MANUFACTURING PROCESSES
(TA-202)

TOOL WEAR, TOOL LIFE, HAND TOOLS AND MACHINE TOOLS

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**PROCESS OF CUTTING TOOL FAILURE**

**Cutting Tool Failure Mechanisms:**

1. By Plastic deformation
2. By chipping due to mechanical breakage
3. Burning of the tool
4. By gradual wear

A tool that no longer performs the desired function can be declared as “failed”
FLANK WEAR AND TIME RELATIONSHIP

Three stages of flank wear:
1. Rapid growth region (Break in region)
2. Steady state region (Temperature Insensitive region)
3. Catastrophe failure (Temperature sensitive region)

Flank wear formation depends on
* Cutting Conditions (f, d, V, tool angles)
* Properties of work material and tool material

Flank wear characterised by wear land (or Height) $h_f$ of wear band

Fig: (a) Three stage flank wear curve, (b) Various elements of flank wear and crater wear, (c) Variation of various crater wear with time
Tool wear Index, feed marks and surface finish

- **TYPE OF WEAR DEPENDS MAINLY ON CUTTING SPEED**
  - If cutting speed increases, predominant wear may be "CRATER" wear else "FLANK" wear.
  - Failure by crater takes place when index $h_k$ reaches 0.4 value, before flank wear limit of $h_f=1\text{mm}$ for carbide tools is attained.

$$h_k = \frac{C}{(l/2) + f}$$

Where, $C =$ Depth

- $l =$ Width
- $f =$ Distance

For HSS $h_k = 0.6$

$$R_{CLA} = \frac{8f^2}{R18\sqrt{3}}$$

$$R_{\text{max}} = 4R_{CLA}$$

Where, $f =$ Feed

$R =$ Tool Nose Radius
Effect of tool wear on machined surface

**FLANK WEAR AFFECTS:**

* Dimensional accuracy
* **Process stability**
* Surface finish

Effect of tool wear on machined component dimensions (Exaggerated view)
Tool no longer performs desired function — failed
Re-sharpen and use it again.

TOOL LIFE:

- Useful life of a tool expressed in terms of time from start of a cut to termination point (defined by failure criterion). Sometimes also expressed in terms of no. Of the parts machined.
- Tool failure criterion depends on
  - 1. The requirements of the component being produced.
  - 2. Type of Operation:
    - Roughing: force and power requirement.
    - Finishing: Surface finish & dimensional accuracy.

TAYLOR’S TOOL LIFE EQUATION

\[ VT^n = C \]

After 12 Years of Experiments

Where, \( V = \) Cutting Speed

\( T = \) Tool life (Minutes)

\( n = \) Exponent for conditions tested

\( C_t = \) Taylor’s constant

\( C_t \rightarrow \) represents cutting speed for 1 minute as tool life
Does not account for:

- Feed (f)
- Depth of cut (d)
- Tool geometry (Rake Angle $\alpha$)

\[
VT^n = C
\]  
(n<1), $C_t$ is very large

Taking logarithm on both sides

\[
\log V + n \log T = \log C_t
\]

This becomes a straight line on the log-log scale

\[
VT^{nf_1d_2} = C
\]

$N$, $n_1$, $n_2$: Constants depending upon tool material (=0.1 to 0.4).
$C$: constant that depends on tool-work material combination and tool geometry (>100)
VARIABLES AFFECTING TOOL LIFE

- Cutting Conditions (V, d, f)
- Tool Geometry (all six angles, and nose radius)
- Workpiece Material
- Cutting fluid
- Machine tool and Workpiece region
- Tool Material

MACHINABILITY

Mainly concerned with workpiece material properties not the tool properties. It depends on workpiece material properties and good machinability means:

1. Low tool wear
2. Good surface finish produced
3. Low cutting forces

Machinability is defined as “THE EASE WITH WHICH A GIVEN WORKPIECE MATERIAL CAN BE MACHINED WITH A SPECIFIED CUTTING TOOL.”
Apart from tool material, one has to give tool angles and tool nose radius in the following sequence while going to purchase or asking some one to make a tool:

- Tool specifications (all six angles, and nose radius): 7-8-5-6-9-4-1mm.
- Back rake angle (7°),
- Side rake angle (8°),
- End clearance (relief) angle (5°),
- Side clearance (relief) angle (6°),
- End cutting edge angle (9°),
- Side cutting edge angle (4°),
- Nose radius (1 mm)
FITTING SHOP EQUIPMENT

BENCH VICE
HAND VICE
PIPE VICE

File

Hand File
Flat File
Half-round File
Round File
Square File

File Card
Hammer

Hack Saw
Pitches of Hack Saw
Three Square File
Fitting Shop Equipment

Twist Drill
Counter bore Drill
Countersink Drill

Hand Reamer
Machine Reamer
Adjustable Reamer

Chisels

Die
Die Nut

Starting  Intermediate  Finishing

Taps
Tap Wrench
Measuring Equipment

- Ruler Scale
- Vernier Caliper
- Outside Micrometer
- Outside Caliper
- Dial Gauge
- Inside Micrometer
- Inside Caliper
- Vernier Height Gauge
- Depth Micrometer
Measuring & Marking Equipment

- Divider
- Surface Plate
- Bevel Protector
- Wire Gauge
- Center Square
- Engineer’s try Square
- Scriber
- Universal Marking Surface Gauge
- Center Punch
- Dot Punch
- Combination Set
- V-Block
- Striking Tools/Hammers
- Angle Plate
Measuring, Marking Equipment, tools and cutters

- Universal Marking Surface Gauge
- Dog Carrier
- Dog Plate
- Drill Chuck & Key
- Revolving Centre
- Cylindrical Cutter
- Slitting Saw Cutter
- Threading Tool
- Parting Tool
- Boring Tool
- Turning Tool
- Knurling Tool
- Screw Driver
THANK YOU
SUPPLEMENTARY MATERIAL