

3.080 Cost Modeling & Materials Selection EXAM

November 17, 2005

1. Frank's Widgets is considering opening a new business around a remarkable new technology which casts whole tables in one step. It is expected that the business will sell and produce 100,000 such tables. To allow for future growth, Frank wants to construct a plant with a production capacity of 200,000 tables.

The relevant cost information is provided below.

Table Weight	6	kg
Cycle Time	30	minutes/table
Reject Rate	15%	of total production
Trim Scrap Rate	12%	of total mass processed
Material Price	\$2	/kg
Workers per machine	2	
Wage	\$15	/hour
Discount Rate	10%	
Equipment Life	10	
Equipment Cost	\$500,000	/machine
Operating Days	250	per year
Downtimes		
Paid Breaks	0.5	hours/day
Unpaid Breaks	0.5	hours/day
No operations	8	hours/day
Unplanned	1	hours/day

- What is the Effective Production Capacity of this process?
- How many pieces of equipment are required to provide that capacity?
- How much material must Frank's Widgets purchase per year?
- What is the Unit Equipment Cost per table?
- What is the Unit Labor Cost per table?
- What is the Unit Material Cost per table?
- If you charge 10% above your cost, what would the present value of this business be?

2. Frank's Discount Furniture would like to make legs for its cheap tables out of the cheapest material that will satisfy its design requirements. Derive the index for selecting materials for the cheapest cylindrical column of specified height, H , that will safely support a load F without buckling elastically. You will need the equation for the load F_{crit} at which a slender column buckles. It is:

$$F_{crit} = \frac{n\pi^2 EI}{H^2}$$

where n is a constant that depends on the end constraints and $I = \pi r^4/4 = A^2/4$ is the second moment of area of the column.

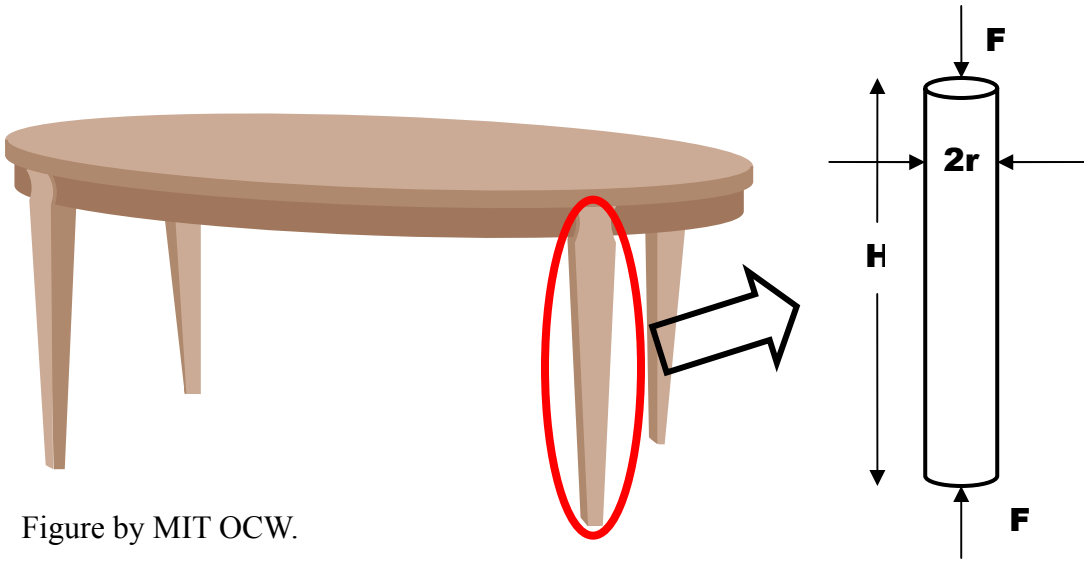


Figure by MIT OCW.

- a. Write the Function, Constraints, Objectives, and Free Variables.

- b. Write the mathematical expression for the objective function.
- c. Determine a material index, showing the derivation.
- d. Using one or both of the material property charts below, select two or three promising material candidates. State the method you used to eliminate other materials (e.g., if you plot a line on the chart, what is the slope of the line?).

- e. Make your final selection, clearly stating what extra criteria (if any) you used to make your selection.

Two figures removed for copyright reasons.

"Modulus vs. Relative cost" and "Strength vs. Relative cost."

From Granta Design's "Materials and Process Selection Charts" Web site

<http://www.grantadesign.com/userarea/teachingresource/ashbycharts.htm>