Sheet Metalworking

- Sheet metalworking includes cutting and forming operations performed on relatively thin sheets of metal.
- Typical sheet-metal thicknesses are between 0.4 mm and 6mm .
- When thickness exceeds about 6 mm, the stock is usually referred to as plate rather than sheet.
- The sheet or plate stock used in sheet metalworking is produced by flat rolling.

Sheet Metalworking

- The most commonly used sheet metal is low carbon steel (0.06%–0.15% C typical).
- Its low cost and good formability, combined with sufficient strength for most product applications, make it ideal as a starting material.
- Sheet-metal processing is usually performed at room temperature (cold working) .
- The exceptions are when the stock is thick, the metal is brittle, or the deformation is significant.

Sheet Metalworking

- These are usually cases of warm working rather than hot working.
- Most sheet-metal operations are performed on machine tools called presses.
- The term stamping press is used to distinguish these presses from forging and extrusion presses.
- The tooling that performs sheet metalwork is called a punch-and-die; the term stamping die is also used.
- The sheet-metal products are called stampings.

Sheet Metalworking

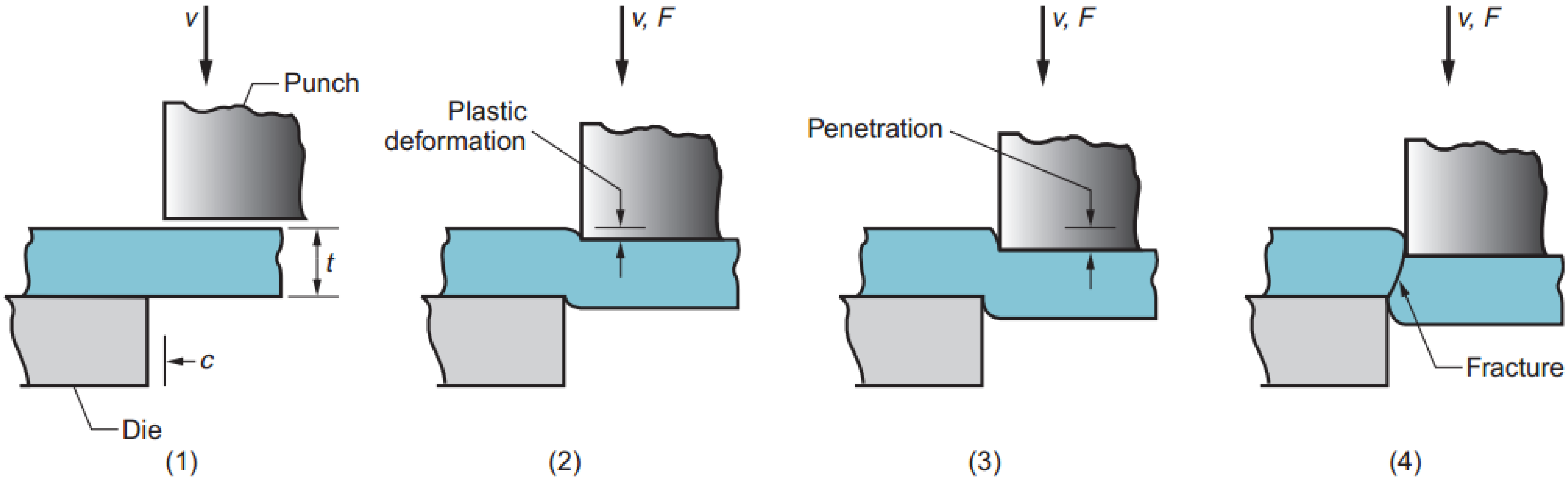
- To facilitate mass production, the sheet metal is often presented to the press as long strips or coils.
- The three major categories of sheet-metal processes are ***(1) cutting, (2) bending, and (3) drawing.***
- Cutting is used to separate large sheets into smaller pieces, to cut out part perimeters, and to make holes in parts.
- Bending and drawing are used to form sheet-metal parts into their required shapes

CUTTING OPERATIONS

- Cutting of sheet metal is accomplished by a shearing action between two sharp cutting edges.
- The shearing action is depicted in the four stop-action sketches of Figure, in which the upper cutting edge (the punch) sweeps down past a stationary lower cutting edge (the die).
- As the punch begins to push into the work, plastic deformation occurs in the surfaces of the sheet.

