Think power, Think HSS
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<th>BROACHING PROCESS</th>
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• Used in gear boxes, transmission systems, etc, gears are essential components in the mechanical industry. They can be found in all vehicles such as cars, trucks, tractors, construction equipment but also in marine drives, rolling mills, generating stations, etc.

• Most gears are cut by a hob or a shaper cutter. Hobbing is a generating process, wherein the metal is progressively removed to produce gear teeth.
TYPES OF GEARS

- Straight spur gears
- Helical gears
- Internal gears
TYPES OF GEARS

- Straight bevel gears
- Conical bevel gears
- Spiral bevel gears
- Hypoid gears
- Helical gears
- Worm gears
## Tool Maker's Tip

Reach the highest performance with HSS-PM

<table>
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<tr>
<th>HSS</th>
<th>HSS-E 5%-8% cobalt</th>
<th>HSS-PM (powder metallurgy)</th>
<th>HSS-E-PM with cobalt (powder metallurgy)</th>
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</table>
| Used for hobs and for shaving cutters | Used for hobs and shaper cutters | Mainly used for shaving cutters | • High performance  
• High cutting speeds  
• Longer tool life  
• Suitable for dry machining  
• Used for hobs and for shaper cutters |

### Success Story

**Operation**

High speed dry hobbing of planet gears, module 1.25, flank angle 20°, 21 teeth, face width 24 mm

**Solution**

HSS-PM hob with multilayer TiAlN coating

**Cutting data**

$\text{vc} = 220 \text{ m/min}$, $f_a = 2.5 \text{ mm/rev}$, $t_h = 12.4 \text{ sec.}$

**Benefits**

- Cutting time reduced by 51% and 38% more pieces (6444 pieces before resharpening)

**Steel**

20MoCrS4

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**Which HSS for Maximum Efficiency?**
### TOOL MAKER’S TIP
For maximum coating efficiency, prefer a HSS-PM substrate

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<th>COATINGS FOR THE BEST PERFORMANCE</th>
<th>TiN</th>
<th>TiCN</th>
<th>TiAlN or TiAlCN</th>
<th>MoS$_2$ or WC-C</th>
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<tr>
<td></td>
<td>Gold</td>
<td>Grey-violet</td>
<td>Black-violet</td>
<td>Grey-black</td>
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<tr>
<td>Conventional, general purpose coating</td>
<td>• Reduces friction</td>
<td>• High abrasion-wear resistance at low cutting speed and with plain-oil lubrication</td>
<td>High performance coating ($v_c \geq 120$ m/min)</td>
<td>Reduces friction</td>
</tr>
<tr>
<td>Reduces friction</td>
<td>• Good abrasion-wear resistance at low cutting speed</td>
<td>• Prevents the tool from overheating</td>
<td>• Limited temperature resistance</td>
<td>• Suitable for dry hobbing and dry shaping</td>
</tr>
<tr>
<td></td>
<td>• High abrasion-wear resistance at high temperature</td>
<td>• Suitable for dry hobbing and dry shaping</td>
<td>• High abrasion-wear resistance at high temperature</td>
<td>• For dry machining</td>
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**COATINGS FOR THE BEST PERFORMANCE**
A gear shaper cutter is basically a gear with teeth relieved to provide suitable cutting edges and clearances. The stroking, together with the related rotation of the cutter and the workpiece results in a molding-generation process.

Shaper cutters are used to produce gears and also racks, cams, latches, ratchets, clutches, etc.

This technology is used when hobbing is not possible due to accessibility problems.
French: un outil pignon
German: ein Hobelwerkzeug
Italian: stozzatore
Spanish: una herramienta para cepillar

SHAPER CUTTER AROUND THE WORLD

Addendum
Whole depth
Pitch circle
tip chamfer
Datum face
Radial relief angle
Side relief angle
Chamfer
Counter bore diameter
Pitch circle diameter
Outside diameter
Cutting face

Downhill side
Uphill side
Side relief angle on uphill side
Side relief angle on downhill side
Face angle
Sharpening angle
Helix angle

Helical gear shaper cutter
TYPES OF SHAPER CUTTERS

- Disk type shaper cutter
- Shank type shaper cutter
- Disk type helical shaper cutter
- Deep counterbore type shaper cutter
Disk shaper cutter for shoulder gears

Deep counterbore shaper cutter with recessed nut

Shank shaper cutter for small diameter internal gears

Pot shaper cutter for external gears

TYPES OF SHAPER CUTTERS AND WORK SHAPES
DID YOU KNOW?
The hob profile is the mating profile of the gear teeth

Throughout the hobbing process, the gear blank and the hob rotate in continuous coordinated movement. A linear feed is also applied. The hob resembles a worm with cutting teeth located where the flutes intersect the worm.

Hob cutting

Hob cutting action
A Hob Around The World

French: une fraise-mère
German: ein Walzfräser
Italian: un creatore
Spanish: una fresa madre

HOB - VOCABULARY

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CONVENTIONAL VS. CLIMB HOBBING

Conventional cut (or up-hobbing)

Climb cut (or down-hobbing)
EXAMPLES OF HOBS

Solid hob
Segmented hob
Hob for roller chain sprockets
Hob for ratchet wheels
Hob for worm wheels
SPECIAL PROFILES PRODUCED BY HOBBING
CHIPS PRODUCED DURING HOBBING

Chip produced by a roughing tooth

Chip produced by a finishing tooth

Workpiece

Roughing tooth

Finishing tooth

Hob

Chip produced by a roughing tooth

Courtesy of J. Rech
Types of wear on a hob tooth

Cutting edge rounding
Chipping
Crater wear
Back wear
Flank wear (fillet)

Wear development on a hob

A) Flank wear mark width VB on an uncoated hob

B) Crater wear development on a coated hob

B1) Crater wear in the tooth tip corners

B2) Fully formed crater wear
Gear shaving is a finishing operation, taking place after roughing with a hob or a shaper cutter. Shaving consists in removing small amounts of metal from the working surface of gear teeth and produces fine hair-like chips.

The process also improves tooth surface finish and eliminates, by means of crown tooth forms, the danger of tooth end load concentrations. Shaving modifies the tooth profile to reduce gear noise and to increase gear’s load capacity, safety and service life.

The cutter has the form of helical gear with serrations in the flanks of the teeth acting as the cutting edges.