Massachusetts Institute of Technology
2.008: Design and Manufacturing II

Problem Set 6

Problem 6-1. Forming

(a) Name some process parameters of a metal forming operation.

(b) Recall the equation on page 11 of the forging notes for F_z :

$$F_z = (\pi R^2)(1/2)\left(\frac{h}{\mu R}\right)^2 Y\left[e^{\frac{2\mu R}{h}} - \frac{2\mu R}{h} - 1\right]$$

What does the Y represent in this equation? What is the only process parameter that you can really change in this equation?

Lets consider an even more back-of-the-envelope version of this.

(c) Note that for $0 < x \leq 1.75$, $e^x \leq 1 + x + x^2$. Convince me of this.

(d) Assume that $\frac{2\mu R}{h} \leq 1.75$. Simplify the expression for F_z for this range. Within this range, what are the only two parameters left? Is this a realistic range for μ, R, h?

Problem 6-2. Springback

(a) Recall the equation for springback given on page 22 of the lecture notes.

$$\frac{R_i}{R_f} = 4\left(\frac{R_i}{t}\frac{Y}{E}\right)^3 - 3\left(\frac{R_i}{t}\frac{Y}{E}\right) + 1$$

In this problem, we will explore whether it is possible for there to be zero springback based on these equations.

Find a solution to the equation $4x^3 - 3x = 0$.

(c) Look up a few different values for Y/E for some exotic materials of your choosing (for example, balsa wood). Now for reasonable values of t (think about where you would be using these exotic materials), and using your solution from part (b), plot the R_i for which bending to this radius would produce no springback. Are these values realistic?

(d) Explain what happens when you increase the thickness of the wire that you are bending by say, 10 percent.