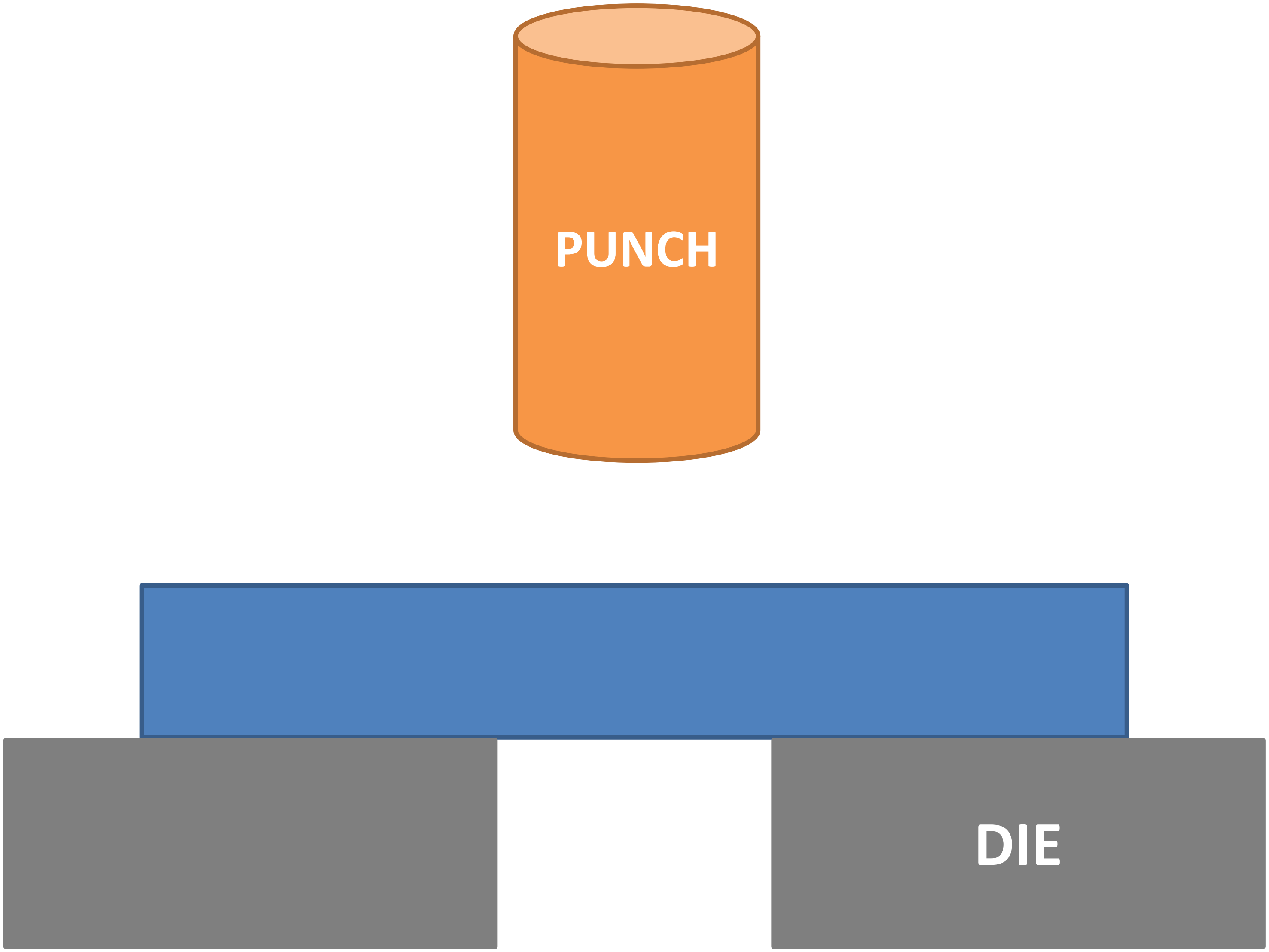
CUTTING OPERATIONS

- If the clearance between the punch and die is correct, the two fracture lines meet, resulting in a clean separation of the work into two pieces.



CUTTING OPERATIONS

- As the punch moves downward, penetration occurs in which the punch compresses the sheet and cuts into the metal.
- This penetration zone is generally about one-third to half the thickness of the sheet.
- As the punch continues to travel into the work, fracture is initiated in the work at the two cutting edges.


