PRPC21 MANUFACTURING TOOLING AND AUTOMATED INSPECTION

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Products Portfolio

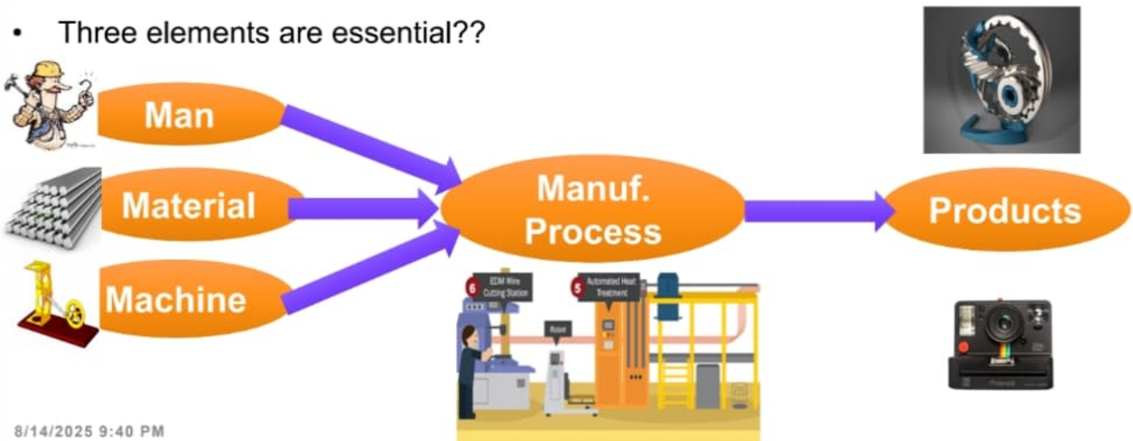





Credit: https://giphy.com/explore/iphone-x
https://in.pinterest.com/pin/302374562467957812/?lp=true

What is Manufacturing Process?

- "Manufacturing is the process of converting raw material into useful products"
- Three elements are essential??



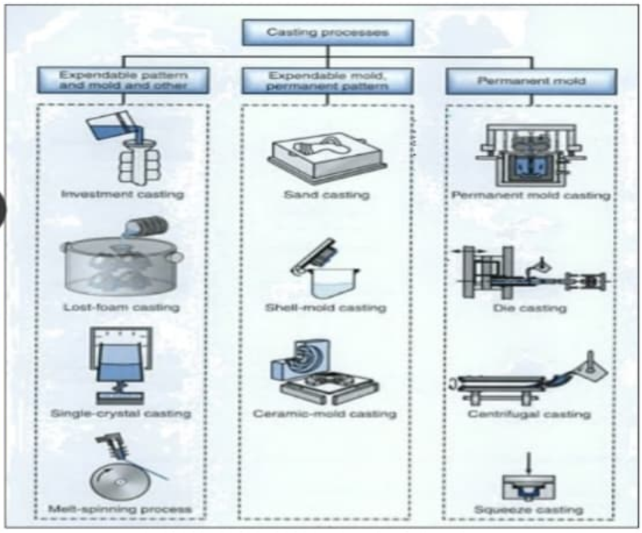
Basic Manufacturing Processes

- Casting
- Deformation processes (Forging, Rolling, Extrusion, Drawing, Sheet metal forming, Powder metallurgy)
- Joining (Fastening, Welding, and Adhesive joining)
- Machining (Lathe, Milling, Drilling, CNC etc.)
- Finishing (Grinding, Lapping, Honing etc.)

Credit: https://gfycat.com/accuratejampackedarcherfish

Basic Manufacturing Processes

There is often more than one method that can be employed to produce a component for a product from a given material. The following broad categories of casting processes are all applicable to metallic materials:



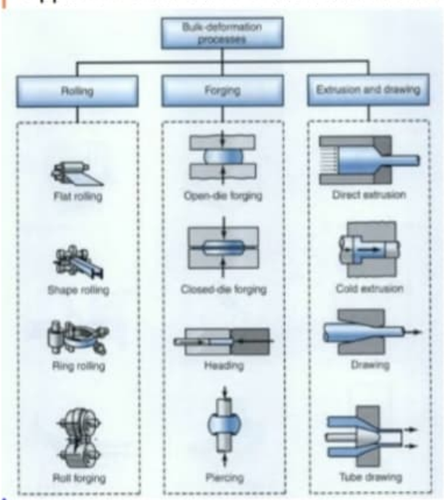
Various Casting Processes credit: KalpakJian

Various casted parts

Stainless Steel Pump Diffuser Casting

Basic Manufacturing Processes

There is often more than one method that can be employed to produce a component for a product from a given material. The following broad categories of bulk deformation processes are all applicable to metallic as well as non-metallic materials:



Various Bulk Deformation Processes credit: KalpakJian

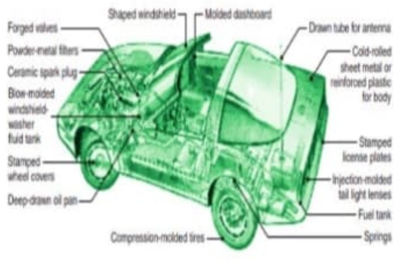
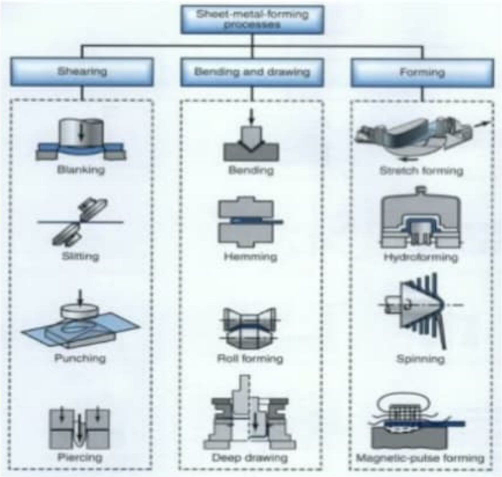


FIGURE III.1 Formed and shaped parts in a typical automobile.

