Various Types of Limit Gauges

- Cylindrical Pin Gauge
- Adjustable Snap Gauge
- Plain Ring Gauge
- Thread Plug Gauge
- Cylindrical Plug Gauge
- Progressive Cylindrical Plug Gauge
- Adjustable Thread Ring Gauge
This theory is the key to design of limit gauges, which defines the function (i.e. the form) of most limit gauges.

- **GO gauge** checks the Maximum Material Condition (MMC), and it should check as many dimensions as possible.

- **NOT-GO gauge** checks the Least Material Condition (LMC), and it should only check one dimension.

- **GO gauge is used to ensure that MMC is not exceeded.** Thus, it should be made to MMC based on wear and gauge tolerances, which are explained in the following sections.

- However, if NOT-GO gauge is made to both dimensions of LMC, a condition would arise where the width of work is within specified limits whereas the length is oversize. Such a gauge will not enter the work, and hence the work will be accepted although its length is outside the limits (see the figure). **Thus, a separate NOT-GO gauge** is required for each individual dimension.

- **NOT-GO gauge is always relatively shorter**, and approximately equal in length to the hole diameter. **GO gauge should be equal in length to about three or four diameters.** This would enable to check that the MMC is not exceeded due to geometric errors (e.g. straightness as illustrated in figure).
For a hole to be checked, **GO gauge** is a cylinder with diameter equal to the **minimum hole size** whereas **NOT-GO gauge** is a cylinder with diameter equal to the **maximum hole size**. It is vice versa for a shaft to be checked.

However, it is not simple due to the fact that limits of size are required for work which states that **nothing can be made to an exact size, including gauges**.

The gauge maker needs a tolerance to which gauges may work. So, defining the **gauge tolerance relative to the nominal gauge size** is critical.

For instance; when the gauge tolerance increases GO gauge size but decreases NOT-GO gauge size, then the gauge will **tend to reject good work** which is near the upper or lower size of limits.

If the otherwise happens, the gauge will **tend to accept doubtful work** which is just outside the specified limits.

This decision has been made in **BS 969** as follows:
1) **The tolerance on GO gauge shall be within the work tolerance zone.**
2) **The tolerance on NOT-GO gauge shall be outside the work tolerance zone.**

**Allowances** must also be made for the initial wear which occurs on a new gauge. Thus, the tolerances shall be:
1) **Gauge tolerance = 10% of work tolerance**
2) **Wear allowance = 5% of work tolerance**
Tolerancing System and Wear Allowance

- There are two systems for gauge tolerances: **unilateral** and **bilateral**

- In unilateral system; *the gauge tolerance zones lie entirely within the work tolerance zone*. The disadvantage of this system is that certain parts may be rejected as if they were outside the limits.

- In bilateral system; *the gauge tolerance zones are bisected by high and low limits of work tolerance zone*. The disadvantage is that parts within the working limits can be rejected and parts outside the working limits can be accepted.

- In modern limit systems, **unilateral system is usually preferred**.

- Measuring surfaces of GO gauges constantly rub against the surfaces of parts in inspection, thus they lose their initial size due to wear.

- Therefore, to prolong the service life of gauges, **wear allowance** (i.e. 5% of work tolerance) is added to nominal dimension of GO plug gauge whereas **subtracted from** nominal dimension of GO snap gauge.

- Wear allowance is not considered for NOT-GO gauge as it is not subjected to much wear.
A Case Study on Gauge Design

1. Suppose that size of the hole to be tested is: $25 \pm 0.02$ mm
   - Highest limit of hole = 25.02 mm
   - Lowest limit of hole = 24.98 mm
   - Work tolerance = 25.02 - 24.98 = 0.04 mm
   - Gauge tolerance = 10% of work tolerance = 0.004 mm
   - Wear allowance = 5% of work tolerance = 0.002 mm
   - Nominal size of GO plug gauge = 24.98 + 0.002 = 24.982 mm
   - Nominal size of NOT-GO plug gauge = 25.02 mm

2. If bilateral system was used, the gauge dimensions would be as follows:
   - Dimension of GO plug gauge: $24.982^{+0.004}_{-0.000}$
   - Dimension of NOT-GO plug gauge: $25.02^{+0.000}_{-0.004}$

3. For testing a shaft using snap gauge, the order of tolerances and wear allowance must be reversed:
   - Size of GO gauge = 25.02 - 0.002 = 25.018 mm
   - Dimension of GO snap gauge: $25.018^{+0.000}_{-0.004}$
   - Dimension of NOT-GO snap gauge: $24.98^{+0.004}_{-0.000}$
The advantages of limit gauges can be summarised as follows:

😊 Conveniently used in mass production for controlling various dimensions.

😊 Can easily be used by semi-skilled people.

😊 Economical in their own cost as well as engaging cost.

The followings are the limitations/disadvantages of limit gauges:

😢 Do not indicate the actual size of the component

😢 Susceptible for wear, expansion and collapse

😢 Need for large space for storage of gauges

😢 Cannot handle finer quality jobs due to precision issues

😢 Require frequent checking of gauge dimensions