PUNCH
DIE

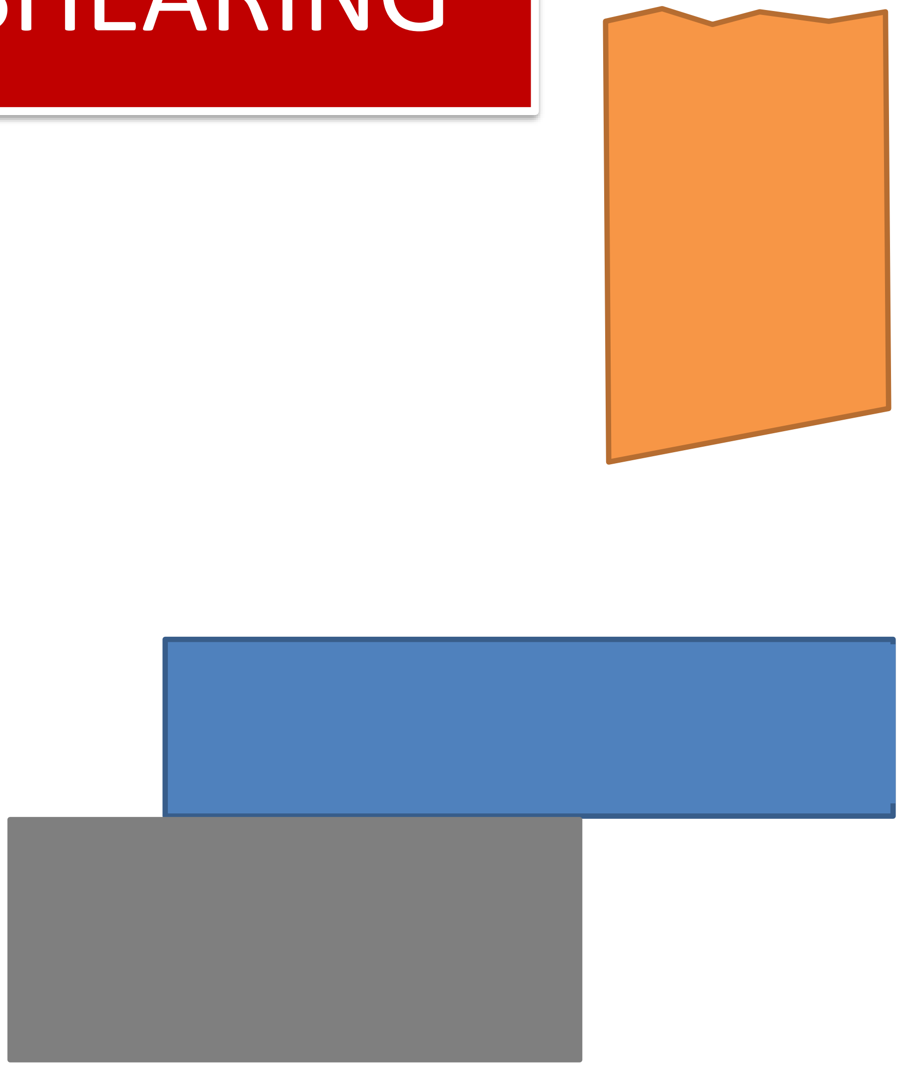
SHEARING , BLANKING, AND PUNCHING

- The three most important operations in pressworking that cut metal by the shearing mechanism just described are ***shearing, blanking, and punching.***

SHEARING

- Shearing is a sheet-metal cutting operation along a straight line between two cut tiny edges, as shown in Figure .
- Shearing is typically used to cut large sheets into smaller sections for subsequent pressworking operations.
- It is performed on a machine called a power shears , or squaring shears .
- The upper blade of the power shears is often inclined, to reduce the required cutting force.