Basic Manufacturing Processes

There is often more than one method that can be employed to produce a component for a product from a given material. The following broad categories of **sheet metal forming processes** are all applicable to metallic materials:



Various Sheet-Metal Forming Processes credit: KalpakJian

Metal desk

File cabinets

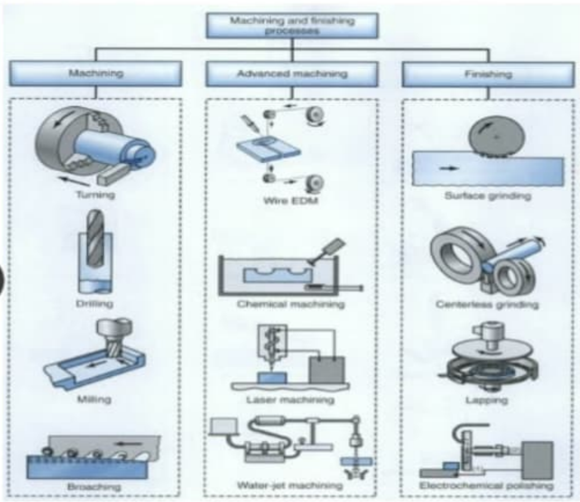
Appliances

Aircraft Fuselage

Car bodies

Basic Manufacturing Processes

There is often more than one method that can be employed to produce a component for a product from a given material. The following broad categories of **machining processes** are all applicable to metallic materials



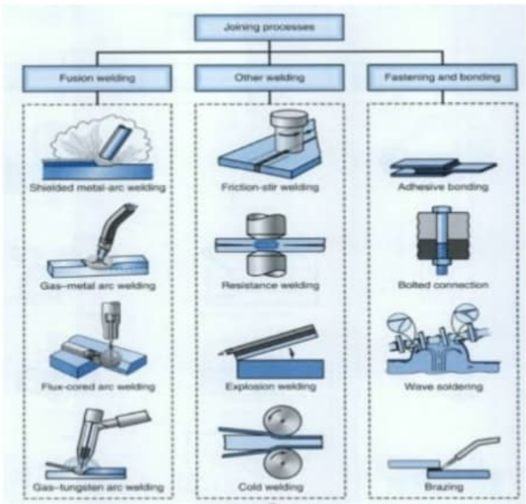
Various Machining and Finishing Processes credit: KalpakJian

Machined Parts

Micro Machined Parts

Basic Manufacturing Processes

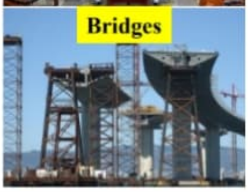
There is often more than one method that can be employed to produce a component for a product from a given material. The following broad categories of **joining methods** are all applicable to metallic materials:



Various Joining Processes credit: KalpakJian

Automobile Construction **Rail Road Equipment**

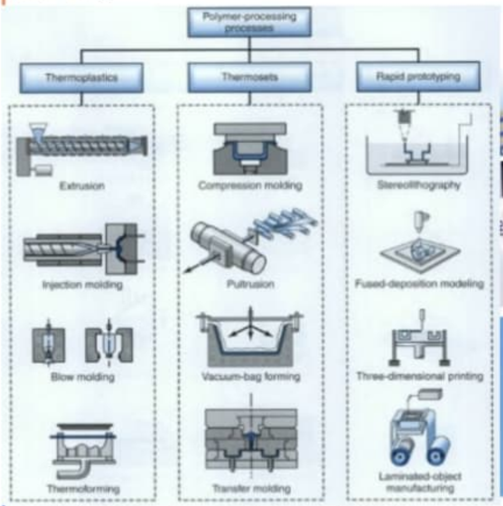
Bridges

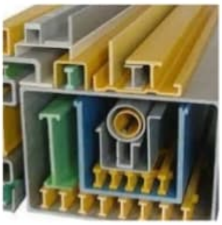


Buildings

Basic Manufacturing Processes

There is often more than one method that can be employed to produce a component for a product from a given material. The following broad categories of **polymer processing methods** are all applicable to polymer materials:





Various Polymer Processing Methods credit: KalpakJian

Manufacturing Processes Objectives

Quality Control: Ensuring that the final products meet the required specifications and standards. This includes maintaining consistent quality across all units produced and minimizing defects.

Cost Reduction: Reducing the cost of production through efficient use of materials, energy, and labor. This involves optimizing processes to minimize waste and enhance productivity.

Productivity Improvement: Increasing the output of manufacturing processes by improving the efficiency of machines and labor. This can involve the implementation of automation and lean manufacturing techniques.

Flexibility: Developing manufacturing processes that can easily adapt to changes in product design and production volume. This is particularly important in industries where product customization and rapid response to market changes are crucial.

Safety: Ensuring that manufacturing processes are safe for workers and comply with health and safety regulations. This includes implementing safety protocols and using machinery and equipment that reduce the risk of accidents.

Sustainability: Reducing the environmental impact of manufacturing processes. This involves using sustainable materials, reducing energy consumption, and minimizing waste and emissions.

Manufacturing Processes Objectives

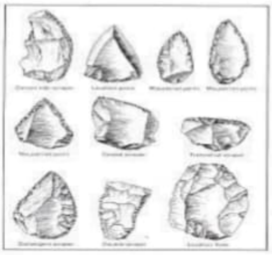
Innovation: Continuously improving and innovating manufacturing processes to stay competitive. This includes adopting new technologies and methodologies that can enhance efficiency and product quality.

Reliability: Ensuring that manufacturing processes are reliable and capable of producing products consistently without unexpected downtime or failures.

Customer Satisfaction: Meeting or exceeding customer expectations in terms of product quality, delivery times, and cost. This involves aligning manufacturing processes with customer requirements and market demands.

What is Tool?

- A **tool is an object** that can extend an individual's ability to modify features of the surrounding environment or help them accomplish a particular task (Wiki).
- An instrument such as a hammer, screwdriver, saw, etc. that you hold in your hand and use for making things, repairing things, etc. (Oxford dict.).

Tools around 4000 BC, scrapers, hand axes and other stone tools

Carpentry Tools

Image credit: Google images

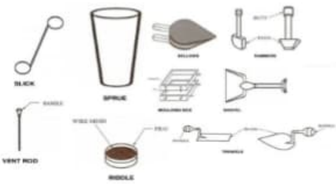
What is Tool?

- **A tool is component or equipment which is used for manufacturing other components is called a tool**
- **In the context of machining, a cutting tool or cutter is typically a hardened metal tool that is used to cut, shape, and remove material from a work piece by means of machining tools as well as abrasive tools by way of shear deformation.**


Cutting Tools

Bicycle multi-tool

Pliers, Hammers etc.



Foundry tools

Image credit: Google images

What is Manufacturing Tooling?

- Manufacturing tooling is the process of designing, cutting, shaping, and forming materials to produce parts and components.
- Tooling can include a variety of equipment and gear, such as molds, jigs, fixtures, gauges, and cutting equipment.
- Effective tooling can help ensure the:
  - correct functionality of manufactured goods,
  - increase product life cycles,
  - decreases downtime due to repairs and maintenance, increases consistency, and reproducibility
  - produce high-quality products.

Tooling image credit: Reid Supply

What is Engineering Design?

