ABA-PGT INC
to be precise ...

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ACHIEVE SMOOTH-RUNNING GEARS WITH PROPER CENTERLINE CALCULATION

Proper centerline calculations are vital to the operation of a gear set. With the right centerline calculations you are on your way to a smooth, quiet mesh that transfers the intended load over a manufacturing-friendly range of tolerances. Treat centerline calculations lightly and the list of potential problems is formidable- excessive noise, premature wear, stripped and broken teeth, tight centerline tolerances that are difficult to hold, decreased efficiency- to name a few.

To understand centerline calculations you must first understand the concept of the Close-Mesh-Center-Distance (CMCD). Consider a pair of perfectly round gears at their maximum allowable diameters and circular tooth thickness -- meshed along a centerline such that there is no binding and no backlash. This is the close-mesh-center-distance (CMCD). This is theoretically the closest that the gears can ever be meshed without binding. However, in the real world there are a number of factors that force the designer to change the working center distance from the CMCD. These factors are:

a) **Imperfections in Manufactured Gears-** Out-of-roundness, tooth spacing errors, diameter tolerances, and profile errors will cause binding if the gears are meshed at CMCD. The working center distance must be increased from the CMCD to account for these factors. The American Gear Manufacturers Association (AGMA) publishes a set of standards that will aid the gear designer in determining the required increase in center distance to account for gear errors.

b) **Bearing Runout**- Runout in the gear mounts (bearings, shafts, etc) will also force the designer to increase the working center distance beyond the CMCD to avoid binding.

c) **Temperature**- Plastics are much more sensitive to changes in temperature than metals. As temperature rises, plastic gears will grow; as temperature drops, they will shrink. This also holds true for a plastic gear housing. The designer

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must consider the temperatures to which the gears and housing will be exposed and then either increase or decrease the working center distance accordingly. Many plastics suppliers can provide data regarding the growth rate due to temperature changes.

d) **Moisture and Humidity-** This is one factor that is often overlooked. Some plastics, nylons in particular, are hygroscopic (that's "hygroscopic", not "hydroscopic"). Plastic gears will grow if they absorb moisture. If this growth is not taken into account, noise, wear, and gear binding can occur. Plastics suppliers can provide data regarding growth rate due to moisture absorption.

These factors, when added together, are commonly referred to as Δc- the required increase (or decrease for internal gears) in center distance to avoid binding. When Δc is applied correctly, the designer will be able to determine the minimum and maximum operating center distances to obtain a smooth, quiet mesh without binding or premature failure.