MACHINING TIME ESTIMATION METHODS

- The TOTAL MACHINING TIME (T_T) calculus is very important to determine:
- Manufacturing costs: Machine rate [€/h] * T_T [h]
- Machine work loads
- Personnel needs.
- Delivery time

$$T_T = T_{SET\ UP} + T_{\substack{MANUAL\\OPERATION}} + T_{CUTTING} + T_{UNFORESEEN}$$

- The cutting time ($T_{CUTTING}$) is the only one that can be accurately calculated. Rest of the times need to be estimated.

- Most commonly used TIME ESTIMATION methods are:

1. By estimation.
2. By comparison.
3. By timing.
4. By the sum of elementary predefined times.

MACHINING TIME ESTIMATION METHODS

$$T_T = T_{SET-UP} + T_{\substack{MANUAL\\OPERATION}} + T_{CUTTING} + T_{UNFORESEEN}$$

□ - : Set-up time

- Time necessary to prepare the machine-tool to be ready to start machining:
    - Workholding device set-up
    - Toolholding device set-up
    - Material procurement
    - Tool procurement

□ MANUAL OPERATION : Manual operation time

- It is difficult to calculate properly because it varies depending on part's dimensions and weight, machine tool, etc.
- In general, manual operation time > cutting time.
    - Workpiece clamping and un-clamping
    - Non-cutting movements
    - Tool changes
    - Taking references
    - Measurements

□ CUTTING : Cutting time

- It is the time consumed in movements that remove material.
- Non-cutting movements, such as fast approximations or retracts, are not considered.

$$T_{CUTTING} = \frac{L}{V}$$

L: tool or workpiece displacement.
V: displacement speed.

□ UNFORESEEN : Unforeseen time

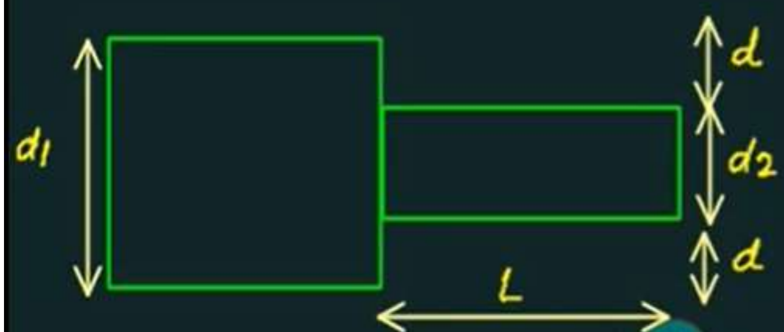
- It covers all the time gone in unforeseeable events during the machining process (unexpected times).
    - Machine-tool breakdown.
    - Tool wear or breakage
    - Lack of raw material.
    - Blackout

Turning

Turning is a machining process to produce parts round in shape by a single point tool on *lathes*. The tool is fed either linearly in the direction parallel or perpendicular to the axis of rotation of the workpiece, or along a specified path to produce complex rotational shapes. The *primary* motion of cutting in turning is the rotation of the workpiece, and the *secondary* motion of cutting is the feed motion.

$$d = \frac{d_1 - d_2}{2}$$

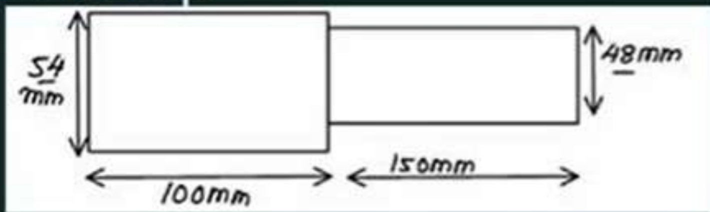
d=Depth of cut.



$$T = \frac{\text{Length of the job}}{\text{Feed/rev.} \times \text{r.p.m.}}.$$

Depth of cut. It is the thickness of the layer of metal removed in one cut or pass measured in a direction perpendicular to the machined surface, The depth of cut is always perpendicular to the direction of the feed motion.