- **Engineering Design** is the systematic, creative, and iterative process of identifying and solving engineering problems. It's about transforming ideas into tangible solutions that meet specific needs or requirements.

Key Characteristics of Engineering Design:

- **Problem-Focused:** It starts with identifying a problem or need.
- **Creative:** Engineers use their imagination and knowledge to develop innovative solutions.
- **Iterative:** The process involves continuous improvement and refinement.
- **Constraint-Based:** Designs must adhere to limitations like budget, materials, time, and safety.
- **Solution-Oriented:** The ultimate goal is to create a functional and effective product or system.

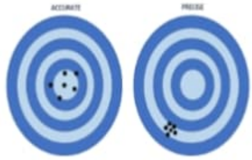
Design Thinking Process Movie (3.56 Min)

Tool Design

- Tool design is a specialized area of manufacturing engineering comprising the **analysis, planning, design, construction, and application** of tools, methods, and procedures necessary to increase manufacturing productivity.
- Word of **tooling** refers to the **hardware necessary** to **produce a particular product**
- **Today's tool designer must have a working knowledge of machine shop practices, toolmaking procedures, machine tool design, manufacturing procedures and methods,**
- **Also more conventional engineering disciplines of planning, designing, engineering graphics and drawing, and cost analysis.**

Objectives of Tool Design

- Reduce the overall cost of manufacturing a product by making acceptable parts at the lowest cost.
- Increase the production rate by designing tools to produce parts as quickly as possible.
- Maintain quality by designing tools to consistently produce parts with the required precision.
- Reduce the cost of special tooling by making every design as cost-effective and efficient as possible.
- Design tools to be safe and easy to operate.



Tool Design Process

1. Statement of the problem

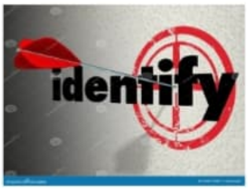
- Define the problem in a **clear and simple statement** of the functional needs
- Manufacturing engineer usually provides the tool designer with the problem
- Tool designer will receive a **part print**, **information on why the tool is needed**, **what capabilities of tool must be**, **type of the machine tool must be used on**, **the number of parts to be produced** and other pertinent information concerning the part.
- The problem statement should identify the problem in one or two sentences

For example

- "To design a drill jig to hold a support bracket while drilling three 5/8-in,-dia holes"

2. The Need Analysis

- Some times called as **predesign analysis**
- Pinpoints the problem in terms of functional need
- The problem is analyzed by asking who, why, how, when, what, and where questions about the functional requirements of the problem
- For Example:
  - Will the tool be used by skilled or unskilled operators?
  - What are the hole location tolerances on the part?
  - Will operating handles of the machine strike the tool?
  - What previous operation have been done on the part?
  - Can tool made with the available components and facilities?



3. Research and Ideation (Sketches)

Information and data based on the needs analysis are gathered

- Dimensions of the part to be held or produced,
- Material from which part is made,
- Tolerances of the part,
- The dimensions of the machine,
- The limitation of the machine and
- Amount of tonnage of the blank part

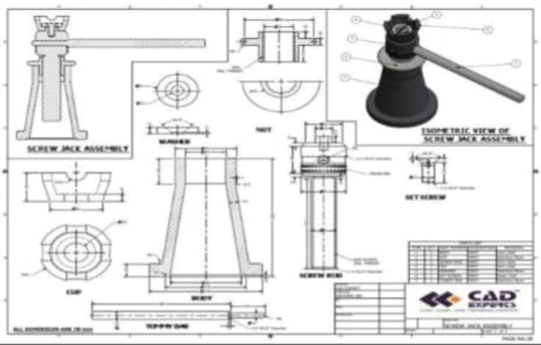
- All the information may be obtained by talking to people, magazines, catalogues, handbooks, making calculation, making measurements, consulting experts, experimental mock-ups.
- Ideas must be sketched on paper for future references
- Research will lead to new ideas and the sketches will show the need for more research

4. Tentative Design Solutions

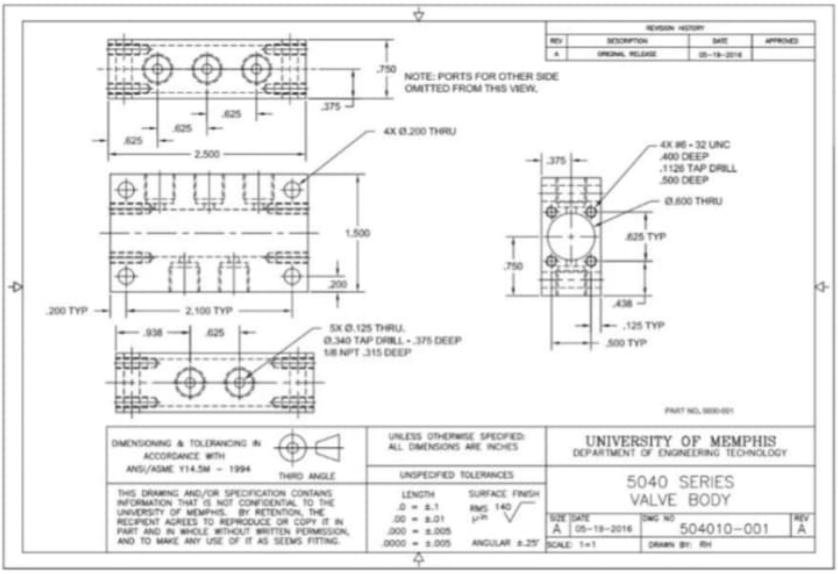
- The research and sketches should be combined into one or two tentative design solutions,
- It may consists of rough working drawings showing a side and top view and perhaps an end view if needed.
- They may not be scale,
- Isometric or perspective sketch may be made
- The tentative design solutions will be evaluated
- The best selected and reworked and final design decided upon

5. The Finished Design

- The design may not be the actual finished product
- For even in the final design drawing changes and additions may be necessary
- However, an accurate drawing must be completed before the tool maker is able to begin construction
- Drawing will probably consists of a isometric or orthographic according to the scale and to the tool drawing procedures of the company



Tooling Drawings



Tooling Drawings

- Do not crowd views
- Analyze each cut
- Use standard values
- Use only the views necessary to define the part
- Realistic, thoughtful tolerances
- Shaft easier to change than hole
- Use stock sizes if possible
- Notes may be necessary

Types of Tooling

The most common classification of tooling is as follows:

1. Cutting tools, such as drills, reamers, milling cutters, broaches, and taps
2. Jigs and fixtures for guiding the tool and holding the work piece
3. Gages and measuring instruments
4. Sheet-metal press working dies for all types of sheet-metal fabrication
5. Dies for plastic molding, die casting, permanent molding, and investment casting
6. Forging dies for hot and cold forging, upsetting, extrusion, and cold finishing

