Doctoral Qualifying Exam – Manufacturing  
January 16, 2003 
1 hour  
Open Book and Open Notes

Question 1.

The bearing part device shown in Figure 1 has two functions.

1. It holds a shaft by the two end bearing surfaces and it provides slight pressure and an indexing mechanism on the shaft by virtue of deflecting the cantilever spring. The indexing function is further provided by grinding slight hollows on the shaft as shown in Figure 2. Please answer the following questions.

   a) We are considering making the bearing part by injection molding. Please look at the drawing in Figure 1 and estimate both the cycle time and the clamp force necessary to make this part. The molding material will be high density polyethylene.

   b) Now we suggest a redesign to improve the manufacturability of this part by injection molding. Show the new design in a sketch and comment on each feature which you are improving. Has your redesign made any improvements or simplifications for tooling? Please show these specifically. Now recalculate the cycle time and the clamping force to make this part.

   c) There is a need to make a family of sizes of the bearing part. It is suggested to scale up all dimensions by a factor of 1.5. How would this change the cooling time?

   d) Consider the same question as in part c, only now consider that the part is made by die casting.

Question 2

In Figure 3 there is shown a diagram for a Toyota Production System type manufacturing cell. The manual time and the machine time at each station are shown. Dark circles show quantities of material in the cell indicating both parts that are in the machines as well as parts that are in a decoupler station, each holds one part.

   a) Please estimate the production rate for this cell if there is a single operator.

   b) What is the takt time for this cell?

   c) What is the inventory in the cell?

   d) What is the throughput time for one part, that is if you put a tag on a particular part and watch it go through the system, how long will that take?
Fig 1 bearing part

Fig 2 Shaft
Legend: X / Y

X = Manual Time
Y = Machine Processing Time

Fig 3