Basic Gear Terminology

Face Width is the length of the teeth in the axial direction.

Outside Diameter (O.D.) is the diameter of a circle around the outer surface, or tops of the gear teeth.

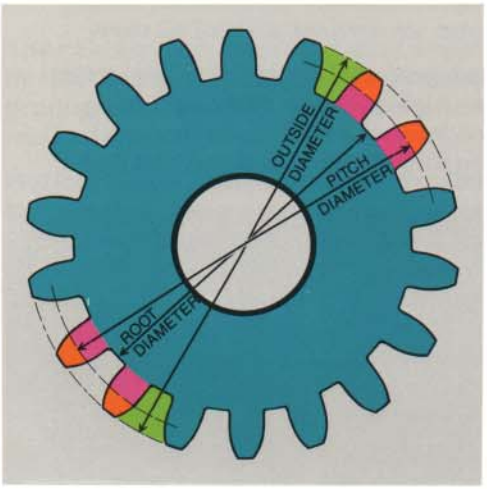
Pitch Diameter (P.D.) is the diameter of the pitch circle.

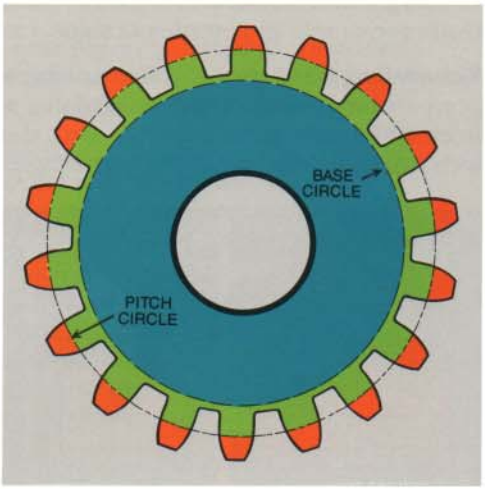
Pitch Circle. When gear sets are visualized as a pair of smooth contacting discs, the pitch circles of the gears correspond to the diameters of the discs. Pitch circles of mating gears are tangent to each other, and have identical linear velocities. For that reason, pitch circles, rather than base circles, are used in many gear calculations. The operating pitch circles will respond to any variations in center distance of the pair by enlarging or contracting.

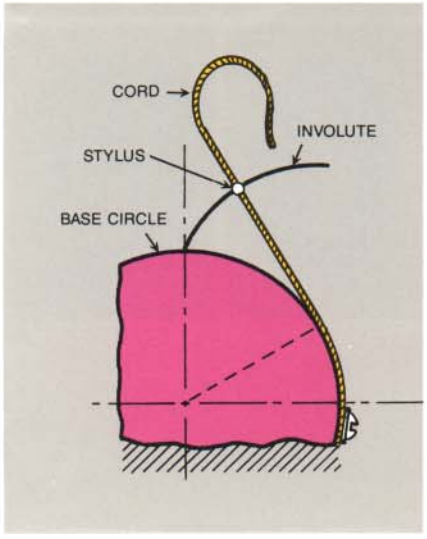
Pitch Point. When a pair of gears are operating in mesh, the point of tangency between the two pitch circles is called the pitch point.

Root Diameter (R.D.) is the diameter of a circle around the bottom (root) of the gear tooth spaces.

Base Circle is the circle from which the involute portion of the tooth profile is generated.







Involute Curve is the mathematical curve most commonly used for gear tooth profiles. It is an arc generated from the base circle, and described by lines drawn normal from this curve and tangent to the base circle — much like a taut string being unwound from a cylinder.