Cutting Tools

1. Cutting tools, such as drills, reamers, milling cutters, broaches and taps

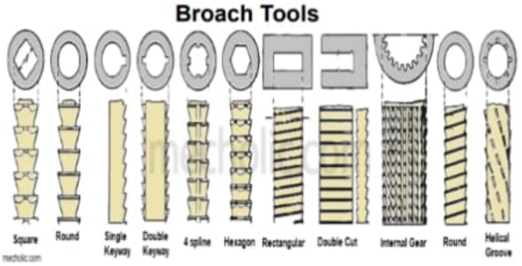
Drill bits

Reamers

Taps

Types of Milling Cutters

Broach Tools



Drill Jigs

For Guiding The Tool

Fixtures

For Holding The Workpiece

Gages and Measuring Instruments

Snap Gauge

Plug Gauge

Ring Gauge

Feeler Gauge

Dial Gauge

Scale Ruler

Bevel Protector

Height Gauge

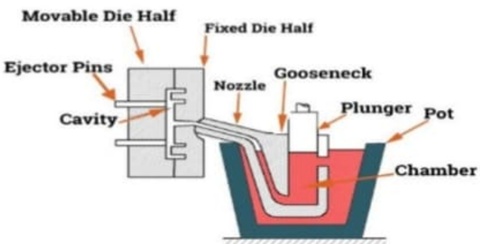
Credit: https://qidemy.com/wp-content/uploads/2020/11/Types-of-Gauges.pdf

Gages and Measuring Instruments

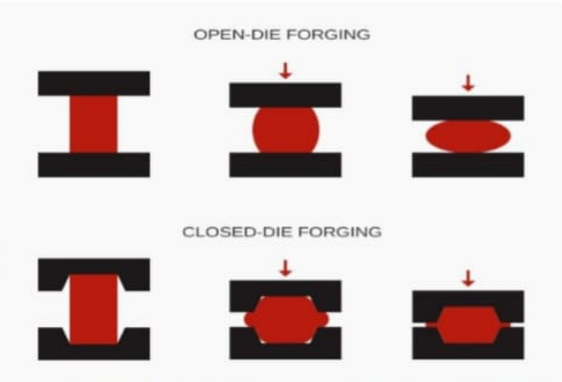
Dies For Plastic Molding, Die Casting, Permanent Molding And Investment Casting

Plastic die mold

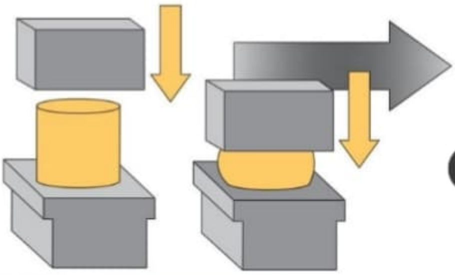
Die casting



Forging Die For Hot and Cold Forging, Upsetting, Extrusion and Cold Finishing

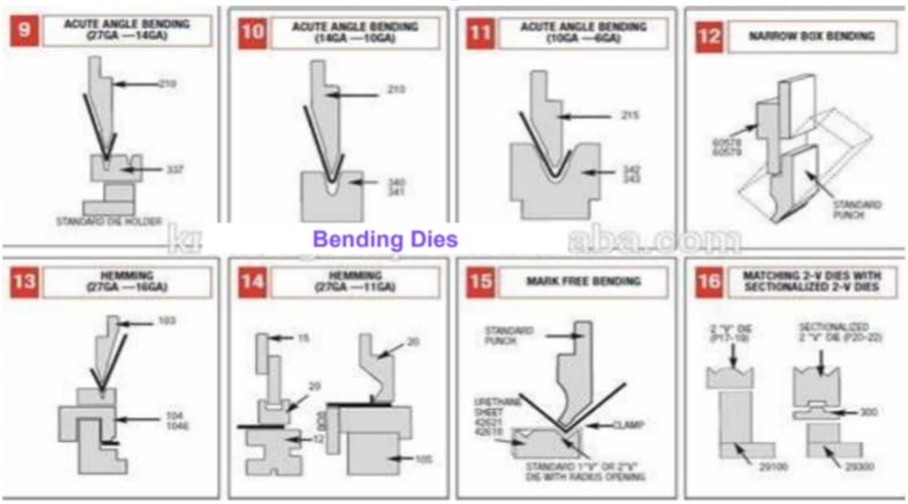


Upsetting

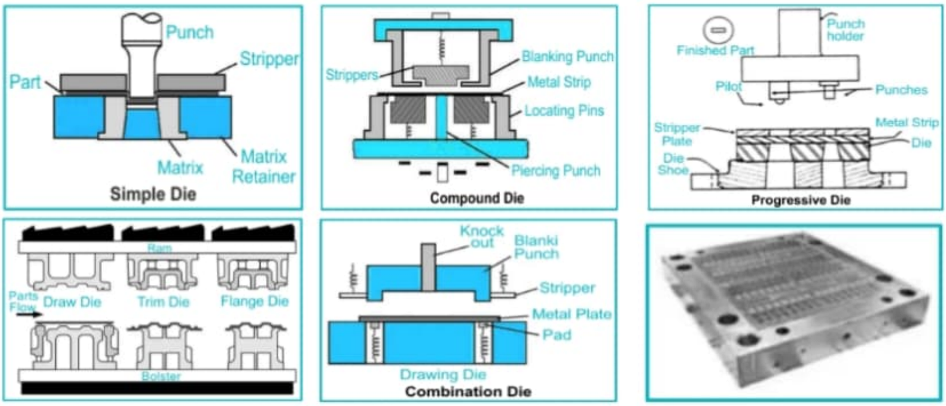


Sheet-metal Press Working Dies For All Types Of Sheet Metal Fabrication

Bending



Sheet-metal Press Working Dies For All Types of Sheet Metal Fabrication



Transfer Die

Round Split die

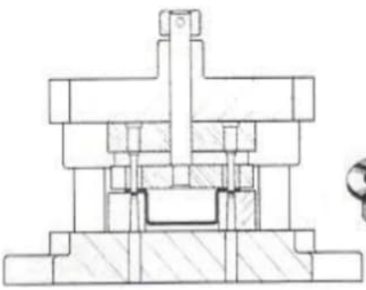
Adjustable Die:

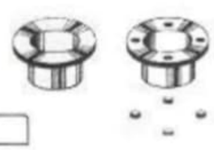
Acron Die:

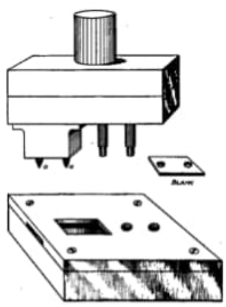
Credit: https://testbook.com/mechanical-engineering/types-of-dies

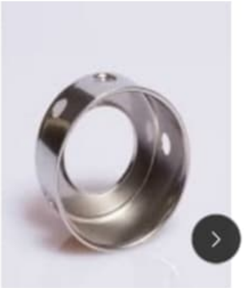
Sheet-metal Press Working Dies For All Types of Sheet Metal Fabrication

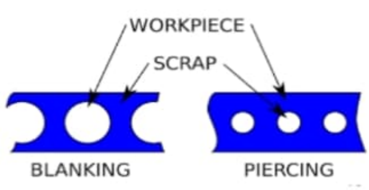
Blanking & Piercing Dies











Cutting Tools

- Cutting tools are tools used to remove material from a workpiece in the form of chips. They are used in a wide range of manufacturing and machining processes, such as drilling, milling, turning, and grinding.

