Chapter 16

Taguchi Loss Function

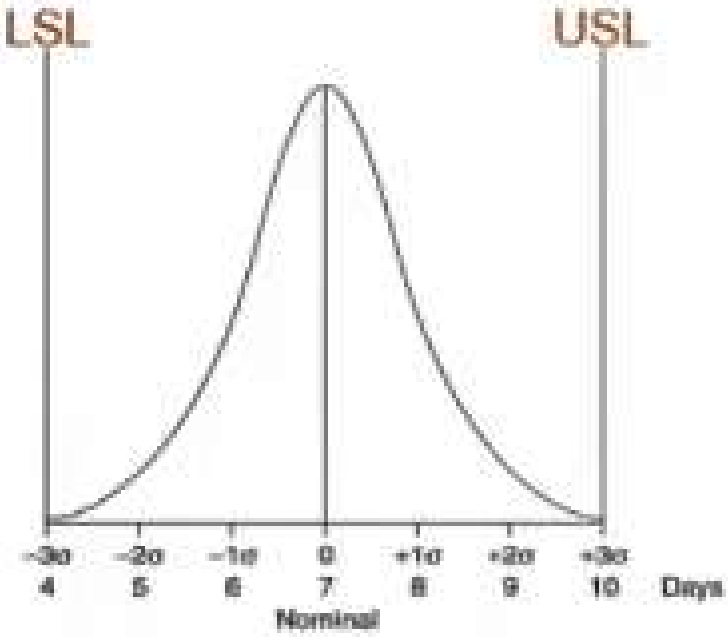
Dr. Md. Ahsan Akhtar Hasin
Professor
Industrial and Production Engineering (IPE)
BUET

16.1 Introduction

Traditionally, it is believed that any quality characteristics should be measured within a specification limit, which is to be set either by the designer, or by the customer.

But **Taguchi differs**.

Taguchi says that as soon as a quality characteristic departs from its exact mean or target (termed the 'nominal value'), performance starts deteriorating with increased customer dissatisfaction, although the measurements may be well within given specification limits.



Thus, departure from mean is a Quality Loss, because the part may require rework at extra time and cost, or may be totally rejected which is a loss in terms of time and material.

Taguchi expresses this quality loss as a quadratic function, known as ***Quality Loss Function (QLF)***. Deming defines QLF as - "a minimal loss at the nominal value, and an ever-increasing loss with departure either way from the nominal value" [W. Edwards Deming, "Out of the Crisis", p-141].

16.2 Inside History

Dr Genichi Taguchi, born in 1924, was a statistician.

He worked in different organizations – both public and private.

He took a position with Electrical Communications Laboratory of the Nippon Telephone and Telegraph (NTT), to increase the productivity of the R&D activities.

Academic life:

In the mid 1950's, he was Indian Statistical Institute's visiting professor.

He worked as the Visiting Research Associate at Princeton University in 1962.

The same year, he was awarded his PhD by Kyushu University.

He acted as Professor at Tokyo's Aoyama Gakuin University (1964 - 1982).

He was received many awards for his contribution in quality, including the prestigious Deming award (several times).

16.3 Quality Loss Function

Dr. Genichi Taguchi developed the idea of Quality Loss Function (QLF) in the 1970's.

Although Japanese companies widely accepted the idea and started applying it successfully and achieving benefits as well, Taguchi's Impact upon North American product design and manufacturing processes began considerably late, in November 1981, when Ford Motor Company requested that Dr. Taguchi to make a presentation.

His presentation inspired many American companies to adopt the idea. Besides Ford, many other famous companies, like Xerox, ITT, etc. are the early American pioneers to adopt his philosophy.

Dr. Taguchi stated that quality loss is a –
Loss to the whole society.

Taguchi suggests for a three stage product development:

1. System design stage –Basic elements of the design, such as the best combination of processes and materials.

2. Parameter design stage – Parameter design determines the most appropriate, optimizing set of parameters which will minimize variation from the target.