Find the time required to turn a 60 mm diameter rod to the dimensions shown in Take cutting speed as 20 m/min, feed as 1.2 mm. All cuts are 3 mm deep



$$V_c = \frac{\pi d_1 N_1}{1000}$$

$$20 = \frac{\pi \times 60 \times N_1}{1000}$$

$$N_1 = 106.1 \text{ rpm}$$

$$T_1 = \frac{L_1}{f N_1} = \frac{250}{1.2 \times 106.1} = 1.96 \text{ min}$$

$$V_c = \frac{\pi d_2 N_2}{1000}$$

$$N_2 = \frac{20 \times 1000}{\pi\ 54} = 117.89 \text{ rpm}$$

$$T_2 = \frac{L_2}{f N_2} = \frac{150}{1.2 \times 117.89} = 1.06$$

$$T = T_1 + T_2 =$$

2) Estimate the machining time sec required in rough turning a 1.5-m-long, annealed aluminum-alloy round bar 75-mm in diameter, using a high-speed-steel tool, Let feed = 2 mm/rev and maximum cutting speed of 4 m/s

$$V_c = \frac{\pi D N}{1000} = \frac{m}{min}$$

$$240 = \frac{\pi \times 75 \times N}{1000}$$

$$N = 1018\ rpm$$

$$T = \frac{L}{fN}$$

$$= \frac{1500}{2 \times 1018}\ min$$

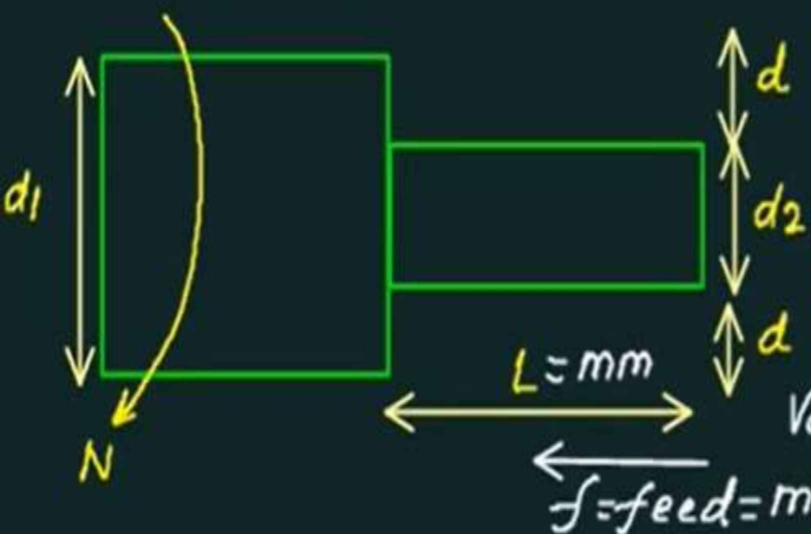
$$= 0.74\ min$$

$d = \frac{d_1 - d_2}{2}$

$T = \frac{L}{fN}$

d=Depth of cut.

