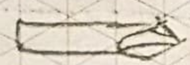
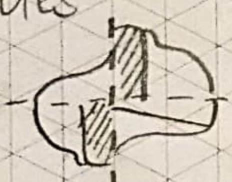
Title: Speeds and Finds

Lesson Goals
- Identify common cutting tools
- Learn the definition of speeds and feeds
- Calculate cutting speeds and feed rate.

Basic Cutting Tools
- Center Cutting End mill
- Ball end mill
- Non-center Cutting End Mill
- Indexable Shell mill
- Combination Drill & Countersink 
- Spotting Drill 
- Countersink 

Flutes



2 Flute End mill
More room for chip evacuation
Used for light metals
weak, Short tool life

4 Flute End mill
More cutting edges, longer tool life
Used for harder Metals
Clogs easily in deep cuts

Milling Tools

Description	Application

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Description	Application
1/4" 2 Flute HSS Single End mills for cutting aluminum — 3/8 shank x 1 1/4 cutting length	Facing, profiling, pocketing, slotting, roughing, and finishing.
1/4" 2 Flute Ball End mill for aluminum — 3/8 shank x 1 3/4 cutting length	Surfacing, slotting, profiling, roughing, and finishing
1/4" Countersinking & De-burring tool — 90 degree	Engraving, de-burring, counter-sink, spot drilling

Description	Application
#3 Combined drill & countersink 90 degree	Spot drilling, engraving
1/4" Spotting drill 90 deg	Spot drilling, engraving

Definitions

Cutting Speed — the rate of a tool measured in surface feet per minute

Spindle Speed — the number of revolutions per minute (rpm) that is made by the cutting tool of a machine

Feed rate — the distance advanced by the cutting tool along the length of the work for every revolution of the spindle.

Spindle Speed

Spindle speed: the number of revolutions per minute (rpm) that is made by the cutting tool of a machine

Spindle speed is expressed as revolutions per minute (rpm)

Spindle speed is calculated by dividing the cutting speed by circumference of the tool

Spindle Speed Formula

$$N = \frac{CS\left(12 \frac{in}{ft}\right)}{\pi d}$$

N = spindle speed (rpm)

CS = cutting speed (surface ft/min)

d = diameter (inches)

πd = circumference

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Title: Speeds and Feeds

Recommended cutting speeds

Milling speeds for high speed steel tools	
Material	Cutting speed in surface ft/min
Magnesium	300
Aluminum	250
Brass and Bronze	150
Copper	100
Cast iron (soft)	80
Cast iron (chilled)	50
Mild Steel	90
Cast Steel	80
Alloy steel (Hard)	40
Tool steel	50
Stainless steel	60
Titanium	50
High manganese steel	30

Double speed for carbide cutting tools

$$N = \frac{CS\left(12\,\frac{in}{ft}\right)}{\pi d}$$

$$N = \frac{150\,\frac{sf}{min}\left(12\,\frac{in}{ft}\right)}{\left(\pi\,(0.25\,in)\right)\,\frac{1}{rev}}$$

$$N = 2200\,\frac{rev}{min}$$

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Title: Speeds and Feeds

Feed rate — the distance advanced by the cutting tool along the length of the work for every revolution of the spindle.

$f_m = f_t * n_t * N$

f_m = feed rate (inches/min)
f_t = feed per tooth (or chip load) (inch/tooth rev)
n_t = Number of teeth on the cutting tool (unitless)
N = Spindle speed (rpm) $N = \frac{CS(12\frac{in}{ft})}{\pi d}$

$f_m = f_t \cdot n_t \cdot N$

$$N = \frac{CS(12\frac{in}{ft})}{\pi d}$$

$= 0.0050 \frac{in}{tooth\ rev} \cdot 4 \cdot N$

$$N = \frac{280\frac{sf}{min}(12\frac{in}{ft})}{(3.14(0.50\ in))\frac{1}{rev}} = 1910.83\frac{rev}{min}$$

$= 0.0050 \frac{in}{teeth\ rev} \cdot 4 \cdot 1910.83 \frac{rev}{min}$

$= 38 \frac{inches}{min}$

Factors That Affect Feed Rates

Power of spindle motor
Condition of cutting tool
Depth of cut
Quality of surface finish required
Roughing vs. finish cuts
Condition of the machine
Strength of fixture

Plunge Feed Rate

Feed rate at which mill can plunge into material while still cutting material
The plunge feed rate is calculated as one half of the feed rate.

Special Operations

Reaming: 1/2 to 2/3 of the speed used for drilling material

Counterboring: 1/4 of the speed used for drilling

Countersinking: 1/4 of the speed used for drilling material

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