Hwk 26 Solutions to Prob 5

5a) $3Y = 3 \times 35{,}500\,psi = 106{,}500\,psi$

from text values for aluminum range $0.15 - .4 \frac{hp \cdot min}{in^3}$

Note $\frac{1\,hp \cdot min}{in^3} = 396{,}000\,psi$

giving $U_s = 59{,}400$ to $158{,}400\,psi$

$3Y$ in the middle of this range

5b) $\frac{106{,}500}{396{,}000} = 0.27 \frac{hp \cdot min}{in^3}$

$0.27 \frac{hp \cdot min}{in^3} \times 3.8 \frac{in^3}{min} = 1\,hp$

only 1/7 of spindle hp

5c) Steel #2 and #4 have the same MRR $= 0.6\,in^3/min$

so $0.7 \frac{hp \cdot min}{in^3} \times 0.6 \frac{in^3}{min} = 0.42\,hp$ for both cases

5d) The high rotational rate for #4 1714 rpm (vs 857 rpm for #2) resulted in a lower feed per tooth and therefore a lower cutting force

#2 $f = 5.6 \times 10^{-3}$ in $F = 310$ lb

#4 $f = 2.8 \times 10^{-3}$ in $F = 155$ lb

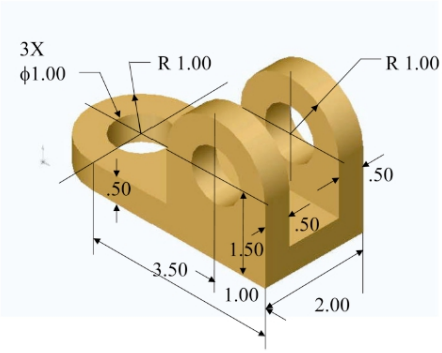
Problem 6: Process plan for Rocker Arm part

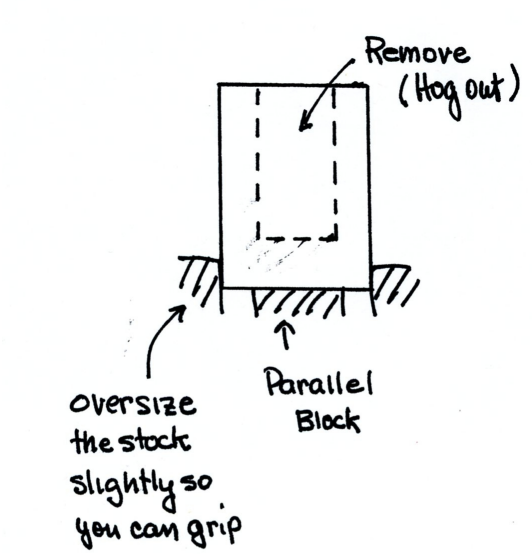
Machines: horizontal saw, and vertical CNC milling machine

Stock: 2” x 2.75” Cross Section steel stock.

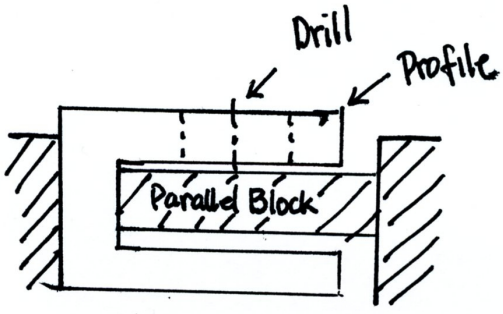
(we oversize by ¼” to allow easier fixuring in the mill).

Process step	**Machine**	**Operation**	**Tool**
1	Horizontal saw	Cut to 4.6”	
2	Vertical Mill	Fixture as shown in lst step-up	
2.1	Vertical Mill	Face end(s)	½” end mill
2.2	Vertical Mill	Hog-out	½” end mill
2.3	Vertical Mill	Profile	½” end mill
2.4	Vertical Mill	Drill	Center drill
2.5	Vertical Mill	Drill	Pilot ½”
2.6	Vertical Mill	Drill	Pilot 63/64”
2.7	Vertical Mill	Drill	Ream
3.	Vertical Mill	Refixture on side	
3.1	Vertical Mill	Profile	½” end mill
3.2	Vertical Mill	Drill	Center drill
3.3	Vertical Mill	Drill	Pilot ½”
3.4	Vertical Mill	Drill	Pilot 63/64”
3.5	Vertical Mill	Drill	Ream
4.	Vertical Mill	Refixture on other side	
4.1	Vertical Mill	Profile	½” end mill
4.2	Vertical Mill	Drill	Center drill
4.3	Vertical Mill	Drill	Pilot ½”
4.4	Vertical Mill	Drill	Pilot 63/64”
4.5	Vertical Mill	Drill	Ream
5.0	Vertical Mill	Refixture	
5.1	Vertical Mill	face bottom	1/2” end mill