$$T = \frac{\text{Length of the job}}{\text{Feed/rev.} \times \text{r.p.m.}}$$

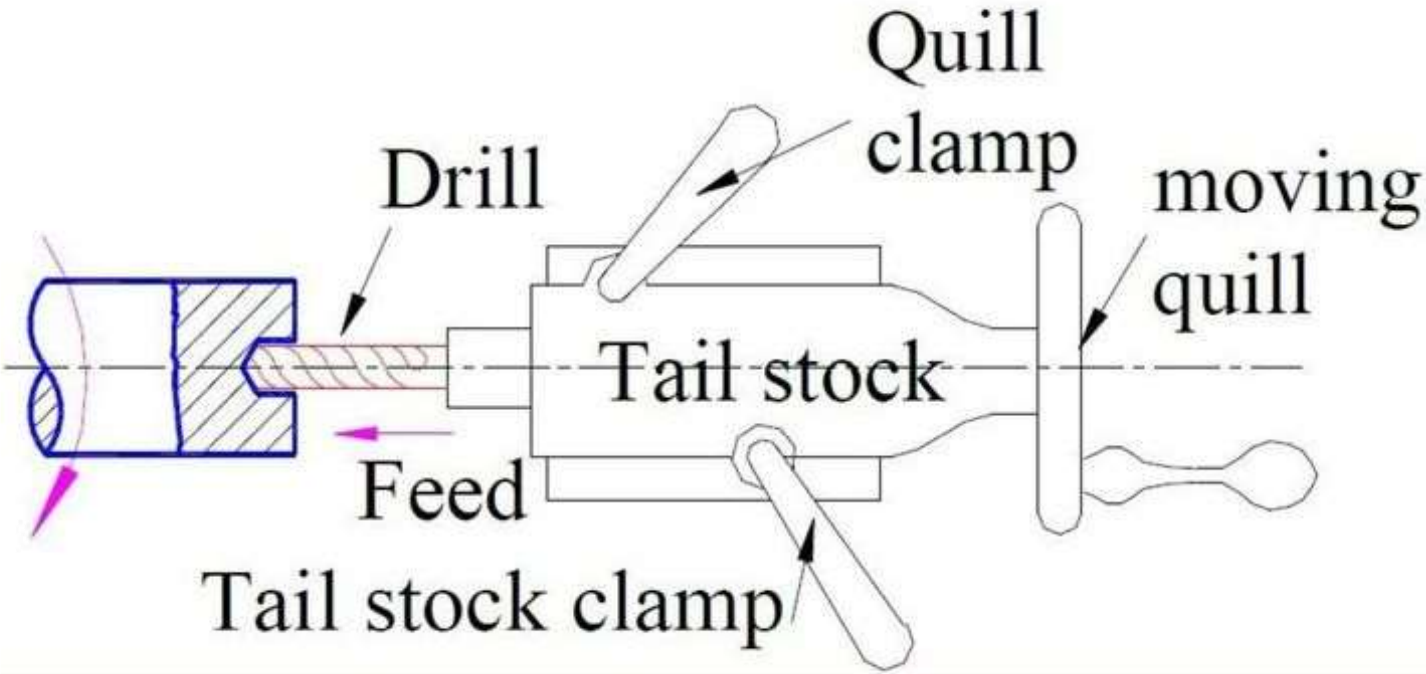


$V_{oxial} = f \cdot N \ \frac{mm}{min}$

V_c = Cutting Velocity = m/min

$= \frac{\pi d_1 N}{1000}$

Calculation of Machining Time for Drilling Operations



T = time required for drilling	(min)
f = feed per revolution	(mm)
L = Depth of hole to be produced	(mm)
N = Revolutions of the job per minute	(rpm)
$= \frac{1000 \times S}{\pi D}$	
S = Cutting speed	(m/min)
D = diameter of the hole to be drilled	(mm)

Time taken to drill unit length $= \frac{1}{Feed/min}$

Time taken to drill **L** mm length $= \frac{L}{Feed/min}$

$$T = \frac{L}{fN}$$

Time required for drilling = T = $\frac{Depth\ of\ hole\ to\ be\ produced}{f \times N}$

A 10 cm thick laminated plate used in pressure vessels consists of 8 cm thick steel plate cladded with titanium plate of thickness 2 cm. A 1 cm diameter hole is to be drilled through this composite plate. Estimate the time taken for drilling this hole if, cutting speed of steel and titanium are 2.5cm/min and 1cm/min respectively. Also the feed of drill for steel and titanium are 0.025 cm/rev and 0.02 cm/rev respectively.