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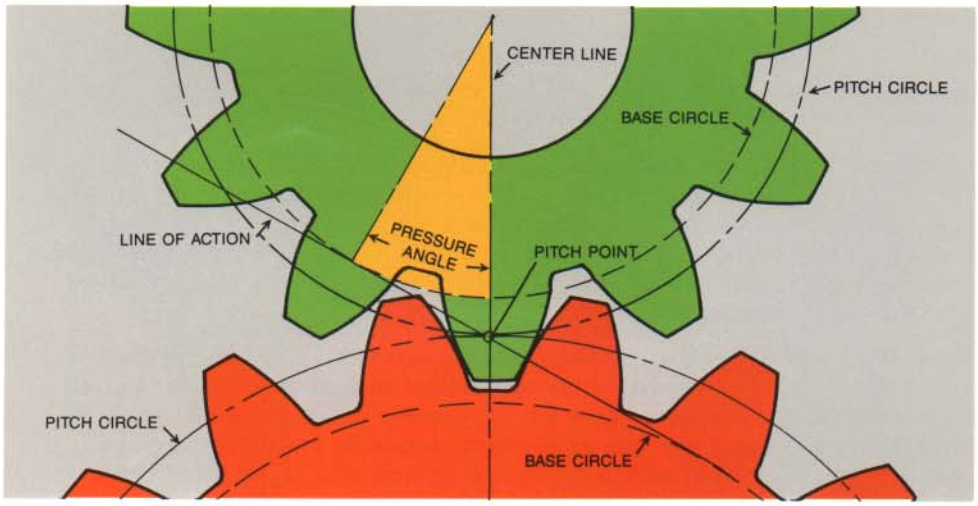
Pressure Angle (P.A.) describes the direction of the force created by a driving gear acting upon its mate. It is formed by a line drawn between centers and a line drawn perpendicular to the "line of action", which is tangent to both base circles and includes the pitch point. The preferred pressure angle in use today is 20° — a good compromise for power and smoothness — with 25°, 22.5°, and 14.5° pressure angles also commonly specified. In general, higher pressure angles provide higher strengths and a lower tendency to experience tooth tip interference, but are susceptible to noise and higher bearing loads. Low pressure angles are quieter and smoother, have lower bearing loads, and lower frictional forces, but are susceptible to undercutting at low numbers of teeth. It is important to note that meshing gears must have the same pressure angles.



Addendum is the height of the tooth above the pitch circle.

Dedendum is the depth of the tooth below the pitch circle.

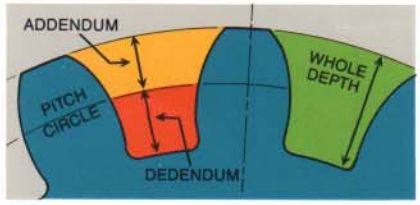
Whole Depth is the total length of a tooth space equal to the sum of the addendum and dedendum.

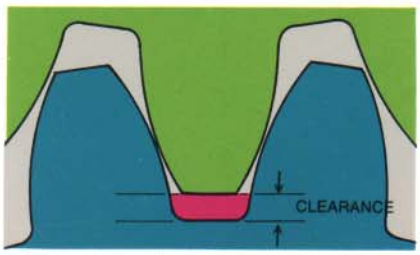
Clearance is the distance between the outside diameter of a gear and the root diameter of its mate. This margin compensates for the thermal expansion that occurs during operation, and prevents the top of a gear tooth from interfering with the root of its mating gear tooth.

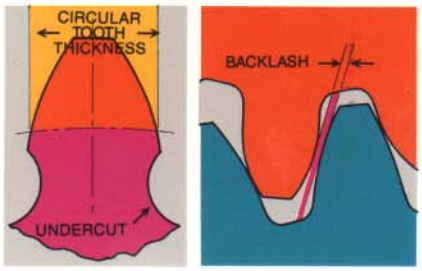
Undercut is the removal of a portion of the tooth profile below the gear's theoretical base circle diameter, and above the root diameter. Undercut is caused by the rolling geometry of the cutting tool during gear manufacture, and most often occurs in gears with small numbers of teeth and low pressure angles.

Circular Tooth Thickness is the distance from a point on one side of a gear tooth to a corresponding point on the opposite side of the same tooth, measured along the pitch circle.

Backlash is the amount by which the width of a tooth space exceeds the thickness of the engaging gear tooth. Backlash is achieved either by decreasing tooth thickness slightly (increasing tooth space) on one or both members, or by increasing center distance between gears. This prevents binding and compensates for the effects of thermal expansion, machining and installation variation.







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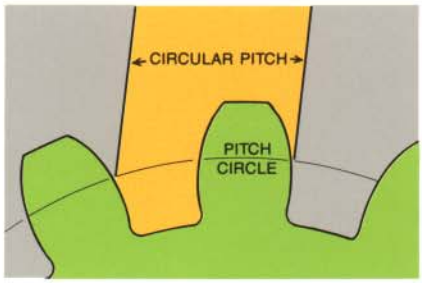
Diametral Pitch (D.P. = n/P.D.) is the number of teeth per inch of pitch diameter, and is also an index of tooth size. A large diametral pitch ratio indicates a small tooth, and vice versa. The use of D.P. is a handy reference in gear design, and a standardized code has been established to facilitate the specification process. It's important to note that meshing gears must have the same D.P.

Module (M =P.D./n) is the metric equivalent of diametral pitch — that is, the pitch diameter (in millimeters) divided by the number of teeth — but unlike D.P., the higher the number, the larger the teeth. Meshing gears must have the same module.

