measures of fitness for use?

Table 24.1 Sources of Information

Input	Usual Sources
Who will the user be?	Marketing
How will this product be used?	Marketing; client
Are there risks to human safety or to structural integrity?	Product research and design
What is the urgency?	Marketing; client
What are the company's and users' economics?	All departments; client
What are the users' measures of fitness for use?	Market research; marketing; client

Communication decision

1. *Communication to "outsiders".*
(Usually customers) who have a right and a need to know.

2. *Communication to insiders.*
When nonconforming goods are shipped as fit for use, the reasons for doing so are not always communicated to inspectors and especially not to production workers.

Disposition of nonconforming product

Do not ship?

- *Rework*
- *Scrap*
- *Return to supplier*
- *Downgrade*

Ship?

- *Waiver by the designer*
- *Waiver by the customer*
- *Waiver by the quality department*
- *Waiver by a formal material review board*
- *Waiver by upper managers*

Corrective action?

- *Sporadic change*
- *Chronic condition*

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Inspection planning

Where to do inspection:

- *Receipt of goods*
- *Setup approval / following the setup of a production process*
- *During critical or costly operations (process inspection)*
- *Between departments*
- *Prior to shipping*
- *Before an irreversible path*
- *At natural windows*

>> does this sound familiar?

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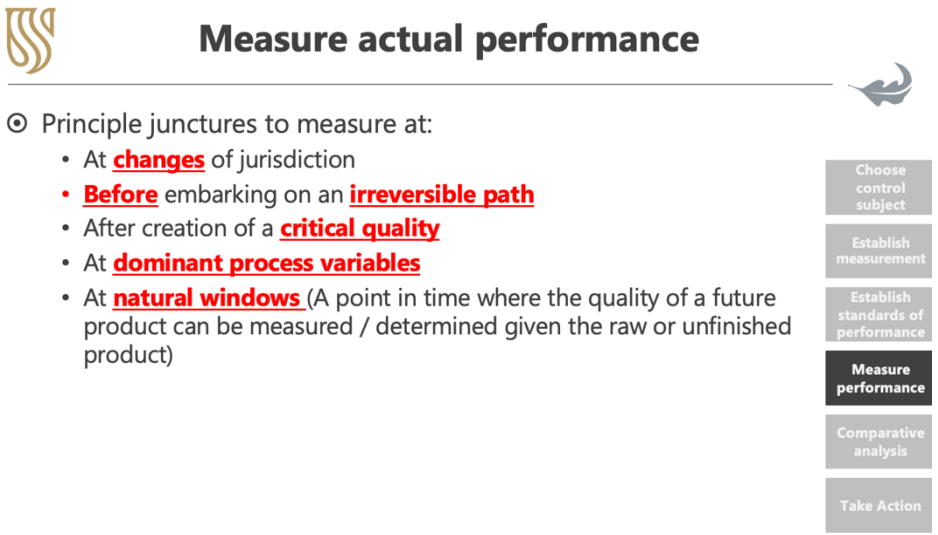


Choosing & interpreting quality characteristics

- ***Quality characteristics*** are to be checked at inspection stations
- ***Vital few*** product or process characteristics for inspection
- ***Product specifications*** are prepared by comparatively few people, each generally aware of the needs of fitness for use. In contrast, these ***specifications must be used by numerous inspectors and operators***, most of whom lack such awareness.

Bridging the gap

- By providing inspection and test environments that ***simulate the conditions of use***
- By providing ***supplementary information*** that goes beyond the specifications prepared by product designers and process engineers
- By helping ***to train inspectors and supervisors*** to understand the conditions of use and the ***"why"*** of the specification requirements.
- By providing ***seriousness classification***

