A Description of Gear Drive Train Noise and Methods of Reduction
by Mark Thompson of ABA-PGT Inc.

If you have a noisy gear train, the first step is the **Identification of Gear Drive Train Noise.** A description of the type of noise can assist our gear engineers to identify the source. Noise measurement and analysis may be required, at this step. If the source is from gears, dimensional inspection to identify transmission errors may be required. Our gear engineers will also review the friction effects of the gears, selection of gear materials, stack-up of tolerances and gear tooth geometry. A description of the type of noise will include noise at what <u>speed</u>? Noise with or without <u>load</u>? Noise in both <u>directions</u>?

Types of Gear Drive Train Noise

1. **Growl** -- Most common type of gear drive train noise!
    - medium pitch noise
    - caused by:

    a) imperfections in gear geometry or tooth interference, with frequencies tied to:
        1. tooth meshing rate
        2. rotation rate
        3. a combination of tooth meshing rate and rotation rate
        4. imperfections in the machine tools which generated the gear geometry by machined electrodes versus wire EDM method

    b) gear tooth interference associated with gear runout or out-of -round
        - may be intermittent at the rotation rate
        - may be intermittent at the or out-of-round rate

    c) high friction at gear teeth, but independent of tooth meshing frequency

    d) reversing friction at gear teeth, with frequency tied to tooth meshing rate
2. **Low pitched noise**
    - Caused by gear or motor rotor under light radial load slapping back and forth in bearings. The frequencies are at low multiples of the rotation rate.
    - Sounds like low frequency growl, but audible only with high-speed rotation.
3. **Screech --** high pitched noise
    - caused by static- dynamic friction effects at gear teeth or bearings, also known as slip-stick friction of the bearings.
    - sounds like fingernails scratching on blackboard
4. **Irregular --** low pitched noise
    - caused by axial vibration of the gear or motor rotor
    - sounds like Morse code signals
5. **Rattle**
    - Caused by gears under light load slapping back and fourth in gear backlash.
    - Sounds like ticking
6. **Non - gear generated noise** caused by:

    a) various motor generated vibrations transmitted through mounting or through gear train to sound radiating surfaces

    b) various ball (or roller) bearing vibrations, generally after wear or other damage to bearing surfaces

    c) noise with frequency and/or amplitude swings caused by motor speed changing during cycle of varying load

If the source of the noise is NOT gear related, bearing noise source reduction, structural vibration isolation and radiating surface dampening may be required.

If the source of the noise is gear related, the following table is helpful in determining the source of transmission error. And the following Process is suggested as a guide to reduce gear noise.

Gear Quality Characteristics and Their Influence on Gear Noise

Quality Characteristic	Influence	Specification
Involute tooth shape	primary	Tooth to tooth & Involute Mean slope
Runout	secondary	Total composite and test radius
Out-of round	secondary	Total composite and test radius
Tooth spacing variation	secondary	Tooth to tooth composite
OD or ID (on internal gears)	slight	OD or ID
Root diameter	none (**)	root diameter
Circular tooth thickness	none (**)	measurement over wire or test radius

**(Unless interference with mating gear)

Process to Reduce Gear Noise in Molded Plastic Gears

1. Noise source identification (determine which gear is noisy)
   - Record noise with drive operated at known constant speed
   - Analyze noise into its component frequencies (Fourier analysis)
   - Compare frequencies to rotational and tooth meshing frequencies
     Note: side bands are caused by eccentricity and out-of round
   - Identify components of most objectionable noise amplitudes.
   - Associate objectionable components with the gears that produce them.
2. Gear geometry analysis
   - Measure involute profile of both tooth flanks
   - Compare to geometry of mating gear
3. Test for effects of geometry correction
   - Make samples of one or both mating gears with compatible geometry
   - Repeat noise measurements
4. Redesign gear proportions (if needed), with tolerance analysis
   - Maximum depth of engagement
   - Adequate backlash
5. Redesign mold cavities
   - Apply proper shrinkage
   - Allowance for non-uniform shrinkage
   - Correct the geometry
6. Inspection of new molded parts
7. Retest noise level

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