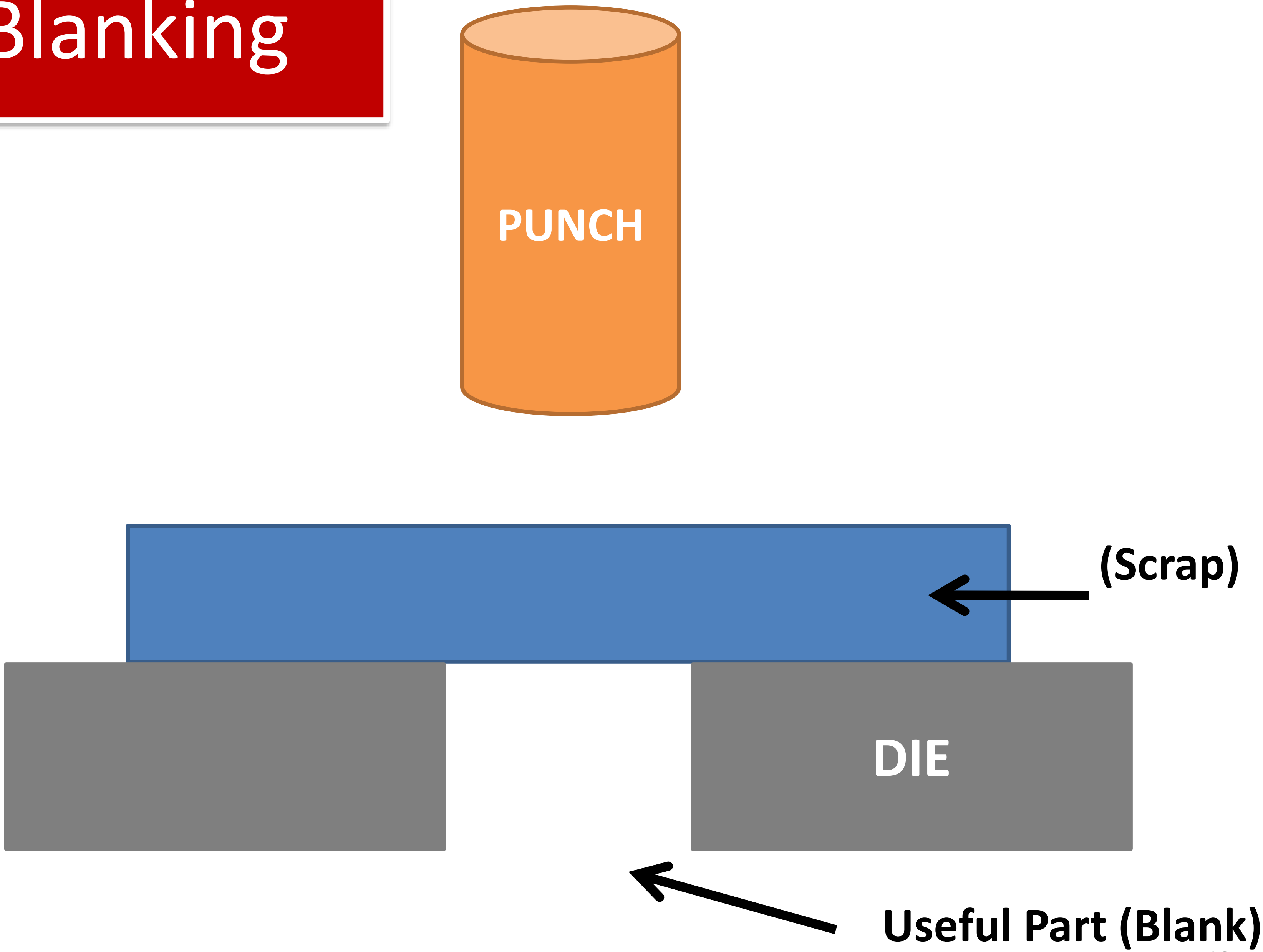
SHEARING



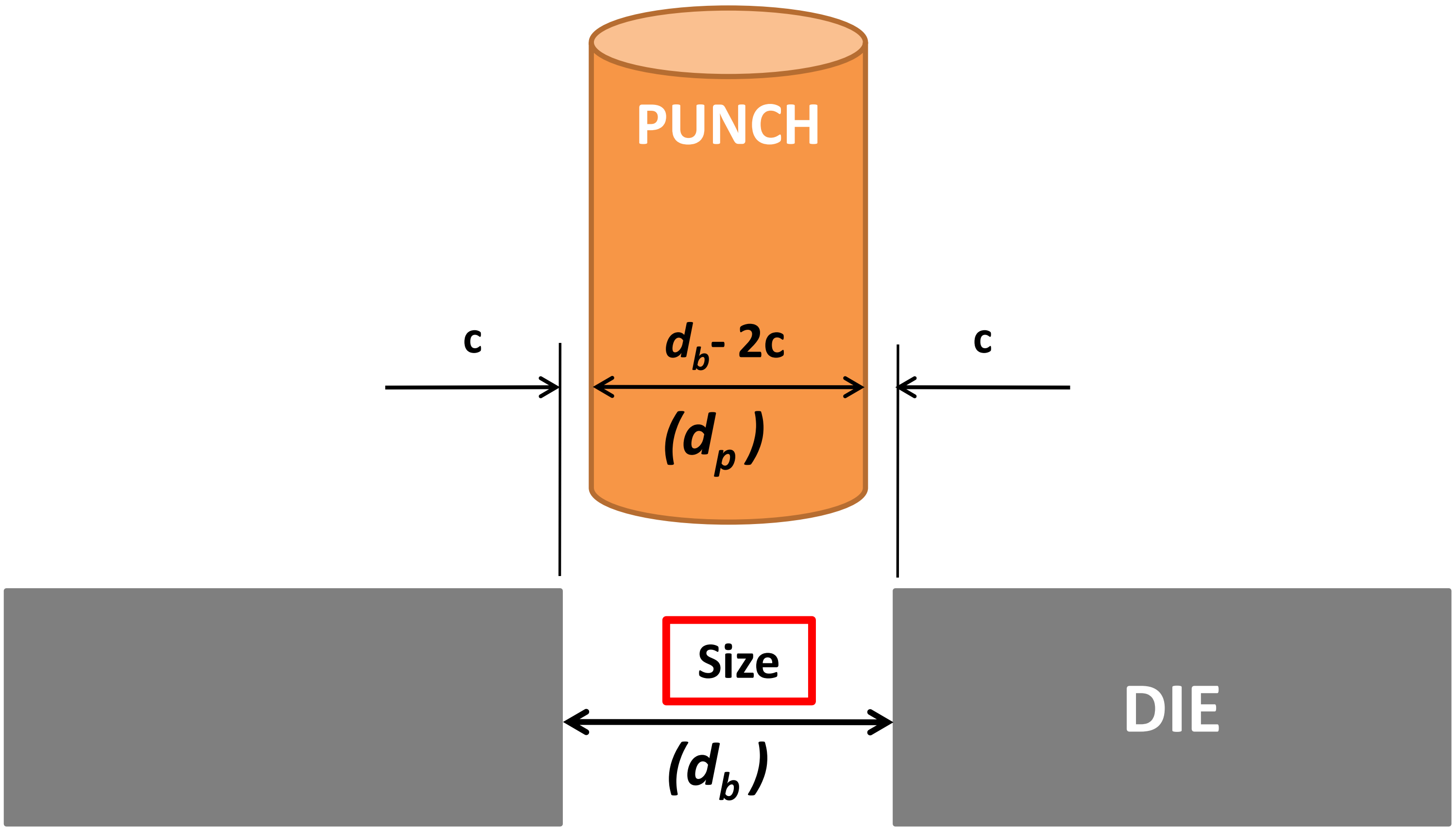
Blanking

- Blanking involves cutting of the sheet metal along a closed outline in a single step to separate the piece from the surrounding stock.
- The part that is cut out is the desired product in the operation and is called the blank.