Detailed inspection planning

Part Number: XXXX **Part Name: YYYY**

Process	Characteristics	C_p[1] Index	C_{pk}[1] Index	Frequency[2]	Sample size[2]	Analysis methods	Out-of-control conditions are encountered[4]
Incoming inspection	Stock thickness	1.6	1.0	Every shipment	—	Review control charts provided with each lot	Impound lot—contact supplier for resolution
In-process inspection	Thickness	1.9	1.1	Every 1000 parts	2 pieces	Micrometers/$\bar{X}$ and s chart	Correct process
	Width	1.5	1.4	Every 10,000 parts	5 pieces	Micrometer/median chart	Correct process
	Length	1.6	1.2	Every 4 hours	75 pieces	Tapered ring gage/p chart	Correct process
Assembly area	Thickness	2.0	1.8	Hourly	30 pieces	Special gage/p chart	Correct process
	Width	2.2	1.9	Chart hourly	100%	Automatic tester/u chart	Repair by responsible operator
Outgoing[3]	Complete assembly	2.8	1.9	Hourly	20 pieces	Automatic tester/$\bar{X}$ and s chart	Correct process
	Complete assembly	NA	1500 DPM	Each lot	50 pieces	Complete visual inspection plus gage and test stand/c chart	Reject lot and sort for identified nonconformance

[1]Explanations and formulas are contained in the SPC Guideline.
[2]The frequencies and sample size are determined from the performance study of the stability of each process. They are periodically reviewed and updated as required.
[3]After 6 months production experience, the process control and inspection records will be reviewed to determine if outgoing inspection can be reduced.
[4]If any nonconforming products are found in the process samples, then there will be performed 100% inspection of all products produced since the last in control point.

Seriousness classification

Quality characteristics are decidedly unequal in their effect on fitness for use

1. Decides how many classes or strata of seriousness to create (usually three or four).
2. Defines each class.
3. Classifies each characteristic into its proper class of seriousness

Defect	Effect on Consumer Safety	Effect on Usage	Consumer Relations	Loss to Company	Effect on Conformance to Government Regulations
Critical	Will surely cause personal injury or illness	Will render the product totally unfit for use	Will offend consumers' sensibilities due to odor, appearance, etc.	Will lose customers and will result in losses greater than value of product	Fails to conform to regulations for purity, toxicity, identification
Major A	Very unlikely to cause personal injury or illness	May render the product unfit for use and may cause rejection by the user	Will likely be noticed by consumers and will likely reduce product salability	May lose customers and may result in losses greater than the value of the product; will substantially reduce production yields	Fails to conform to regulations on weight, volume, or batch control
Major B	Will not cause injury or illness	Will make the product more difficult to use, e.g., removal from package, or will require improvisation by the user; affects appearance, neatness	May be noticed by some consumers and may be an annoyance if noticed	Unlikely to lose customers; may require product replacement; may result in loss equal to product value	Minor nonconformance to regulations on weight, volume, or batch control, e.g., completeness of documentation
Minor	Will not cause injury or illness	Will not affect usability of the product; may affect appearance, neatness	Unlikely to be noticed by consumers and of little concern if noticed	Unlikely to result in loss	Conforms fully to regulations

Inspection accuracy

Accuracy depends on:

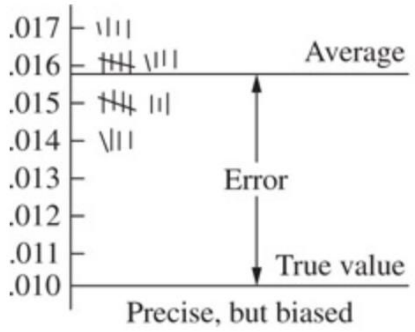
1. Completeness of inspection planning
2. The bias and precision of the instrument
3. Level of human error

Errors of measurement

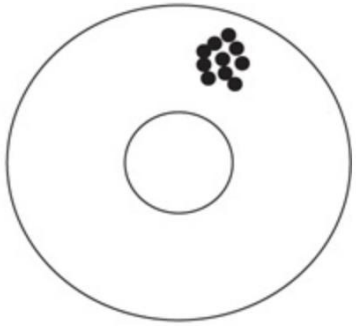
$$\sigma^2_{Total} = \sigma^2_{Process} + \sigma^2_{Measurement\ System}$$

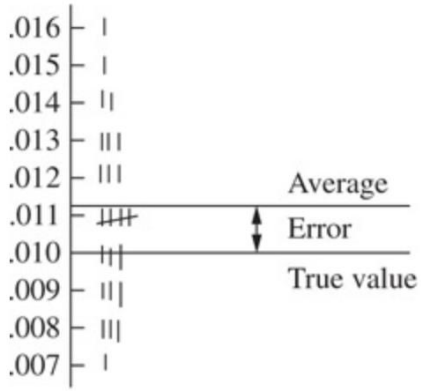
- All measurement systems have error
- If you don't know how much of the variation you observe is contributed by your measurement system, you can't make confident decisions

