Design Tip
ZT at MMC should be considered whenever the function of a FOS is assembly.

Figure 9-10*A* shows a part with a conventional TOP of 0.3 at MMC. Figure 9-10*B* shows the same part dimensioned with the ZT at MMC method. The 0.3 tolerance has been removed from the TOP callout and included in the size tolerance. Note that the functional parameter—the virtual condition of the hole—is the same for both parts. With ZT at MMC, all of the hole location tolerance is derived from the bonus tolerance, so manufacturing can divide the available tolerance between size and location to best suit the process for the part.

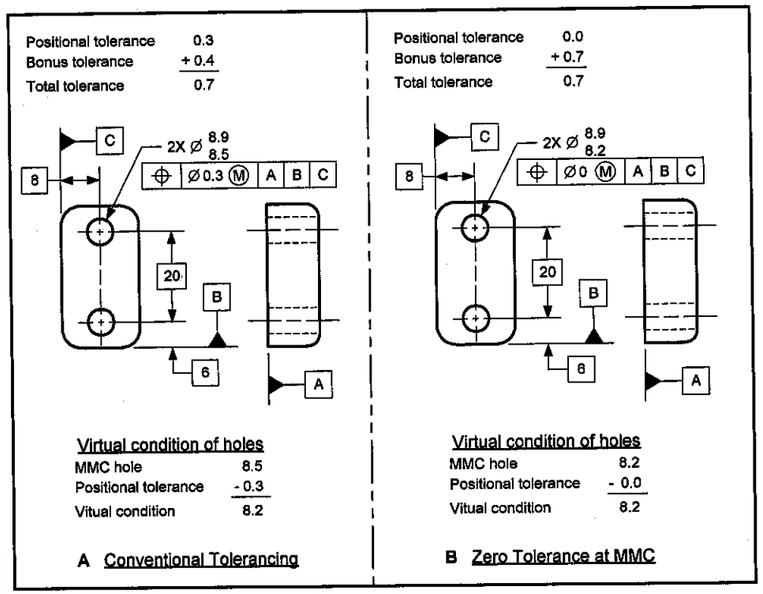
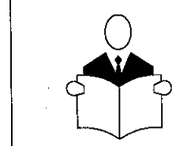


FIGURE 9-10 Conventional and Zero Tolerance at MMC Comparison



Author's Comment
All the benefits of the ZT at MMC method of tolerancing are also available with straightness, parallelism, perpendicularity, and angularity.

There are three primary benefits to ZT at MMC:

1. It provides flexibility for manufacturing.
2. It prevents the rejection of usable parts.
3. It reduces manufacturing costs.

The effects of ZT at MMC can be demonstrated through the use of a tolerance analysis chart. A ***tolerance analysis chart*** is a means of graphically displaying the limits of a part as defined by the print specifications. The tolerance analysis chart in Figure 9-11*A* describes the parameters for parts from Figure 9-10*A*. On the vertical scale, the allowable positional tolerance values are listed. The horizontal scale shows the virtual condition and hole sizes for the part.

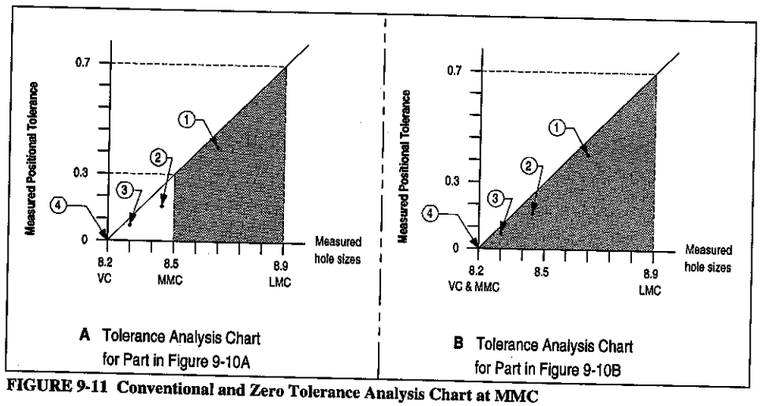


FIGURE 9-11 Conventional and Zero Tolerance Analysis Chart at MMC

The shaded area of the chart represents the acceptable parts according to the print specifications. The dots labeled "1, 2, 3, and 4" represent the actual hole size and location for four parts. Three of the four parts would be rejected on the basis of the hole size not being to print specifications. It is important to note that the virtual condition of the hole size between the MMC and the virtual condition may be a functional part if it is located properly. Conventional TOP dimensioning can result in functional parts being rejected.