3. Tolerance design stage – At this stage, tolerances are designed appropriately, requiring a trade-off between -
   a) loss, when it goes beyond tolerance and,
   b) cost to maintain the tolerance.

Tolerances for less important parameters may therefore be opened up for cost reduction (related to Design of Experiments - DoE).

Taguchi suggested to minimize the influence of "*noise*" –

the factors those affect performance of operations and create variation.

Noises are the uncontrolled sources of variation.

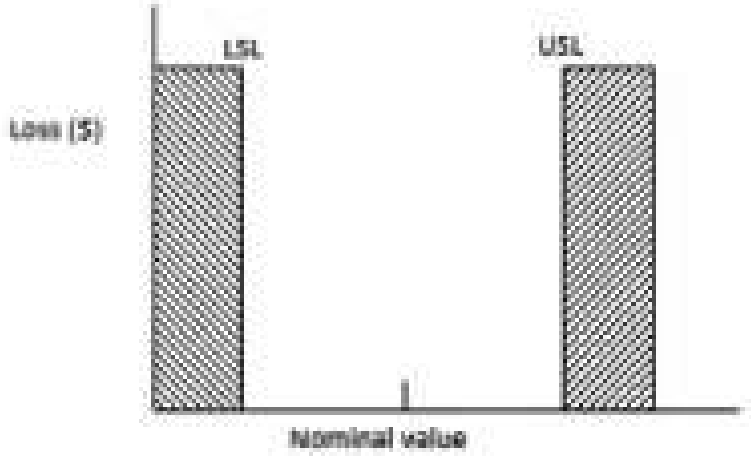
There are three kinds of noise factors:

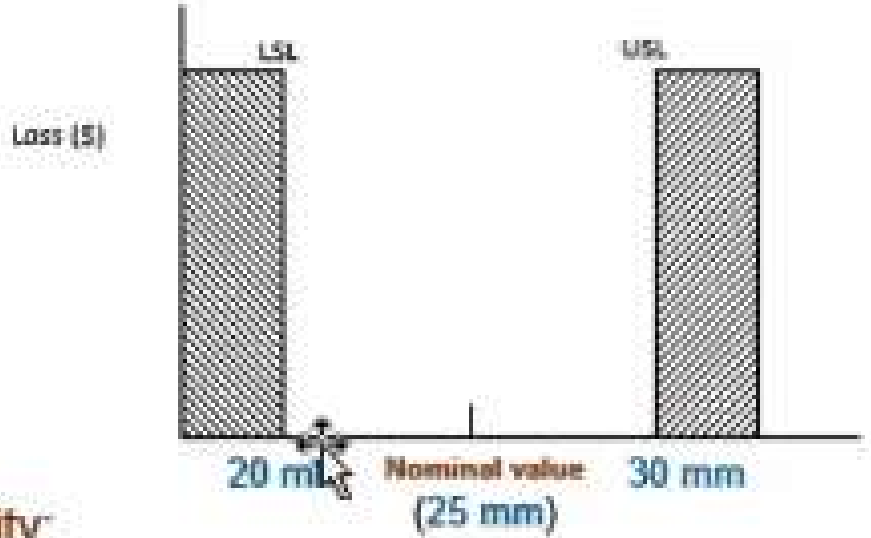
1. External noise factors: These are the environmental factors in which the product is produced or used. E.g. humidity, temperature, etc.

2. Internal noise factors: These are the factors that act from within the product. E.g. deterioration or physical depreciation with age or use, wear and tear, etc.

3. Unit-to-unit noise: Some uncontrollable factors create variation from one unit to another unit of product. E.g. variation in diameter, length, weight, amount, etc.

16.4 Traditional Goal Post View of Quality





An example of the goal post view of quality:

A medical surgeon needs to insert a medical device into the chest of a patient that is 25 mm in diameter (the nominal value), with ±5 mm tolerance.

Is it really true that diameters of 21, or 25, or 29 mm will give exactly the same feeling to a patient ?

If a medical device's diameter measures less than 20 mm or more than 30 mm, it is deemed as not conforming and scrapped at a cost of $1,000.00 per device.