Or

- In the context of machining, a cutting tool or cutter is typically a hardened metal tool that is used to cut, shape, and remove material from a workpiece by means of machining tools as well as abrasive tools by way of shear deformation.

Credit: https://www.theengineerspost.com/cutting-tools-types/

Cutting Tool Materials

- High-speed Steels
- Cast-cobalt Alloys
- Carbides
- Ceramics Alumina and Silicon-nitride Based Ceramics
- Cubic Boron Nitride
- Diamond
- Whisker-reinforced Materials and Nanomaterials

HSS

Cemented carbide

CBN

Diamond

High Speed Steel (HSS)

- High-speed steel (HSS) tools were developed to machine higher speeds than was previously possible
  - compared to carbon steels (low hot hardness ⇒low speeds)
- Can be hardened to various depths, have good wear resistance and are inexpensive
- Suitable for: high +ve rake angle tools, interrupted cuts, machines subject to vibration/chatter, complex tools
- Biggest drawback: low cutting speed (V) vs carbide tools

Two basic types of HSS:

1. Molybdenum (M-series: 10% Mo; other alloys: Cr, V, W, Co): higher abrasion resistance than T-series, less distortion during heat treatment, less expensive ⇒ comprise 95% of HSS
2. Tungsten 18-4-1 (T-series: Tungsten: 18%, Chromium: 4%, Vanadium: 1%)

High Speed Steel (HSS)

- High-speed steel tools are available in:
  - wrought (rolled or forged)
  - cast
  - powder-metallurgy (sintered) forms
- They can be treated to improve performance:
  - Coating
  - Surface treatment (to improve hardness, wear resistance)
  - Steam treatment (reduce tendency of BUE formation)

Cast-cobalt Alloys

- Usually contains 25% to 35% chromium, 4% to 25% tungsten and 1% to 4% carbon. Remaining is Cobalt.
- It is a non- ferrous alloy consisting mainly of Cobalt, Tungsten and other elements like Tantalum, Molybdenum and Boron.
- It has good shock and wear resistance and retains it's hardness at red heat upto 920°C.
- Tools made of this are capable of operating at **speed up to 2 times more than** those of common **HSS tools**.
- This material does not respond to the usual heat treatment process and only grinding can be used for machining it effectively.
- Cast alloys also called **Stellite**.

Cemented Carbide Cutting Tool and Cermet

- The cemented carbide cutting tool is **produced** by **powder metallurgy** technique. It consists of **tungsten, tantalum and titanium carbide with cobalt** as a **binder** (when the binder is nickel or molybdenum, then it is called cermet).
- Cemented carbide tools are **extremely hard**; they can withstand very high-speed cutting operation. Carbide tool does not lose **their hardness up to 1000° C**.
- A high cobalt tool is used for a rough cut while low cobalt tool used for finishing operations.

Cutting speed range - 60-200m/min

Ceramic

- Most common ceramic materials are aluminum oxide and silicon nitride. Powder of ceramic material Compacted in insert shape, then sintered at high temperature.
- Ceramic tools are **chemically inert and possess resistance to corrosion**.
- They have **high compressive strength**.
- They are stable up to temperature 1800 °C. They are **ten times faster than HSS**. The friction between the **tool face and chip are very low and possess low heat conductivity, usually no coolant is required**. They provide the **very excellent surface finish**.

Cutting speed 300-600m/min

Temperature – 1200 °C

Cubic Boron Nitride (CBN) & Diamond

CBN

- It is the second hardest material after diamond. They are generally used in hand machines. They offer high resistance to abrasion and use as an abrasive in grinding wheels. Sharp edges are not recommended.

Speed 600-800m/min

Diamond

- It is the **hardest material known** and it is also expensive. It possesses very high thermal conductivity and melting point. Diamond offers excellent abrasion resistance, low friction coefficient and low thermal expansion. It is used in machining very hard material such as carbides, nitrides, glass, etc.
- Diamond tools give a good surface finish and dimensional accuracy. They are not recommended for machining steel.

Whisker-reinforced Materials and Nanomaterials

Continuous effort to improve tool performance, increase wear resistance, and enhance properties:

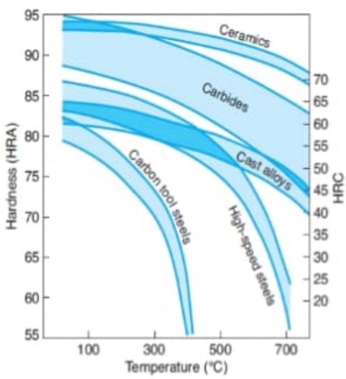
1. High fracture toughness
2. Resistance to thermal shock
3. Cutting-edge strength
4. Creep resistance
5. Hot hardness

- **Whiskers: used for reinforcing fibers in composite tools**
  - e.g. Si-carbide whiskers: 5-100 μm long, diameter: 0.1-1 μm
- **Nanomaterials: also becoming important in tools**
  - e.g. carbides, ceramics; applied as thin coating
  - Increase tool life without coolant (i.e. dry machining)

Characteristics of Cutting Tool

Tool Materials (also used for dies and molds in casting, forming, and shaping metallic and non-metallic materials):

- Hardness (resistance to wear)
- Hot hardness (capacity to retain hardness at high temperatures
- Toughness (resistance to impact forces on tool in interrupted operations)
- Chemical stability or inertness (to avoid adverse reactions)



Characteristics of Cutting Tool

- **Wear resistance**: Wear resistance is a material's ability to resist the loss of material from its surface due to mechanical forces like abrasion, erosion, rubbing, sliding, or scraping
- **Low friction**: Tool material must have a low coefficient of friction. So that the heat generated will be lower, and tool life increases.
- **Shock resistance**: Tool material must have high resistance against thermal and mechanical shocks, specially in intermittent cutting in which tool-work engages and dis-engages at regular intervals.

