Course Project

SYSC4005/5001 – Discrete Simulation/Modeling

Lecturer: Ahmed Raoof   **Winter 2021**

1. System Description

A manufacturing facility assembles three different types of products, named P1, P2, and P3. These products consist of one or more component types. There are three different types of components, named C1, C2, and C3. Product P1 contains one component C1, product P2 contains one component C1 and one C2, and product P3 contains one component C1 and one C3.

Two inspectors clean and repair the components. Inspector 1 works on C1 components. Inspector 2 works on C2 and C3 components in random order. The inspectors will never have to wait for components. There is an infinite inventory of them always immediately available.

There are three workstations in the facility, named W1, W2, and W3, which assemble products P1, P2, P3, respectively. After the components pass inspection they are sent to their respective workstations. Each workstation has a buffer capacity of two components, with one buffer available for each of the component types needed. A product can begin being assembled only when components of all types required are available. If all workstation buffers for a specific type of components are full, the corresponding inspector who finished inspecting a component with the same type is considered "blocked" until there is an opening, at which time the inspector can resume processing and sending components of that type.
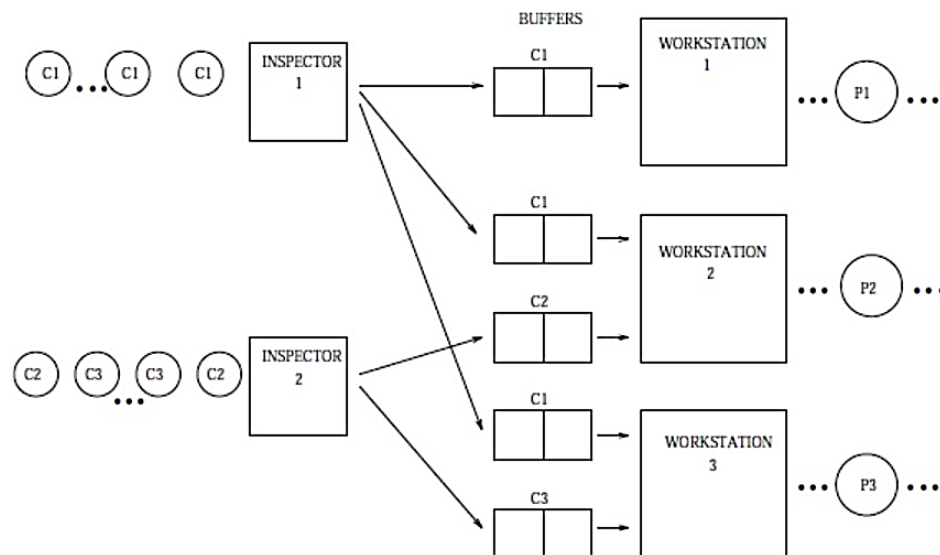

Fig.1: Schematic illustration of the manufacturing facility.

In the present mode of operation, Inspector 1 routes components C1 to the buffer with the smallest number of components in waiting (i.e., a routing policy according to the shortest queue). In case of a tie, W1 has the highest and W3 the lowest priority.

A simulation study is to be conducted to assess the performance of this manufacturing facility, partly based on observed historical data of the inspectors' and workstations' service times given in units of minutes as in the following files:

➢ <u>Inspector 1 inspection time:</u> servinsp1.dat
➢ <u>Inspector 2 inspection time for component 2:</u> servinsp22.dat
➢ <u>Inspector 2 inspection time for component 3:</u> servinsp23.dat
➢ <u>Workstation 1 processing time:</u> ws1.dat
➢ <u>Workstation 2 processing time:</u> ws2.dat
➢ <u>Workstation 3 processing time:</u> ws3.dat

The quantities of interest are the facility "throughput" or product output per unit time, and the probability (or proportion of time) that the inspectors remain "blocked" (and therefore idle).

An additional objective is to possibly improve the policy that Inspector 1 follows when delivering C_1 components to the different workstations, in order to increase throughput and/or decrease the inspectors "blocked" time.

2. Project Requirements

Conduct a complete simulation study of this manufacturing facility (in general, try to follow the steps described in Section 1.12 of the textbook as closely as possible). You may use any programming language you prefer to implement your simulation model. Be thorough in explaining all steps, stating all assumptions, and specifically referring to all equations, statistical techniques, and literature that you use. For executing the simulation, you can use any computer platform and any language you want.

Specific requirements include statistical justification/validation of the random aspects of the model (input modeling); steady-state estimates of the quantities of interest accompanied by 95% confidence intervals with a width that does not exceed 20% of the estimated values; and finally, at least one recommendation for an alternative operating policy in the facility (with simulation results and appropriate statistical justification).

3. Project Marking Scheme

You are expected to follow steps 1-12 in section 1.12 of the textbook in your project report. The marking scheme of the project will be as follows:
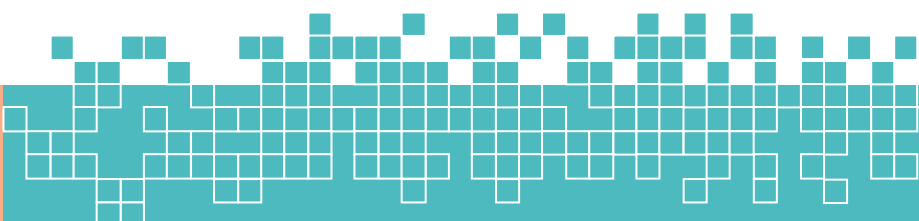
1) **1st Deliverable (Due date: Feb 28, 2021 @12:59PM + 1 hour late submission)**

   ➢ Problem Formulation (4 points)
   ➢ Setting of Objectives and Overall Project Plan (2 points)
   ➢ Model Conceptualization (4 points)
   ➢ Model Translation (15 points)
      Explain about your choice of simulation language. Describe your model implementation with software architecture and functions of each module at high level as well as source code of each module at detail level.

2) **2nd Deliverable (Due date: Mar 14, 2021 @12:59PM + 1 hour late submission)**

   ➢ Data Collection and Input Modeling (15 points)
   ➢ Describe in detail how you generate the input based on the model identified (10 points)
      Identify the distributions of each set of data using histograms (frequency distributions), evaluate the identified distributions with Q-Q plots, and perform chi-square goodness-of- fit test for each distribution.

3) **3rd Deliverable (Due date: Mar 28, 2021 @12:59PM + 1 hour late submission)**

   ➢ Model Verification and Validation (10 points)
      Explain how you have verified your model. Discuss different validation alternatives.

   ➢ Production Runs and Analysis (15 points)
      To find the quantities of interest, perform independent replications in your simulation. Show that number of replications is enough. Consider an initialization phase with a proper length in your simulation. Specify the confidence interval for each quantity and …

4) **4th Deliverable (Due date: Apr 11, 2021 @12:59PM + 1 hour late submission)**

   ➢ An Alternative Operating Policy (10 points)
      Describe in detail how your alternative design is implemented at both high and detail levels. Your recommended policy is supposed to improve the performance of the system. Justify your recommendation. Compare and evaluate these alternatives.

   ➢ Conclusion (5 points)
   ➢ Final report (10 points)
      Your final report should include all four deliverables and your programs source codes.