Is it really true that diameters of 21, or 25, or 29 mm will give exactly the same feeling to a patient ?
No, Taguchi has a different view (see below):

Why in the 1980's did the doors of Japanese automobiles often sound better when they were closed than the doors of automobiles manufactured in America?

Answer:
The Japanese automobile manufacturers produce parts –

- close to nominal value
- and has less part-to-part variability.

The Americans don't.

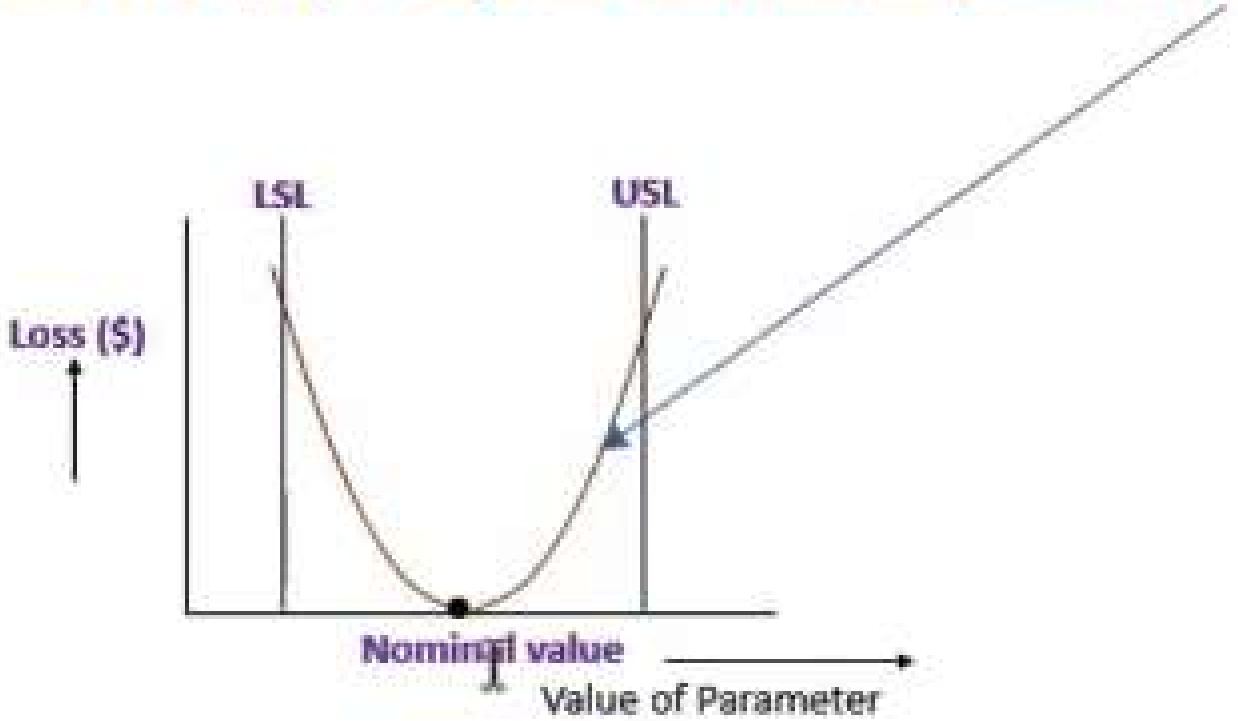
A higher quality sound is then possible since the clearance between mating parts is less, resulting in a tighter fit and better sound when the door is closed.

This is what Taguchi says.

16.5 Continuous Improvement View of Quality

The continuous improvement view of quality was developed by Genichi Taguchi.

The **Quality Loss Function (QLF)**, or **Taguchi Loss Function**, called the *Loss curve*.



Any departure from the nominal value results in a loss!

A study on performance of Sony television sets were performed which reported that –

the sets produced in the Sony factory in Japan are much preferred over those produced in the Sony factory in the USA, although both are using the same blueprint..