Drill Nomenclature
and Geometry
Drill Nomenclature

• Drill Construction:

* A twist drill is made up of three components:
  – Shank
  – Body
  – Drill point
Drill Nomenclature

• Cutting Diameter:
  “Largest diameter measured across the top of the lands behind the point”

• Back Taper
  – The diameter reduces slightly toward the shank end of the drill, this is known as “back taper”
  – Back taper provides clearance between the drill and workpiece preventing friction and heat
Drill Flutes
Drill Nomenclature

**Flute Length:**

“The length of flute measured from the drill point to the end of the flute runout”

- Flute length determines the maximum depth of drilling
Drill Nomenclature - Flute Construction

Parabolic        Conventional          Chipbreaker
Drill Nomenclature - Flute Construction

- **Conventional:**
  - Has “J” shaped flute geometry
  - Used in a wide variety of soft and hard drilling applications
  - Drill up to 3 to 4 diameters before pecking
  - Most drills in the industry have this type of construction
• **Chipbreaker**
  - Has special tight radius “J” shaped flute
  - *Tight radius helps to break up chips*
  - Heel is rolled for increased chip space
  - Used in equipment with fixed feeds where long stingy chips are produced
Drill Nomenclature - Flute Construction

- **Parabolic:**
  
  "Compound radius, cleared heel flute shape"

Parabolic flutes substantially increase available flute space for chips!
Land: “The part of the drill body between the flutes”

- The lands provide the drill with much of its **torsional strength**

- Reducing the land width increases chip space, but reduces strength
Drill Webs
“The thickness measured across the base of the flutes”

– Contributes to the torsional strength of the drill
Drill Nomenclature

• **Web Thickness**

  *Webs normally fall into three categories:*
  
  – Light
  – Medium
  – Heavy
Web Construction

Light

General Purpose

Heavy Duty
Drill Nomenclature - **Web Thickness**

- **Light:**
  - Generally 14 to 16% of the cutting diameter
  - Found on fast helix general purpose drills
  - Weakest of the drill webs
Drill Nomenclature - **Web Thickness**

**Medium**

- Typically 17% to 22% of the cutting diameter
- *Found on all GP drills*
Drill Nomenclature- Web Thickness

- Heavy

- Generally 25% to 40% of the cutting diameter
- Used on cobalt, coolant hole, parabolic, and other heavy duty drills
There are three common web constructions:

- Tapered
- Parallel (Pre-thinned)
- Parallel-Tapered
Web Constructions

Parallel Web - Thin

Parallel Web - Heavy

Thinned Web then Parallel

Constant Increase
Effects of Drill Re-Sharpening

Section A-A
- Web thickness
- Chisel edge length
- Drill Diameter

Section B-B
- Web thickness
- Chisel edge length
- Drill Diameter
Web Thinning

- Drill webs are non-cutting
  - Don’t contribute to the cutting process
  - They consume power and torque to move through the work piece
  - Must reduce the chisel edge length to be as short as possible in length!

Ground notch to thin web and reduce chisel edge length
Web/Point Thinning

No Thinning

No thinning as received from the manufacture.

Conventional

Stock is removed in such a way as to follow the flute contour.
Web/Point Thinning

Split Point

Two secondary back-off grinds, adjacent to the chisel and almost to center

High Tensile Notched

Notched point results in centering ability and reduction of forces
Web/Point Thinning

Flatted Lip Type

Flatting the face of the flute, Eliminates “hogging-in”

Gash Type

Grinding two half-round gashes near the center of the drill
Web Thinning

“K” Notch

- Half radius notch
  - Web is typically thinned to 8% to 12% of the drill diameter
  - Shortens chisel edge length reducing thrust
  - Improves chip evacuation
  - Used in tougher materials and some large diameter drills
Web Thinning

“R” Notch

• Full radius notch
  – Web is typically thinned to 8% to 12% of the drill diameter
  – Shortens chisel edge length reducing thrust
  – Improves chip evacuation
  – Used primarily on coolant hole drills
Drill Helix Angles
Drill Nomenclature