General Characteristics of Cutting Tool

General Characteristics of Cutting-tool Materials (These Tool Materials Have a Wide Range of Compositions and Properties; Overlapping Characteristics Exist in Many Categories of Tool Materials)

	High-speed steels	Cast-cobalt alloys	Uncoated carbides	Coated carbides	Ceramics	Polycrystalline cubic boron nitride	Diamond
Hot hardness	→						
Toughness	←						
Impact strength	←						
Wear resistance	→						
Chipping resistance	←						
Cutting speed	→						
Thermal-shock resistance	←						
Tool material cost	→						
Depth of cut	Light to heavy	Light to heavy	Light to heavy	Light to heavy	Light to heavy	Light to heavy	Very light for single-crystal diamond
Processing method	Wrought, cast, HIP[a] sintering	Cast and HIP sintering	Cold pressing and sintering	CVD or PVD[b]	Cold pressing and sintering or HIP sintering	High-pressure, high-temperature sintering	High-pressure, high-temperature sintering

General Characteristics of Tool Materials

Property	High-speed steels	Cast-cobalt alloys	Carbides WC	Carbides TiC	Ceramics	Cubic boron nitride	Single-crystal diamond*
Hardness	83–86 HRA	82–84 HRA 46–62 HRC	90–95 HRA 1800–2400 HK	91–93 HRA 1800–3200 HK	91–95 HRA 2000–3000 HK	4000–5000 HK	7000–8000 HK
Compressive strength, MPa	4100–4500	1500–2300	4100–5850	3100–3850	2750–4500	6900	6900
Transverse rupture strength, MPa	2400–4800	1380–2050	1050–2600	1380–1900	345–950	700	1350
Impact strength, J	1.35–8	0.34–1.25	0.34–1.35	0.79–1.24	<0.1	<0.5	<0.2
Modulus of elasticity, GPa	200	—	520–690	310–450	310–410	850	820–1050
Density, kg/m^3	8600	8000–8700	10,000–15,000	5500–5800	4000–4500	3500	3500
Volume of hard phase, %	7–15	10–20	70–90	—	100	95	95
Melting or decomposition temperature, °C	1300	—	1400	1400	2000	1300	700
Thermal conductivity, W/m K	30–50	—	42–125	17	29	13	500–2000
Coefficient of thermal expansion, $\times 10^{-6}/°C$	12	—	4–6.5	7.5–9	6–8.5	4.8	1.5–4.8

*The values for polycrystalline diamond are generally lower, except for impact strength, which is higher.

General Operating Characteristics of Cutting-Tool Materials

Tool materials	General characteristics	Modes of tool wear or failure	Limitations
High-speed steels	High toughness, resistance to fracture, wide range of roughing and finishing cuts, good for interrupted cuts	Flank wear, crater wear	Low hot hardness, limited hardenability, and limited wear resistance
Uncoated carbides	High hardness over a wide range of temperatures, toughness, wear resistance, versatile, wide range of applications	Flank wear, crater wear	Cannot use at low speeds because of cold welding of chips and microchipping
Coated carbides	Improved wear resistance over uncoated carbides, better frictional and thermal properties	Flank wear, crater wear	Cannot use at low speeds because of cold welding of chips and microchipping
Ceramics	High hardness at elevated temperatures, high abrasive wear resistance	Depth-of-cut line notching, microchipping, gross fracture	Low strength and low thermomechanical fatigue strength
Polycrystalline cubic boron nitride (cBN)	High hot hardness, toughness, cutting-edge strength	Depth-of-cut line notching, chipping, oxidation, graphitization	Low strength, and low chemical stability at higher temperature
Diamond	High hardness and toughness, abrasive wear resistance	Chipping, oxidation, graphitization	Low strength, and low chemical stability at higher temperatures

Source: After R. Komanduri and other sources.

Selection of Tool Material

The common factors that are considered for economic analysis are

Tool Changing Time	Machine Cost Per Unit Time	Labor Cost
Secondary Treatment	Tool Life	Tool Changing Cost
Tool Regrinding Costs	Number of Regrinding Per Tool	Production Target
Cutting Speed	Tool Material	Cost

Economics of Tool Design

Basic guidelines of economical design are important to keeping costs low while maintaining part quality:

- Keep all designs simple, functional, and uncomplicated
- Use preformed commercial materials where possible
- Always use standard pre-manufactured components
- Reduce or eliminate unnecessary operations
- Do not use overly tight, expensive tolerances
- Combined operations
- Simplify tool drawings and documentation

Combined Operations

- Analysis may sometimes show that operations can be cost-effectively combined.
- So that, tooling costs, production costs, or both can be reduced.
- Table 1-2 illustrates a case where the cost of combined tools was less than the total cost of the separate tools otherwise required.

Table 1-2. Cost of combined versus separate operations

Costs	Blanking Operation Alone	Forming Operation Alone	Total Blank and Form	Combined Operations
Tools	$40.00	$30.00	$70.00	$50.00
Setup	2.00	2.00	4.00	3.00
Maintenance	2.00		2.00	2.00
Processing	4.00	30.00	34.00	4.00
Total cost	$48.00	$62.00	$110.00	$59.00

Process Cost Comparison

Break Even Point

$$N_b = \frac{T_y - T_z}{P_z - P_y} \quad (1\text{-}1)$$

Total unit cost for a particular method

$$C_y = \frac{P_y N_t + T_y}{N_t} \quad (1\text{-}2a)$$

Total unit cost for a particular method

$$C_z = \frac{P_z N_t + T_z}{N_t} \quad (1\text{-}2b)$$

N_t = total number of parts to be produced in a single run
N_b = number of parts for which the unit costs will be equal for each of two compared methods Y and Z (break-even point)
T_y = total tool cost for method Y, $
T_z = total tool cost for method Z, $
P_y = unit tool process cost for method Y, $
P_z = unit tool process cost for method Z, $
C_y, C_z = total unit cost for methods Y and Z, $

Total Unit cost

C_y -Total unit cost for a particular method (Y)

Description: C_y is the total unit cost for method Y ($)

P_y - 3$, Unit process cost for method Y (Dollar/Unit)

N_t - 5, Number of units to be produced in a single run (units)

T_y - 810$, Total tooling cost for method Y, (Dollar)

C_y - ? Total unit cost (Dollar per unit)

$$C_y = \frac{P_y N_t + T_y}{N_t} = \frac{3 \times 5 + 810}{5}$$ = 165 is the total unit cost dollar per unit

Break Even Point

N_b, Break Even Point

Description: N_b is the number of parts for which the unit costs will be equal for each of two compared methods Y an Z.

