

**Massachusetts Institute of Technology  
Department of Mechanical Engineering  
2.810 Manufacturing Processes and Systems  
Sheet Forming Homework**

**Problem 1** Fundamentals of Sheet Forming

- a) What causes burrs? How can they be reduced or eliminated?
- b) Describe the cutting process that takes place when a pair of scissors cuts through aluminum foil.
- c) Identify the material and process variables that influence the punch force in shearing and explain how each of these affects this force.
- d) Explain why spring back in bending depends on yield stress, elastic modulus, sheet thickness, and bend radius.
- e) What is the significance of the size of the circles in the grid patterns used to observed forming limits?
- f) Why are the beads in Fig. 16.36b placed in those particular locations? (Fig. 16.36b applies to all editions of text).
- g) Why is the bending force,  $P$ , proportional to the square of the sheet thickness?
- h) Examine some of the products in your home that are made of sheet metal and discuss the process or combination of processes by which you think they were made.

**Problem 2.** Rank the metals in Table 2.2 (all versions) in terms of spring back, listing those with the largest spring back first).

**Problem 3.** Consider the manufacture of the bracket shown in Figure 1 from sheet steel (available in 4 in. wide strips) using a manual brake press or presses. Assume UTS = 70,710 psi.

We are interested in estimating the unit cost to make these brackets. Please use the following assumptions.

1. the sheet materials costs \$.25/lb.
2. the cost of a press is  $(\text{Press Cost } [\$] = 2[\frac{\$}{lb}](\text{Force Capacity [lb])}$
3. all operations take the same length of time, with no breakdowns or unusual delays between steps.
4. labor costs \$30/hr.
5. equipment has a life of 10 years, tools 1 year.

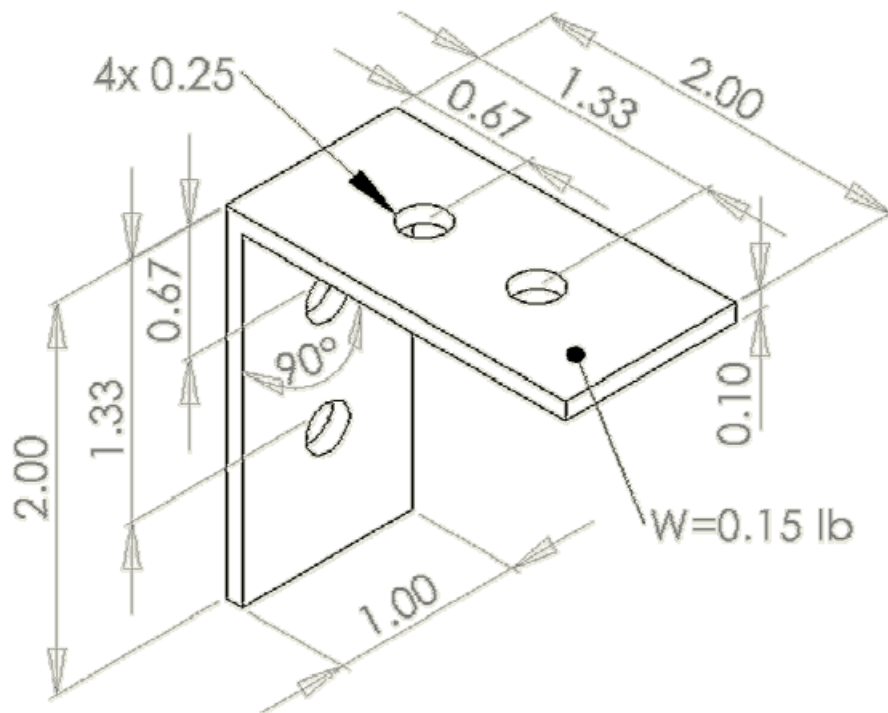


Figure 1. Sheet metal bracket

- a) Describe the sequence operations needed to make this bracket, including materials, tools, machines and operators.
- b) Estimate the size and cost of the equipment needed to make this part.
- c) Estimate the time required to make one of these (ignore waiting time)
- d) Estimate the cost per bracket (materials, labor, and equipment). State any assumptions, beyond those given, explicitly.
- e) Estimate the minimum bend radius for the part.
- f) If the part is formed to  $90^\circ \pm$ , make a rough estimate of the resulting angle due to the spring back. Use  $1.5 \times$  (your minimum bend radius). How would this change if the bracket material was aluminum, or titanium (rough answer ok). How would you compensate for spring back? (list at least 3 ways).