- **Helix Angle:**

  “Angle formed between a line drawn parallel to the axis of the drill and the edge of the land”
Various Helix Angles

High Helix Angle

Regular Helix Angle

Slow Helix Angle
Helix angles generally fall into three categories:

- Slow Spiral
- Regular Spiral
- Fast Spiral
Drill Nomenclature - Helix Angle

Slow Spiral

- 12° to 22° helix angle
- Used in materials producing broken chips such as brass or bronze, or cast iron
- Also used in horizontal applications where the drill is not rotating
**Drill Nomenclature - Helix Angle**

**Regular**

- 28° to 32° helix angle
- Found on most general purpose and cobalt drills
- Used in a wide variety of drilling applications
Drill Nomenclature- Helix Angle

Fast Spiral

- 34° to 38° helix angle
- Used on high helix general purpose and deep hole parabolic drills
- For softer ferrous and non-ferrous materials producing stringy chips
Drill Nomenclature - Helix Angle

• How does changing the helix angle effect performance?

Fast Spiral Drills
  – Provides greater lifting power for chips, but are weaker
  – Generally used in deep holes

Slow Spiral Drills
  – Are stronger, but have less lifting power for chips
  – Generally limited to shallow holes
Various Helix Angles

Regular Helix Drill

High Helix Drill
Drill Margins
• **Margins:**

“The cylindrical portion of the land that is not cut away to provide clearance”

- The balance of the land is reduced in diameter, known as “cleared diameter” or “body clearance”

- Body clearance prevents excessive rubbing and friction
Drill Nomenclature - Margins

- **Single Margin:**
  
  • Has one margin adjacent to the cutting edge
  • Single margins create the least amount of rubbing and friction with minimal support in the hole
  • **Most standard tools are single margin**
**Double Margin:**

- Has a margin at both the cutting edge and heel
- Used in specialized applications where precision hole size, and finish are required
- The additional margin adds stability and reduced the possibility of chatter, but creates more friction
- Often used when drilling through a bushing for support
• **Triple Margin:**

  - Has three margins per land, one at the cutting and heel and one in the middle of the land
  - **Used where very high precision and hole size is required**
  - Provides the greatest amount of stability and the greatest amount of friction and rubbing
Drill Points
Drill Nomenclature - Points

- **The drill points has four main features:**
  - Point Angle
  - Cutting Lips
  - Chisel Edge
  - Lip Relief
Drill Point Angles

- **118°**
  - General purpose

- **118°**
  - Chamfer (to reduce burr)

- **118°**
  - Helical Point (self centering)

- **90°**
  - Soft and ductile material

- **118°**
  - Split (reduce thrust & self centering - NC)

- **140°**
  - High alloyed steels
High Point Angle (Flatter Point)

- Recommend for harder and tougher materials
- Stronger cutting edges
- Shorter cutting lip produces a narrower chip
- Point angle greater than 130° are generally used in materials that have been hardened or are extremely tough

Shorter, flatter cutting lips produce narrow chips
• Point Angle

**Lower Point Angle** (Sharper Point)

- For softer materials
- Points sharper than 118° are generally used for soft non-ferrous materials and non-metallic
Drill Nomenclature

• **Cutting Lips**

  “Cutting edges that extend from the center of the drill to the outer diameter”

  – On most standard drills, the cutting edge should form a straight line
  – Some specialty and high performance drills have curved cutting lips
Drill Nomenclature - Points

- **Elements of Drill Points**
  - **Lip Relief Angle**
    - Varies with the diameter of the drill and hardness of the material
    - On larger diameters and drills for harder materials, lip relief is decreased to as low as 8°
    - Drills for soft materials and small diameters have high relief angles up to 24°
    - *Lip relief angles are measured across the margin width*
Incorrect Lip Clearance

No lip clearance

Extreme pressure required to make drill cut; top of drill shows signs of rubbing and heat caused by little or no lip clearance

Corners of drill broken due to excessive lip clearance
## Suggested Lip Relief Angles