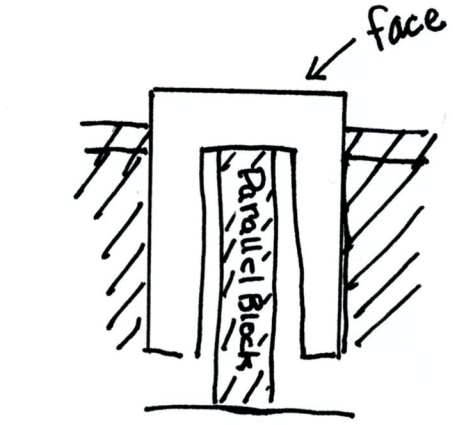




First set up for hogging out, profiling and drilling 1 in hole on base



Refixturing to profile and drill 1 in hole, flip and do other side



Refixture to remove excess material on bottom

Time estimation for Rocker Arm

Step 1: Sawing: 15.3 min
Setup: 10.2 min
Fixturing for 7lbs material: 0.28 min
Run: A=5 in^2 at 1.39 in^2/min => 3.6 min
Debur: 2*9" at 15 in/min => 1.2 min
Visual inspection: 0.05 min

Step. 2.1 Mill two ends to 4.5": 45 min + 5.6 min
Setup: 45 min
Tool change: 2 min
Fixturing + Refixturing: 2*0.26 = 0.52 min
Rough mill: Vol=5*0.125=0.625 in^3 at 0.63 in^3/min => 1min
Finish: A=2*5 in^2 at 15 in^2/min => 0.67 min
Debur: 2*9" at 15 in/min => 1.2 min
Inspection: 0.05 min
Measure: 0.13 min

Step 2.2 Hog out: 24.5 min
Setup & Tool change: 0
Fixturing: 0.26 min
Rough: Vol = 1*2*2+2.5*2*2 = 14 in^3 at 0.63 in^3/min = 22 min
Finish: A=7 in^2 at 15 in^2/min => 0.5 min
Debur: 24" at 15 in/min => 1.6 min
Measure: 2*0.13 = 0.26 min

Step 2.3 Profile: 1 min
Setup & Tool change & Fixturing: 0 if manual add set-up for rotary table
Rough: Vol = 0.4in^2*0.5in = 0.2 in^3 at 0.63 in^3/min = 0.3 min
Finish: A = 3.14in*0.5in = 1.57 in^2 at 15 in^2/min = 0.1 min
Debur: 3.14*2 in at 15 in/min = 0.4 min
Inspection: 0.05 min
Measure: 0.13 min

2.4– 2.7 Drill 1" diameter hole: 8.5 min
Tool change: 2min * 4 = 8 min
Referring to the example in the time-estimation booklet, it is 0.03 + 0.05 + 0.04+0.01 = 0.13
Debur: 0.21 min
Inspect: 0.05 min
Measure: 0.13 min

3.3.1 Mill profile: 3.2 min
Setup: 0
Tool change: 2 min
Fixturing: 0.26 min
Run: 0.3+0.1 = 0.4 min (from step 2.3)
Debur: 0.4 min (from step 2.3)
Inspection: 0.05 min
Measure: 0.13 min

3.2.3.5 Drill 1" diameter hole: 8.5 min (from step2.4-2.7)
4.4.1 Mill profile: 3.2 min (step3-3.1)
4.2-4.5 Drill: 8.5 min (step 2.4-2.7)
5-5.1 Face bottom: fixture, tool change, rough, finish, debur, inspect, measure ≅ 8 min.

TOTAL TIME: 131 minutes