Given data

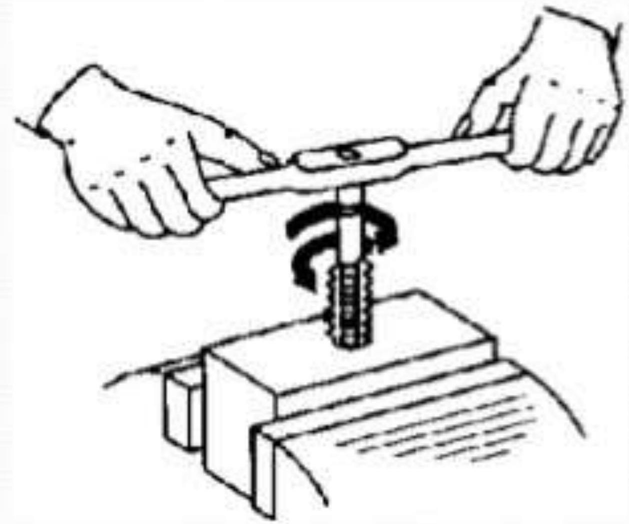
L = 100mm; L_1 = 80mm; L_2 = 20 mm; D = 10 mm; S_{steel} = 25 m/min;

$S_{titanium}$ = 10 m/min; f_{steel} = 0.25 mm/rev; $f_{titanium}$ = 0.2 mm/rev

Calculation of Machining Time
Boring Operation

T = time required for boring	(min)
f = feed per revolution	(mm)
L = Depth of bore to be produced	(mm)
N = Revolutions of the job per minute	(rpm)
$= \frac{1000 \times S}{\pi D}$	
S = Cutting speed	(m/min)
D = diameter of the hole to be bored	(mm)

- Tapping is the operation of cutting internal threads in a hole using a cutting tool called Tap.
- Most of the industries uses the conventional method -- **hand tapping.**
- Threads are taped by manually rotating & feeding the taps through the drilled hole
- This conventional method is very time consuming process, less accurate and includes higher labour cost, and ultimately less productivity.
- So there is a scope to develop the machine for tapping operation.



Time taken to bore unit length $= \frac{1}{Feed/min}$

Time taken to bore **L** mm length $= \frac{L}{Feed/min}$

$$T = \frac{L}{fN}$$

Time required for boring = T = $\frac{Length\ or\ Depth\ of\ bore\ to\ be\ produced}{f \times N}$

What will be the machine time required to rough bore, to second bore and to finish bore a soft cast iron cylinder whose diameter is 220 mm and the length of bore is 260 mm. (i) rough bore 39 rpm, 2.857 mm feed, (ii) second rough bore 45 rpm, 0.987 mm feed and (iii) finish bore 25 rpm, 5.75 mm feed.

Given data

Diameter (D) = 220 mm; Length of the bore (L) = 260 mm

To find

Time required to rough, second and finish bores

Diameter (D) = 220 mm; Length of the bore (L) = 260 mm

To find

Time required to rough, second and finish bores

Solution

(i) Rough bore time (T_1) f = 2.857 mm ; N = 39 rpm

$$T_1 = \frac{L}{fN}$$

$$= \frac{260}{2.857 \times 39} = \mathbf{2.333\ min}$$

Thread cutting – removal of material to produce helix on external or internal circular surface for fastening

Time required for threading = T = $\frac{Length\ of\ cut}{f \times N}$ × no. of cuts

Pitch for a single start thread = Pitch of the thread

Pitch for a multi-start thread = Pitch × number of starts

For external threads, number of cuts = $\frac{25}{threads\ per\ cm}$

For internal threads, number of cuts = $\frac{32}{threads\ per\ cm}$

Estimate the time required for cutting 3 mm pitch threads on a mild steel bar of 2.8 cm diameter and 8 cm long. Assume the cutting speed for threading as 15 m/min.

Solution

N = $\frac{1000 \times S}{\pi\, D}$ = $\frac{1000 \times 15}{\pi \times 28}$ = 170.52 rpm

Threads per cm = $\frac{1}{pitch}$ = $\frac{1}{0.3}$ = 3.333

Number of cuts = $\frac{25}{threads\ per\ cm}$ (for external threads)

$$= \frac{25}{3.333} = 7.5 \text{ or } 8 \text{ approximately}$$

Threading time / cut = $\frac{L}{pitch \times N} = \frac{80}{30 \times 170.52} = 0.156$ min

Time for 8 cuts = 0.156×8 = **1.25 min**