<table>
<thead>
<tr>
<th>Drill Diameter Range</th>
<th>Lip Relief Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>#80 to #61</td>
<td>24°</td>
</tr>
<tr>
<td>#60 to #41</td>
<td>21°</td>
</tr>
<tr>
<td>#40 to #31</td>
<td>18°</td>
</tr>
<tr>
<td>1/8˝ to 1/4˝</td>
<td>16°</td>
</tr>
<tr>
<td>F to 11/32˝</td>
<td>14°</td>
</tr>
<tr>
<td>S to 1/2˝</td>
<td>12°</td>
</tr>
<tr>
<td>33/64˝ to 3/4˝</td>
<td>10°</td>
</tr>
<tr>
<td>49/64˝ and larger</td>
<td>8°</td>
</tr>
</tbody>
</table>
Drill Nomenclature

• **Chisel Edge**

“The edge at the end of the web, that connects the cutting lips”

- The chisel edge *does not cut* - it penetrates displacing the workpiece material

*The chisel edge consumes 60% to 70% of the thrust required!*
• **Chisel Edge Angle**

“The angle formed between the chisel edge and the cutting lips”

- The chisel edge angle is generally 125° to 135°

“Chisel edge angle is an indication of lip relief”
Drill Nomenclature - Points

• 118° Degree
  - General purpose point
  - Used in a wide variety of non-hardened Materials
  - Most common drill point used in the industry

Single primary clearance ground in one operation

Cutting lips
Drill Nomenclature - Points

- **118° Four Facet**
  - General purpose point
  - Used primarily on solid carbide drills
  - Facets provide primary and secondary relief grinds to maintain edge strength

Cutting face
Primary clearance
Secondary clearance
Double Angle:

- 118° or 135° point with a 90° outer chamfer
- Similar to a Racon, but is easier to regrind
- Minimizes outer corner wear
- Helps to eliminate burrs on breakthrough
Drill Nomenclature - Points

- **90° Degree**
  - Generally used for soft non-ferrous materials and non-metallic
  - Occasionally used in soft cast iron

90 degrees included
Drill Nomenclature - Points

• Helical

- Superior self centering point
- Chisel has “S” shape and crown to produce the self centering feature
- Produce accurate hole size with good finish
- Excellent for producing straight holes in deep hole applications
- Minimizes burrs on breakthrough
**Drill Nomenclature - Points**

- **Racon**
  - 118° point with corner radius
  - Prevents “grabbing” when exiting angled or curved surfaces
  - Reduces outer corner wear
  - Minimizes burrs on breakthrough
  - Allows for increased feed rates
Drill Nomenclature - Points

• **Bickford point**
  
  – Combination Helical and Racon point
  – Has helical “S” chisel with corner radius
  – Self centering point
  – Prevents “grabbing” when exiting angled or curved surfaces
  – Reduces outer corner wear
  – Reduces burrs on breakthrough
Drill Nomenclature - Points

- **Split Point: (Crankshaft)**
  - Self centering point
  - Minimizes chisel length, reduces thrust
  - Split produces positive rake angle improving the chip cutting ability at the center of the drill point
  - $118^\circ$ and $135^\circ$ are the two most common split points
  - Extremely good for off hand operations
Drill Nomenclature - Points

- **135° Four Facet Split Point**
  - Heavy duty point for hard and tough materials
  - Used primarily on solid carbide drills
  - Facets provide primary and secondary relief grinds to maintain edge strength
  - Split self centers and reduces thrust
Drill Nomenclature - Points

- **Flat Bottom:**
  - Has 150-180° end to create flat bottom holes
    - Bushings
    - “Press fit” parts
  - Generally used with drill bushings to prevent “wandering” and chatter
Drill styles-

• Drill Lengths: Common standard lengths
  • Screw Machine: (Short flute, short OAL)
  • Jobber Length: (Longer flute, longer OAL)
  • Taper Length: (Longer flute, longer OAL)
  • Extension Length: (Standard shank, long length flutes)
  • Aircraft Extension Length: (6 or 12 inch OAL, jobber length flutes)

Always use the shortest drill possible!