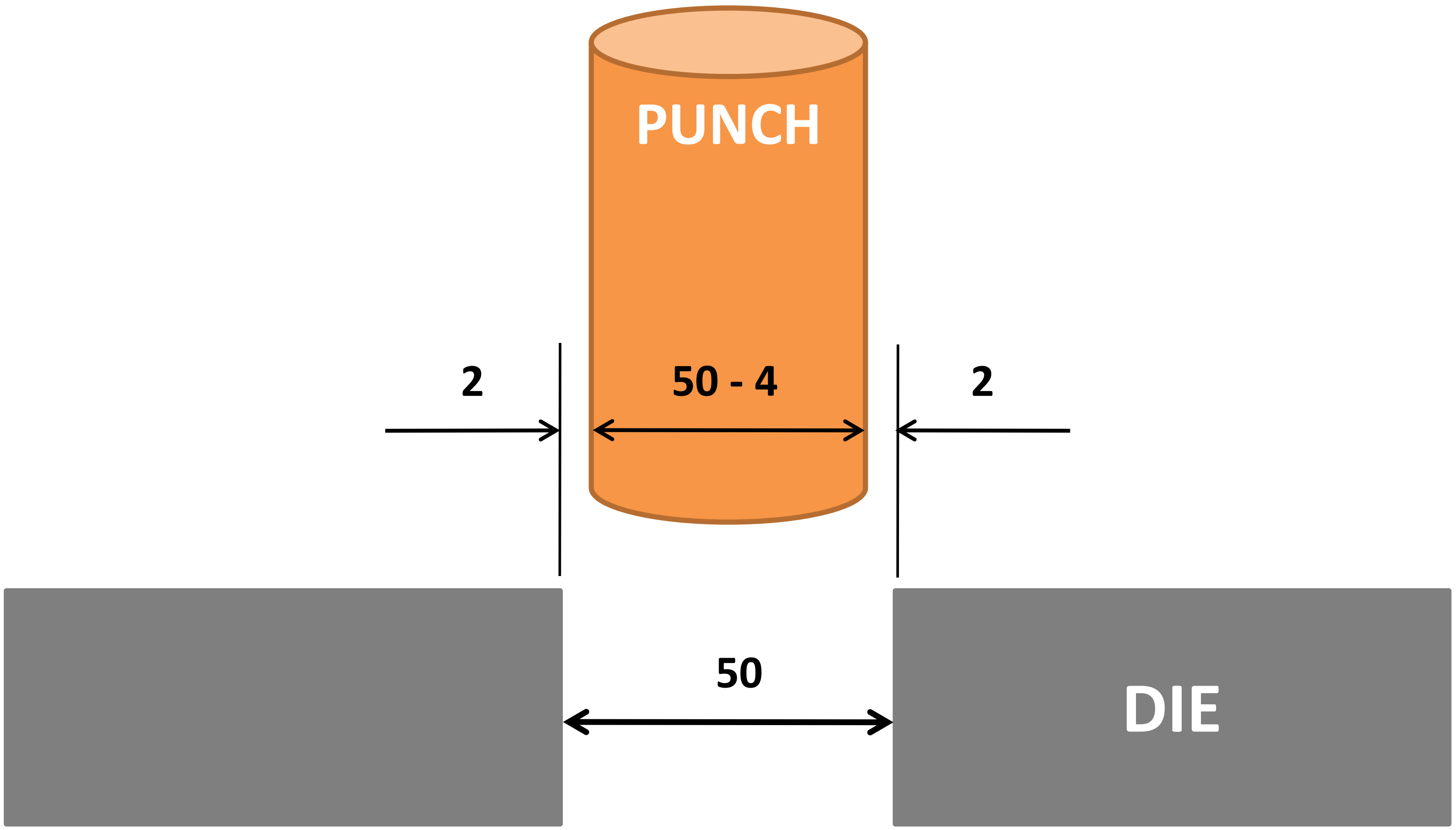
Blanking



Blanking



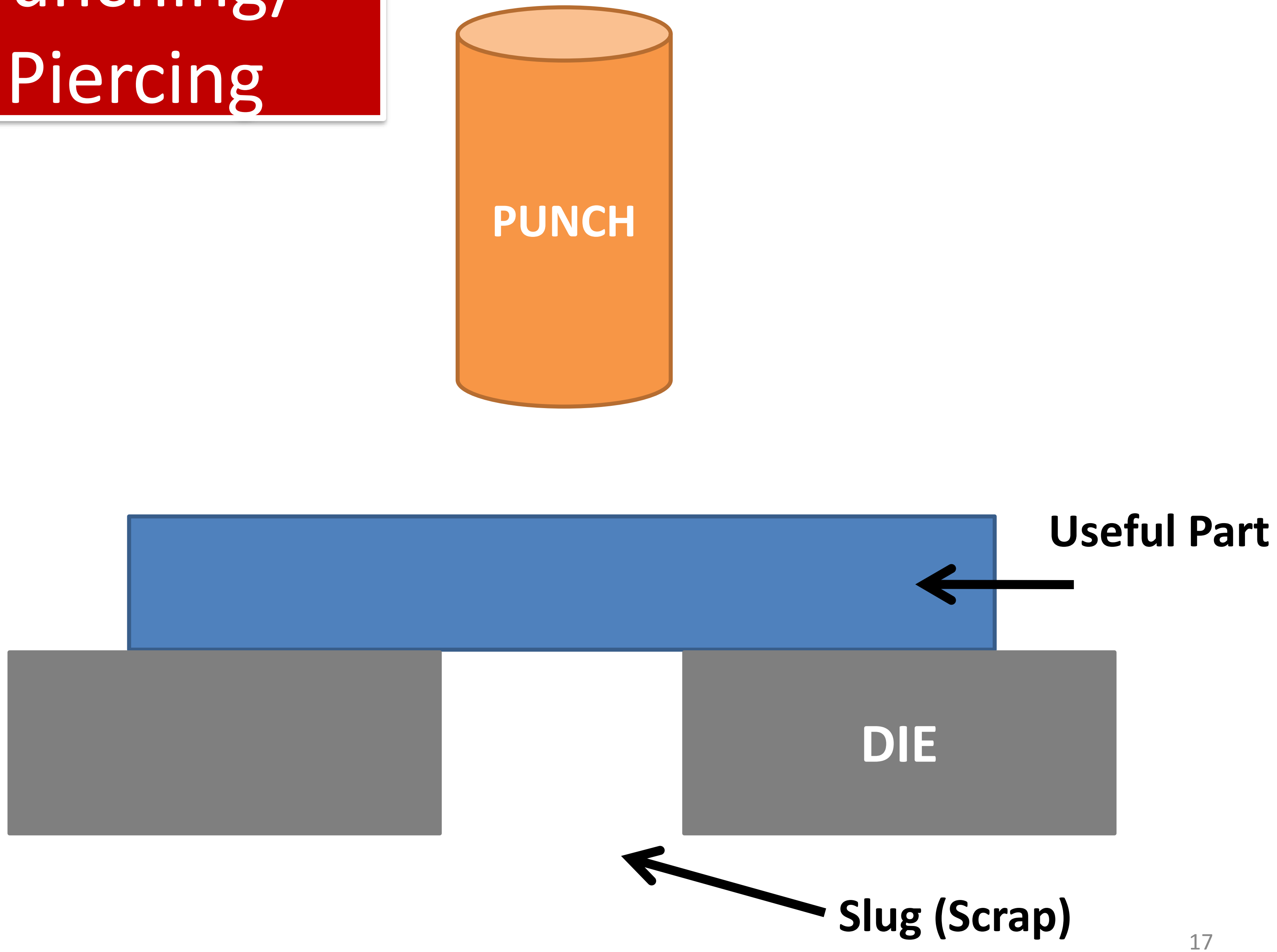
Blanking



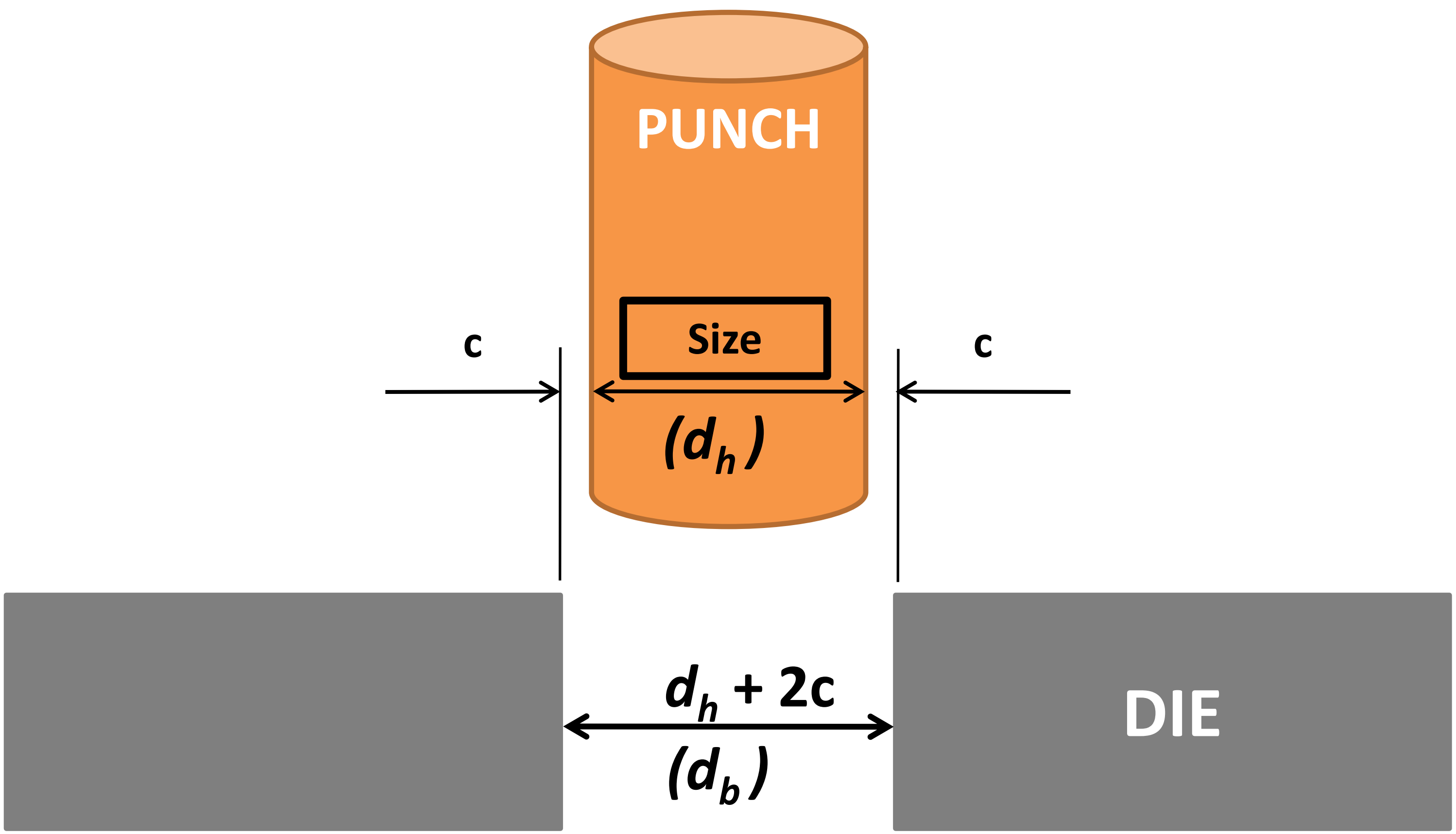
Punching/ Piercing

- Punching/Piercing is similar to blanking except that it produces a hole, and the separated piece is scrap, called the slug .
- The remaining stock is the desired part.