Errors of measurement

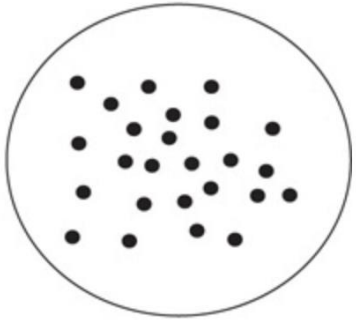


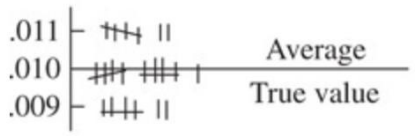
Precise, but biased



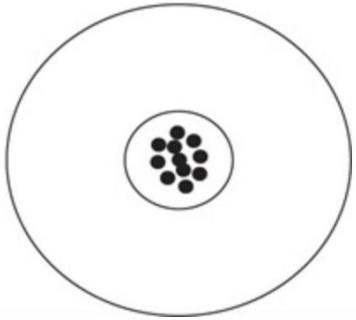


Unbiased, but not precise



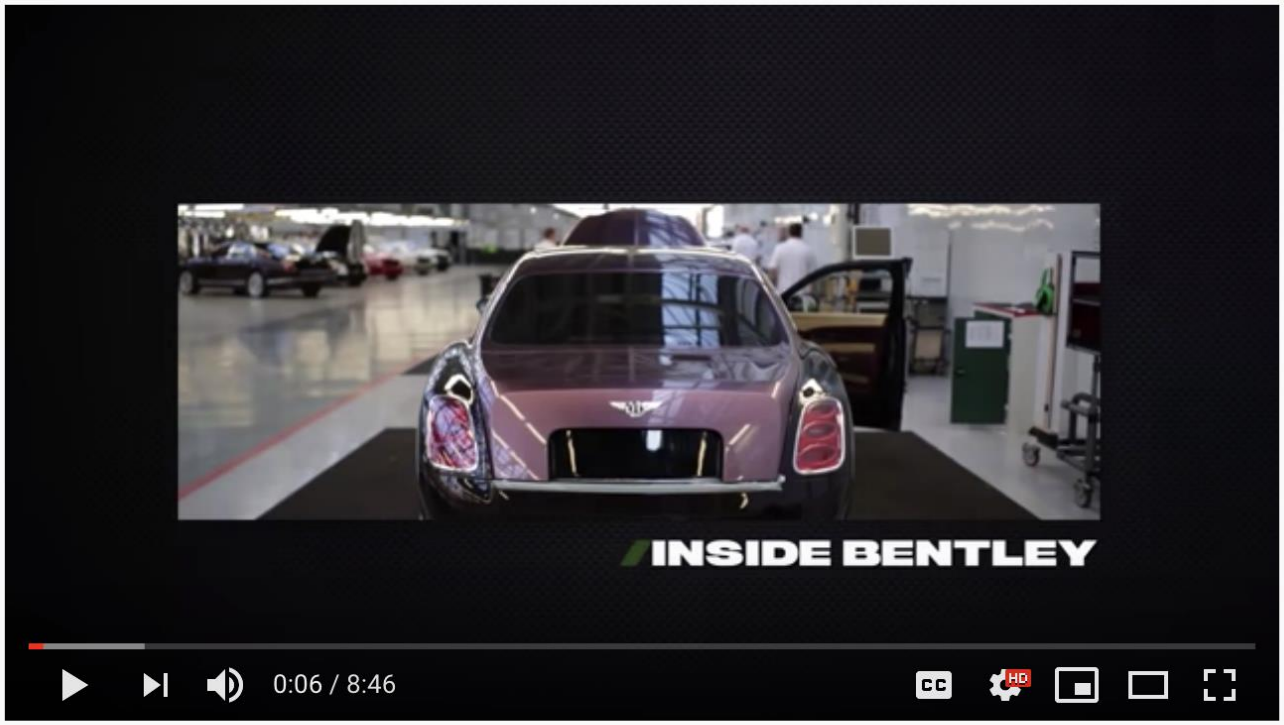


Unbiased and precise



- **Bias is also referred to as accuracy**
- **Precision** relates to the **Variance**

Inside Bentley



Mulsanne Quality Control - /INSIDE BENTLEY

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