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ME424

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Project Learning: Shaft Tolerances

Component machining is imperfect; this is an immutable fact of reality. For engineering, it is crucial to account for the imperfections of the manufacturing process. In the process of machining the shafts for joint 1-2, tolerances were considered in several aspects, but never without several mistakes first.

Part 1: Metric vs. Imperial Tolerance Blocks

Metric and Imperial units have different sized dimensions, and so the tolerances are different. This seems like it should go without saying, but the first piece of learning was to check the general tolerance dimensions. An imperial tolerance block could look something like this:

X.mm +/- .25"
X.Xmm +/- .10"
X.XXmm +/- .01"
X.XXXmm +/- .002

Most machining, even precision machining, does not exceed the thousandths place in the case of inches. Metric, on the other hand, has a far smaller dimension. A general tolerance table in millimeters could look something like this:

X.mm +/- .25mm (.010")
X.Xmm +/- .05mm (.002")
X.XXmm +/- .01mm (.0004")
X.XXXmm +/- .005mm (.0002")

It can be observed that the metric dimensions in millimeters reach approximately the same level of tolerance as the imperial example with only one decimal place. The lesson from this is to think about the necessary tolerances in terms of the actual dimension restrictions instead of a number of decimal places as I was doing. Even using one decimal for millimeters using the given examples achieves an equivalent tolerance for two decimals in imperial.

Part 2: Bearing and Shaft Tolerances

In Machine Component Design, hole and shaft sizing was a substantial unit that covered the concepts of sizing a shaft and hole. For the fit between the shaft and bearing, a slip fit was specified. Due to the bearing supplier site providing a shaft and bearing fit chart in IT grades [1], we made the faulty assumption that the bearing would be sized using IT fitments, which would, in general, oversize the bearing diameter. The bearings are instead tolerance using ABEC grades [2], which resulted in the bearing being undersized. This meant that the actual fit was an interference fit as opposed to a sliding fit. The lesson from this is to always check the tolerances of a given component. Assuming can result in wasted time and effort.

References:

- [1] "Basis of Fitting Selection/Dimensional Tolerances and Fitting." Published 1998.
https://us.misumi-ec.com/pdf/tech/mech/US2010_fa_p3539_3540.pdf.

- [2] "Radial Bearing (Class 0) Tolerances and Allowances." <https://us.misumi-ec.com/pdf/fa/2010/p3499.pdf>.