Method Y

T_y	$ 810.00	Total tooling cost for method Y (dollars)
P_y	$ 1.05	Unit process cost for method Y (dollars/unit)

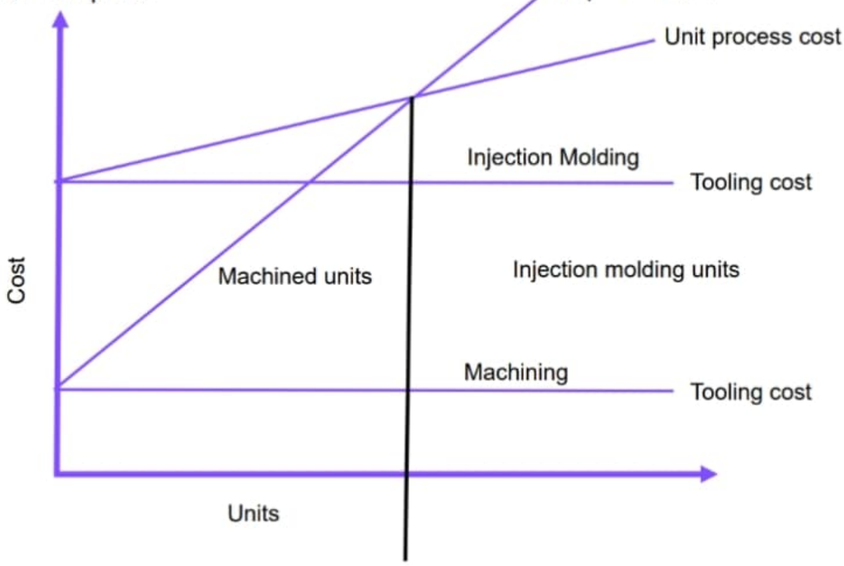
Method Z

T_z	$ 202.00	Total tooling cost for method Z (dollars)
P_z	$ 1.85	Unit process cost for method Z (dollars/unit)
N_b	760	Number of units at break even point

$$N_b = \frac{T_y - T_z}{P_z - P_y}$$

Break Even Point

Two process comaprison



Typical Tooling Example

Molds

Sand casting

Moulds

Casting Mold

Credit: Medium.com

Die-casting mold

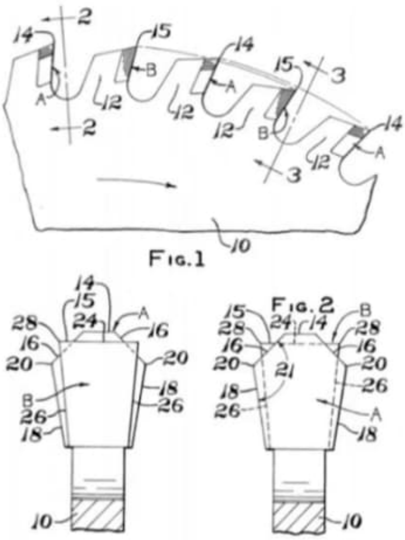
Press Tooling

Fabrication of L-shaped bending part

CMP_ Hydraulic Tube End-form Press

Pipe cutting machine with auto feeding

Cutting tools



Workholding & Inspection Tools

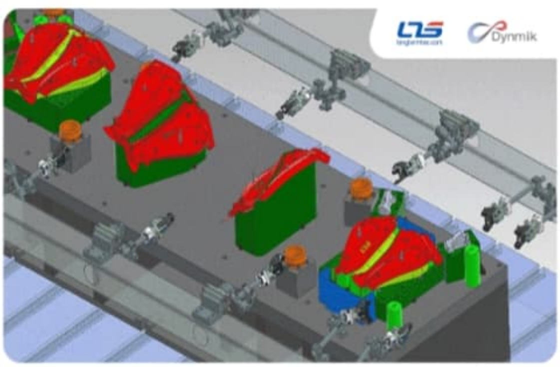
Toolmaker's tools

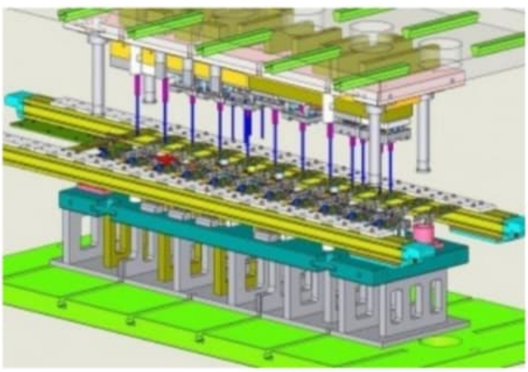
1-2-3 setup and tri blocks
Sine plates & vises
Spin & index fixtures
Planer gages
Bench centers
Measuring instruments

See Suburban Tool's product listing for reference

Activate Windows
Go to Settings to activate Windows.

NX Die Design Wizard





Progressive die

Credit: https://longtermtec.com/nx-die-design/
https://www.ddsplm.com/products/nx-cad-progressive-die-design/

Safety

- Design out hazards if possible
- Always break sharp edges
- Rigidity
- Fool proofing (poka-yoke)
- Make drill jigs large enough to hold without spinning
- Use guards if possible
- Punch Presses
- Limit Switches, Shear Pins
- Feed Mechanisms
- Electrical Equipment
- Lockout provisions
- Other Provisions

Activate Windows
Go to Settings to activate Windows.

Economic of Lot sizes

The economics of Lot Sizes refers to the analysis and determination of the optimal quantity of items to be produced or ordered at one time, considering various cost factors. The goal is to minimize total costs, which include both setup costs (or ordering costs) and holding costs.

Key Points:

- **Setup Costs**: These are the costs incurred each time a production run or order is initiated, such as machinery setup, administrative costs, and ordering expenses. These costs are independent of the quantity produced.

- **Holding Costs**: These are the costs associated with storing inventory, including warehousing, insurance, depreciation, and opportunity costs of the capital tied up in inventory. These costs increase with the size of the inventory.

- **Economic Order Quantity (EOQ)**: This is a formula used to determine the optimal order quantity that minimizes the total cost of inventory management. The EOQ formula balances the setup costs and holding costs to find the most cost-effective lot size.

$$EOQ = \sqrt{\frac{2DS}{H}}$$

Where:

- D is the demand rate (units per period),
- S is the setup or ordering cost per order,
- H is the holding cost per unit per period.

Economic of Lot sizes

- **Lot-for-Lot**: This method involves producing or ordering exactly what is needed for a particular period, minimizing holding costs but potentially increasing setup or ordering costs due to frequent production runs or orders.

