Homework 3

Wednesday, February 21, 2024 3:06 PM

The next day is cold and cloudy, and you wake up distinctly in the mood to machine two 1/2" wide, 1" deep slots in an 8" long block of 316-series stainless steel, which has a unit horsepower of 1.9 (HP*minin3). You have a variety of 1/2" end mills to use with a mill (4000 RPM max, 3 HP motor). Note: when needed, use the table of speeds and feeds at [http://www.niagaracutter.com/speedfeed.](http://www.niagaracutter.com/speedfeed)

1. If you follow the 1/2 diameter rule-of-thumb for depth of cut (DOC), how many passes would it take to make **both** slots using a 1/2" end mill? *2pts*

   a. *8 passes total*

2. *What is the theoretical shortest length of cutting time it would take to make the part with the available machine? Hint: look at the mill specs. 2pts*

   a. *m*

$$T_{RR} = \frac{19}{30}\ \frac{\text{min}}{\text{in}^3} \qquad .5 \cdot 1 \cdot 8 = 4$$

$$t = \frac{4(19)}{15}\ \text{min} = \frac{76}{15}\ \text{min} \approx 5.06\ \text{min}$$

1. *What feed rate would be needed to achieve the time you found in part 4.b? 2pts*

$$M_{rr} = \frac{30}{19}\ \text{in}^3/\text{min} = ipm * w_{oc} * doc$$

$$\frac{30}{19(\frac{1}{2})(1)} = \boxed{\frac{60}{19}\ \text{in}/\text{min}}$$

1. *Recall that spindle speed and feed rate need to be set relative to each other. You have access to 2-,4-, and 6-flute end mills. What spindle speed would you set for each end mill to use with the feed rate you calculated in 4.c? 3pts*

$$r_F = \frac{60}{19}\ \text{in}/\text{min} \qquad CL = 1.5 \cdot 10^{-3}\ \text{in}/\text{tooth} \to \frac{15}{10^4}$$

$$N_F$$

$$r_F = (\omega)(CL)(N_F)$$

$$\Rightarrow \frac{r_F}{(CL)(N_F)} = \omega, \text{ So} \qquad \frac{\cancel{60}^{\,2\ \cancel{4}}}{19} \cdot \frac{10^4}{\cancel{(15)}\cancel{(2)}}, $$

- $\forall N_F \in \mathbb{N} : N = 2 \Rightarrow \omega_2 = \frac{20}{19} \cdot 10^3$ RPM
- $\forall N_F \in \mathbb{N} : N = 4 \Rightarrow \omega_4 = \frac{10}{19} \cdot 10^3$ RPM
- $\forall N_F \in \mathbb{N} : N = 6 \Rightarrow \omega_6 = \frac{20}{57} \cdot 10^3$ RPM

$\cdot \forall N_F \in \mathbb{N} : N = 6 \Rightarrow \omega_6 = \frac{20}{57} \cdot 10^3$ RPM

Assume the end mills are uncoated carbide. Based on the spindle speeds you found in part 4.d, and their resultant cutting speeds, would the 2-,4-, or 6-flute be the best choice in this circumstance? *Hint: look at machine specs and compare cutting speeds to the recommended values. 2pts*

$$\omega_{N_F} = \frac{(SFM)}{\pi \, \frac{1}{2} \cdot \frac{1}{12}} = \frac{24(SFM)}{\pi} \Rightarrow \frac{\omega_{N_F} \pi}{24} = SFM$$

i.) $\forall N \in \mathbb{N} : N = 2 \Rightarrow (\dot{Cut}) \approx 137.789$ [SFM]

ii.) $\forall N \in \mathbb{N} : N = 4 \Rightarrow (\dot{Cut}) \approx 68.895$ [SFM]

iii.) $\forall N \in \mathbb{N} : N = 6 \Rightarrow (\dot{Cut}) \approx 45.930$ [SFM]

So, $C(x) = \forall \; x \in \mathbb{R}, \exists (x) : 100 \leq (x) \leq 150$

So, $C(137.789) \Rightarrow$ True, $\forall$ 316 SS

Thus, use 2 Flute

What would be an advantage of using TiCN-coated carbide instead? *1pt*

we can increase SFM by 40% Relative to an uncoated Carbide. This is also more strict than TiAlN.

A representative from Arbitrary Parts Inc is a big fan of your two-slots-in-a-block design, and wants to mass produce it as “Q71.” The company would make about 500/month using a 3-axis CNC mill.

Ignoring facilities cost, what are 4 sources that will contribute to the cost of manufacturing Q71? *4pts*

1. *Costs of tools*
2. *Number of passes needed per cut (machining time-ish) related to labor time*
3. *Machine down time related to maintenance and tool life time*
4. *Cost of material*

what are some steps Arbitrary Parts Inc. could take to reduce these costs? *3pts*

1. *Redesign the holes to require less passes*
2. *Invest in coated tools to increase speed*
3. *Acquire comparable material with a better unit hp*

For some baffling reason, Q71 is a resounding success and Arbitrary Parts Inc. decides to triple monthly production.

Which of the aforementioned sources of manufacturing cost per part would likely decrease the most? *1pt*

1. *I believe that the material cost will be most significant assuming that the part cannot be redesigned.*