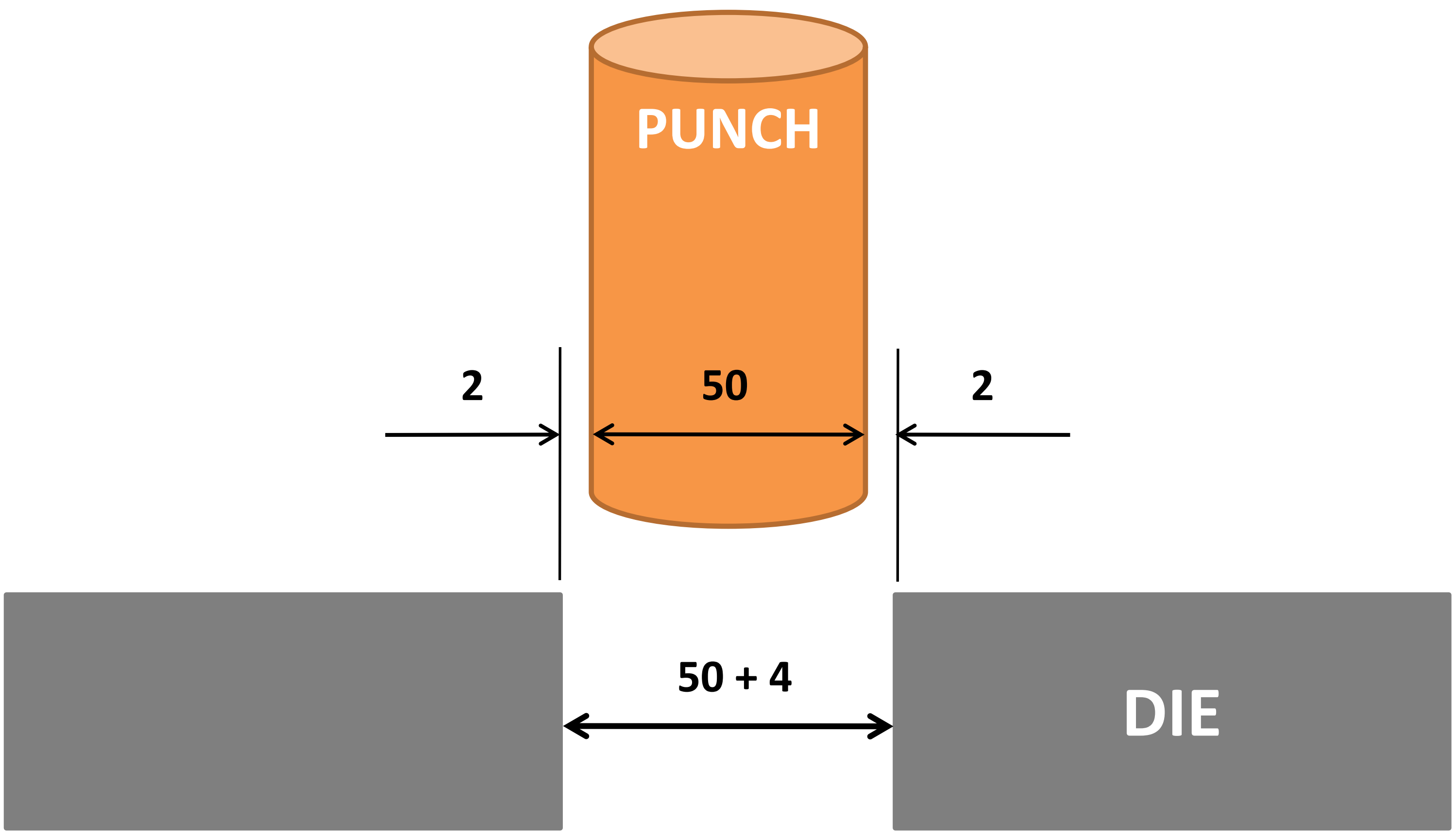
Punching/ Piercing



Punching/ Piercing



Punching/ Piercing



Clearance

- The clearance "c" in a shearing operation is the distance between the punch and die.
- Typical clearances in conventional pressworking range between ***4% to 8%*** of the sheet-metal thickness t.

$$c = a(t) \qquad (1)$$

Where a = *Allowance* = *4 to 8%*

Cutting Forces

- Cutting force " F " in sheet metalworking can be determined by

$$\boxed{F = StL} \quad \textit{(lb)} \qquad (2)$$

S = shear strength of the sheet metal, MPa ***(psi)***

t = stock thickness, mm ***(in)***

L = length of the cut edge, mm ***(in)***

Cutting Forces

- In blanking, punching, slotting, and similar operations, " L "is the ***perimeter length*** of the blank or hole being cut.

NUMERICAL 1

- A blanking operation is to be performed on ***2 mm*** thick cold rolled steel. The part is ***circular*** with ***diameter*** = ***75 mm***. Determine:

a) the appropriate punch and die sizes for this operation if the allowance for the cold rolled steel is ***a= 0.075***.

b) the blanking force required if the steel has a ***shear strength = 325 MPa*** and the tensile strength is 450 MPa

NUMERICAL 1

Solution:

(a) Since $a = 0.075$, the clearance is given by,

$$c = 0.075\ (2) = 0.15 \text{ mm.}$$

Thus the Punch diameter D_h is calculated as

$$\mathbf{D_h} = D_b - 2c = 75.0 - 2(0.15) = \mathbf{74.70\ mm}.$$

and the Die diameter is $\boldsymbol{D_b}$ **= 75 mm.**

NUMERICAL 1

(b) the blanking force is given by

$$F = StL$$

The thick of the metal stock t is given by the problem as t = 2 mm

The length of cut edge is calculated as:

$$L = \pi D = 75\pi = 235.65 \text{ mm}$$

Thus the blanking force is

$$\boldsymbol{F} = 325\ (2)\ (235.65) = \mathbf{153{,}200\ N}$$

ENERGY REQUIRED

- The energy E required for punching is calculated by an emperical formula

$$E = 1.16Fpt/12$$

E = Energy ***ft-lb***

p = penetration of punch into stock (%)

If the punch makes N strokes per minute the power in horsepower is

POWER (hp)

- If the punch makes N strokes per minute the power in horsepower is

$$P = EN/33000$$