- **Batch Production**: In some cases, items are produced in batches rather than continuous production. The size of these batches is determined based on economic factors, aiming to reduce setup costs per unit by spreading them over a larger number of items, while also considering the carrying costs of holding the batch in inventory.

Optimal order quantity
Where total inventory costs are minimized.

Here's a plot showing the Economics of Lot Sizes. The total cost is a combination of setup costs and holding costs. As the lot size increases, setup costs decrease while holding costs increase, leading to a point where the total cost is minimized, indicating the optimal lot size.

Annual consumption is 40000 units, cost to place one order is ₹600, cost per unit is ₹50 and carrying cost is 6% of unit cost. Find EOQ

SOLUTION

Given Data:
Annual Demand (D): 40,000 units
Order Cost (S): ₹600 per order
Cost per Unit (C): ₹50
Carrying Cost (H): 6% of unit cost = 0.06 × ₹50 = ₹3 per unit/year

EOQ Formula:

$$EOQ = \sqrt{\frac{2 \times D \times S}{H}}$$

Calculation:

$$EOQ = \sqrt{\frac{2 \times 40,000 \times 600}{3}} = \sqrt{\frac{48,000,000}{3}} = \sqrt{16,000,000} = 4,000 \text{ units}$$

Interpretation:

- The optimal order quantity to minimize total inventory costs is 4,000 units per order.
- Number of orders per year = 40,000/4,000=10 orders.
- This means the company should place 10 orders of 4,000 units each per year to optimize inventory costs.

A retail clothing outlet sells 2,000 formal shirts for men, women, and children. The outlet incurs $10 to hold a single shirt in the inventory (holding cost), and the fixed cost to place the order is $5.

Solution

Given Data

Annual Demand (D): 2,000 shirts

- Holding Cost per Shirt (H): $10
- Fixed Order Cost (S): $5

To determine the **Economic Order Quantity (EOQ)** for the retail clothing outlet:

EOQ Formula:

$$EOQ = \sqrt{\frac{2 \times D \times S}{H}}$$

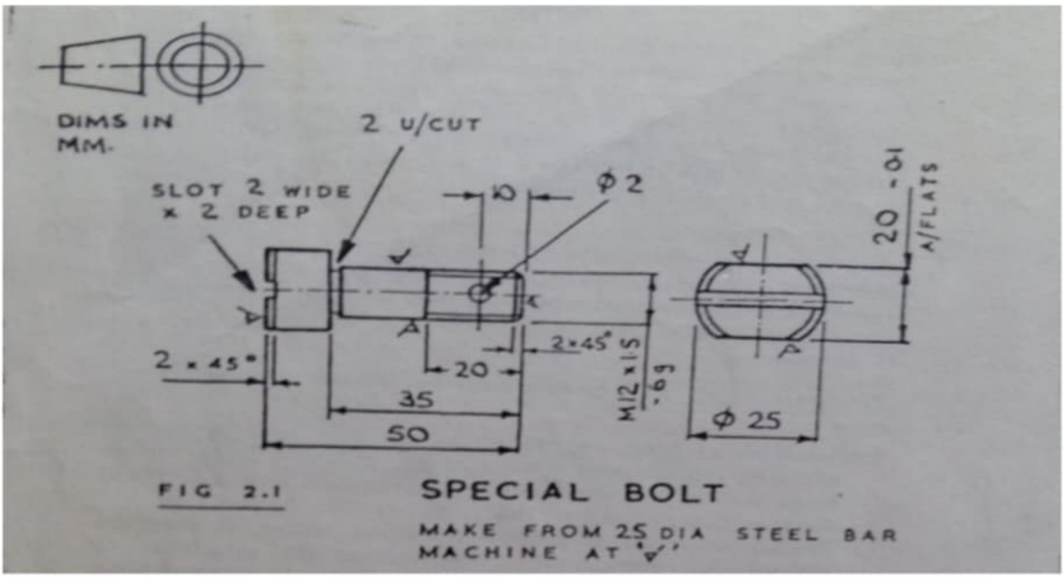
Calculation:

$$EOQ = \sqrt{\frac{2 \times 2000 \times 5}{10}} = \sqrt{\frac{20,000}{10}} = \sqrt{2,000} \approx 44.72$$

Interpretation:

- The optimal order quantity to minimize total inventory costs is ~45 shirts per order.
- This means the outlet should place ~44–45 orders per year (2000/45 ≈ 44.4) to balance ordering and holding costs efficiently.

Special Bolt



Special Bolt

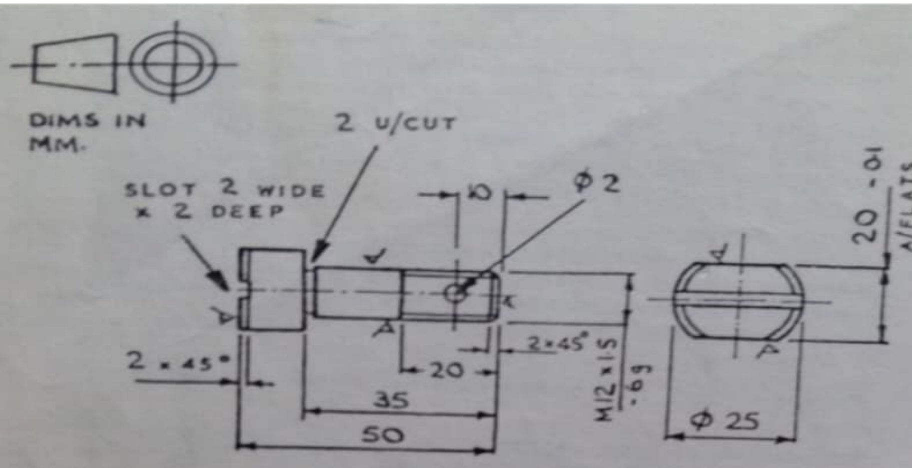


FIG 2.1

SPECIAL BOLT

MAKE FROM 25 DIA STEEL BAR
MACHINE AT '▽'

Operation Layout for Special Bolt

Operation layout for special bolt

Operation number	*Description*	*Machine*
1	In collet: face end, turn shank diameter 12 mm – 0·2 mm for location. Form under-cut and shoulder. Chamfer end and screw to length. Part off to length + 1 mm.	Capstan lathe
2	Reverse. In collet; face end and chamfer	Capstan lathe
3	View	View bench
4	In fixture: locating from shank. Gang mill flats and slot	Horizontal mill
5	Remove burrs	Burr bench
6	In jig: locating from shank and one flat. Drill 2 mm dia. hole in shank	Sensitive drill
7	Remove burrs from hole	Burr bench
8	Final view	View bench

Thank You!