ISAT 341: Modeling and Simulation

Exercise D1

Erwin James Will & Ryan Sheppard

The purpose of this exercise is to familiarize you with some of the concepts of discrete-event simulation and some of the features of ProModel ® discrete-event simulation software (version 6). We will also examine some of statistical output generated by ProModel®, and then make inferences about the behavior of the real-world system based on that output.

We will start by building a simple simulation model of a manufacturing workcenter using the ProModel® tutorial as our guide. A description of the workcenter we will be simulating is attached. Then you will answer questions based on the results of running the simulation for specified periods of time and under different experimental conditions.

Step-by-step directions are provided below. Deliverables are shown at the end. The assignment is due at the beginning of class on January 21, 2009. Each person must build their own model and turn in their own individual assignment; however, you may collaborate in the process of working as long as you indicate with whom. Be sure and follow the directions.

ASSIGNMENT

1. Read this exercise and be sure you understand what is expected. This lab exercise is also posted on Blackboard.

2. Go to the L-drive under ISAT 341/Henriksen or go to the C: drive to the ProModel Tutorial folders. There are two tutorials and they are different: one is a simple Powerpoint and one is an .avi file. Personally, I like the old Powerpoint version. Start whichever Tutorial you are using by clicking on the .ppt or .pps file. I recommend that you go through the entire thing once before diving into the assignment. You may burn these folders onto a CD or put them on your memory stick and take them home with you. Just be sure and take the entire contents of the folder.

3. Go through each step of the Tutorial and build your own model in ProModel exactly as is done in the Tutorial. You can have both applications open at the same time and toggle back and forth between the Tutorial and your model using the Alt + Tab keys. You may want to go through the entire Tutorial first before attempting your own. IMPORTANT: When you are constructing the path network for the machinist to follow, after you have made the path segments for the machinist to follow, you need to go in and manually adjust the *distance* of the path segments and the length of the conveyor to the following lengths: N1-N2: 7.96, N2-N3: 10.99, N3-N4: 6.38, and make the conveyor 20.0 ft. This will ensure that your machinist travels the same distance between the locations as the Tutorial’s machinist does, that the parts will travel the same distance on the conveyor, and so your output will match the official output.

4. Change the following to ensure that your model will match the Tutorial:

* From the ProModel menu, select Tools/Options/Default OutputViewer and click in “Output Viewer” then OK. This will give you the output in the correct form.
* In Build/Arrivals, be sure that the “First Time” is set to “0” the OK. This makes the first entity arrive at *t* = 0.
* In Simulation/Options, be sure that time is set to “Minutes,” Run hours is set to “40,” and Replications is set to “1.”

Now, run your model for one replication for 40 hours of simulation time. After it runs, you will get a message and an offer to view the statistical output. Note the contents of the message you see about “Arrivals” carefully; it is information about how your system is behaving. Say “Yes” to view the *General Report*. Print a copy of the *General Report.*  Check your statistical output against the Tutorial output to see that they are *exactly* the same. Then answer the following questions in your assignment labeled as 4a and 4b:

1. How many entities entered the system?

184 entries

b. Can you think of any reason why you might have gotten that message about “Arrivals” at the end of your simulation run? (Note: When you do the next step, the answer will become apparent.)

Because product was to arrive every 11.37 minutes but the queue had a max of 6 so when the queue reached 6 and a new product is sent it can’t be accepted so it is a failed arrival.

5. Now go to the Build/Locations menu item and change the capacity of the Incoming\_Queue to INFINITE. Once again, run the model for 40 hours of simulation time and 1 replication. When the model is done running, view the statistical output *General Report.*

1. How many entities actually entered the system this time?

212 entries

1. Using the fact one entity enters the system every 11.37 minutes, (remember--we told it so in the Build/Arrivals menu item), calculate the number of entities that *should have* entered the system during the 40 hours?

211.0817 entries in 40 hours plus 1 at time zero

1. If you round the result of *b*. above to a whole number, why are the numbers in 5a and 5b different; that is, where is the extra 1 entry coming from?

Because a product arrives at time 0

6. Study the format and information provided in the *General Report* carefully. For the Incoming Queue with capacity = INFINITE situation, answer the following questions:

1. How many entities were totally processed?

176 entries

1. How many entities are left in the system when the simulation stops at 40 hrs?

36 entries

1. Where exactly in the system are the entities that are left when the simulation stops?

34 entries at the incoming queue, 1entries at the turning center, and 1 entry at the machining center

1. What percentage of the time is the machinist utilized?

61.30%

1. What activities comprise the time that the machinist is busy? Indicate their percentages.

The machinist is in use 61.3% of the time. 2.31% in travel and 36.39% idle (waiting for turning center).

1. What percentage of the time are the two processing steps in the following states: Operating? Idle? Waiting? Blocked? Down?

Turning Center: operation = 95.21%, idle = 1.86%, waiting = 0.89%, blocked = 2.04%, down = 0%

Machining Center: operation = 60.06%, idle = 38.08%, waiting = 1.86%, blocked = 0%, down = 0%

1. From the data above, which of the processing steps appears to be the bottleneck in the system and how do you know?

The turning center is the bottle neck because of the long wait time this is show in the wait time for the machining center which is the step after the turning center.

1. What is the average entity processing time?

188.37 minutes

1. What is the average entity time in system?

208.3 minutes

1. Where exactly is the extra “time in system” being used?

In the turning center

7. View the Single Capacity Location States bar chart (as was done in the Tutorial). Does this chart support your assessment of where the system bottleneck is? Explain.

Yes, cause the turning center is in use most of the time but the machining center is idle 38.08% of the time.

DELIVERABLES (due 1/21/09 at the beginning of class)

1. Post your model to Blackboard: A copy of your model for which the incoming queue capacity is INFINITE (step 5). YOUR MODEL MUST BE NAMED USING THE CONVENTION BELOW OR YOU WILL RECEIVE A GRADE OF ZERO ON THE MODEL. Be sure to actually “Send” your model, which is a separate step from just posting it.

your full last name\_D1.mod

for me, my model would be named

henriksen\_D1.mod

3.) Turn in your answers to the lettered parts of questions 4-7 WITH A COVER SHEET (see syllabus for an example of the cover sheet) at the beginning of class on 1/21/09.

PROMODEL® TUTORIAL SCENARIO DESCRIPTION

The system we will simulate is a manufacturing system with one turning center and one machining center. Only one kind of part (“entity”) is processed in this system. Parts enter the system one at a time and are arrive on a pallet. A machinist takes the part from the pallet to the turning center to be turned. The machinist does not have to actually be present at the turning center while it is turning; he may leave. When the part is done at the turning center, the machinist then picks up the part and takes it to the machining center. The machinist must be physically present for the machining process. After the part has been machined, it is taken to the outgoing conveyor to be delivered to the next manufacturing process.

The incoming queue pallet initially has a capacity of six entities. The turning center and machining center have capacities of one. The conveyor has an infinite capacity. We observed the center in operation and learned about the processing times and the arrival rate. The arrival “frequency” is 11.37. The processing time at the turning center is exactly 12.86 minutes. The processing time at the machining center is N(8.3, 4.18). The parts must be carried between the four locations by the machinist resource. The machinist may do other things while the parts are at the turning center.

The machinist in this manufacturing center says he is so busy that he can not keep up with the number of parts coming into the center. From the simulation, does this appear to be true? What does he spend most of his time doing? What recommendations can you make to improve the productivity of this system? (Hint: try some capital improvements or some resource additions and see which has the greatest impact on productivity.)