Comparison Chart of Diametral Pitch, Module and Circular Pitch

Diametral Pitch	1.0	1.2566	2.0	2.54	3.1416	3.175	5.0	5.08	6.2832	8.0	10.0
Module	25.4	20.223	12.70	10.0	8.8	8.0	5.08	5.0	4.042	3.175	2.54
Circular Pitch	3.1416	2.5	1.5708	1.2368	1.0	.9895	.6283	.6184	.5000	.3927	.3142



Circular Pitch (C.P.) is the distance from a point on one tooth to the corresponding point on the adjacent tooth, measured along the pitch circle. Calculated in inches, the circular pitch equals the pitch circle circumference divided by the number of teeth. Because circular pitch is directly proportional to module and inversely proportional to diametral pitch, meshing teeth must have the same circular pitch.

Tooth Size. Diametral pitch, module and circular pitch are all indications of tooth size — ratios which determine the number of teeth in a gear for a given pitch diameter. In designing a gear set, the number of teeth in each member is, of necessity, a compromise among strength, durability and smoothness of operation. As a rule of thumb, teeth should be large and low in number for heavily loaded gears, small and numerous for smooth operation.

Tooth Form Depths. There are several tooth form depth options for involute gearing in common usage, with the full depth design being the current standard because of its balance of strength and smoothness. Other involute options include modified (long and short) addendum teeth, and the obsolete stub tooth.

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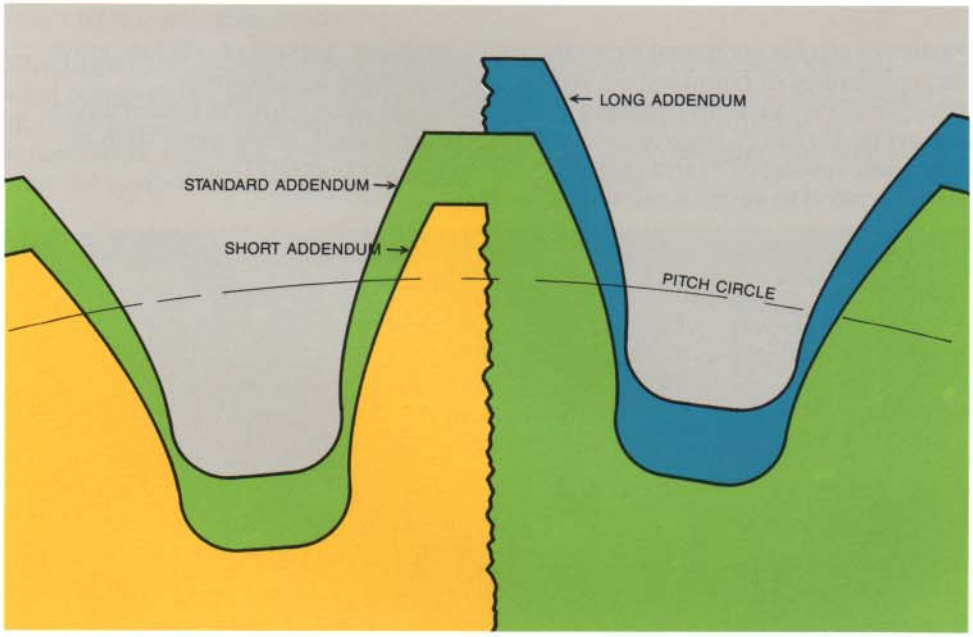
Tooth Form Modification. Because the pinion is usually the smaller, driving member, pinion tooth strength is generally lower than that of the larger, driven gear, when standard tooth proportions are used. To provide increased strength, reduce undercutting and improve operating characteristics, the dedendum of a pinion tooth may be decreased and the addendum increased correspondingly. If the center distance remains the same, the addendum of the driven gear tooth must be decreased and the dedendum increased proportionally. Thus, tooth strengths are brought into balance and wear life of the gear set extended. This modification is called long and short addendum.



Tooth Form Comparison Criteria Table

Criteria	Pressure Angle			Addendum			Dedendum & Fillet Radius	
	BEST		WORST	BEST		WORST	BEST	WORST
Strength	25	20	14½	L&S	STD	Stub	F.R.R.	Stub
Durability	25	20	14½	L&S	STD	Stub		
Smooth Rolling Action-Noise	14½	20	25	L&S	STD	Stub		
Ability to Accept Center Distance Variation	14½	20	25	STD	L&S	Stub		
Separating Force	14½	20	25					
Standard Tooling	20	14½	25	L&S	STD	Stub		
Less Chance of Undercutting	25	20	14½	L&S	Stub	STD	Stub	F.R.R.

L&S = Long & Short; Std. = Standard; Stub = Stub Tooth; F.R.R. = Full Root Radius