Figure 9-11*B* shows a tolerance analysis chart for the parts from Figure 9-10*B*. The shaded area of the chart represents the acceptable parts according to the print specifications from Figure 9-10*B*. The dots labeled, "1, 2, 3, and 4" represent the actual hole size and location of the same four parts from Figure 9-11*A*. Note that all four parts are now considered acceptable. ZT at MMC increases the zone of acceptable parts by making the MMC and virtual condition of the hole equal. As a bonus, any hole that meets its virtual condition requirement (the functional requirement), will also meet its size requirement.

When dimensioning holes for the function of assembly, the designer should consider ZT at MMC. With this method of dimensioning, functional parts are not rejected, and more flexible manufacturing results in additional tolerance to produce parts.

TECHNOTE 9-3 Zero Tolerance at MMC

Zero tolerance at MMC is a method of tolerancing that restates a geometric tolerance so it is included with the FOS tolerance. Three benefits of zero tolerance at MMC are:

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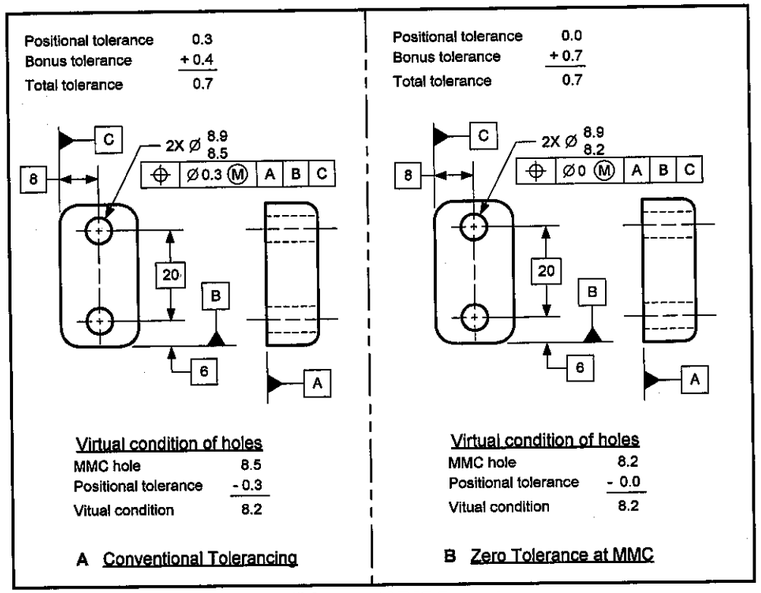

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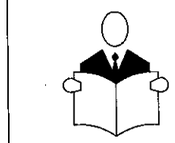

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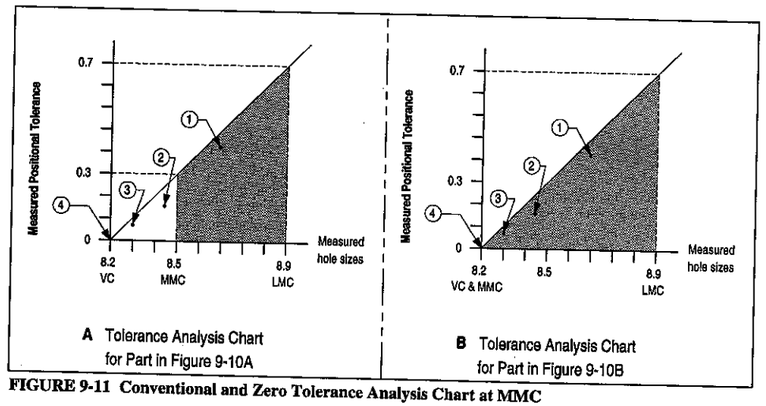

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