

CSI4124/SYS5110
Final Exam 2010 – Annex
Electronic Assembly and Test System Project

1 SUI Key Features

1.1 Introduction

This system under consideration is an assembly/testing department where the final operations of the production of two different sealed electronic units (Parts A and Parts B) are completed using four different areas in the department: preparation area for Part A units, preparation area for part B units, a sealer area for assembling and testing parts, and a rework area for parts that failed in the sealer area.

We are interested in queue lengths and average waiting times of each area; as well as the average time parts spend in the department to determine bottlenecks in the system.

1.2 Goal of project:

A steady-state study is to be used to study the operation of the assembly/testing department to collect in each area the average queue lengths and average queue waiting times. In addition the average time of parts spent in the system separated out by shipped parts, salvaged parts from the rework area, or scrapped parts (parts that failed the second testing in the rework area). There is no parameter used in this study since only one case exists to explore the system operation.

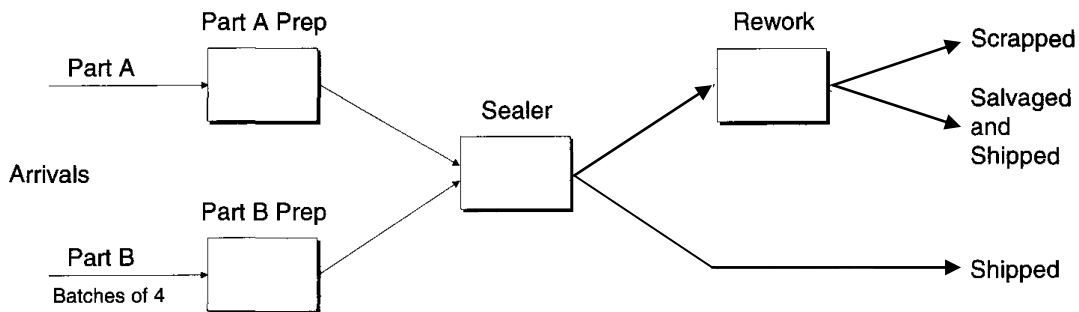
1.2.1 Output:

The output variables of interest are:

The average waiting times of	The average queue lengths of	The average time spent in the system (cycle time) of
<ul style="list-style-type: none"> ○ Preparation area for part A units ○ Preparation area for part B units ○ Sealer area ○ Rework area 	<ul style="list-style-type: none"> ○ Preparation area for part A units ○ Preparation area for part B units ○ Sealer area ○ Rework area 	<ul style="list-style-type: none"> ○ Units shipped without rework ○ Units shipped after rework ○ Units scrapped

1.3 SUI Details

The following diagram shows the organization of the Electronic Assembly and Test system.



Electronic Assembly and Test System

Each of the four areas in the department can process only one part at a time. The arriving units, Parts A and Parts B, are cast metal cases that have already been machined to accept the electronic parts. Each part is directed to one of two separate preparation areas (one for preparing Parts A and one for preparing Parts B) where they are readied for a third area, the sealer area, for assembling, sealing and testing the units. If the unit fails it is sent to a rework area for repair and retesting.

The first units, called Part A, are produced in an adjacent department. Upon arrival, they are sent to the Part A Prep area, where the mating faces of the cases are machined to assure a good seal, and the

part is then deburred and cleaned. The part is then sent to the sealer area. The second units, called Part B, are produced in a different building, where they are held until a batch of four units is available; the batch is then sent to the final assembly and testing department.

Upon arrival at the department, the batch is separated into the four individual units, which are processed individually from here on, and the individual parts proceed to the Part B Prep area. The processing at the Part B Prep area has the same three steps as at in the Part A Prep area. The part is then sent to the sealer area.

In the sealer area, the electronic components are inserted, the case is assembled and sealed, and the sealed unit is tested. Parts that pass testing are transferred to the shipping department. Parts that fail testing are transferred to the rework area where they are disassembled, repaired, cleaned, assembled, and re-tested. Parts that are salvaged (pass testing in the rework area) are transferred to the shipping department as reworked parts while parts that fail testing are scrapped.

2 Conceptual Model

2.1 High Level Conceptual Model

2.1.1 Structural Diagram

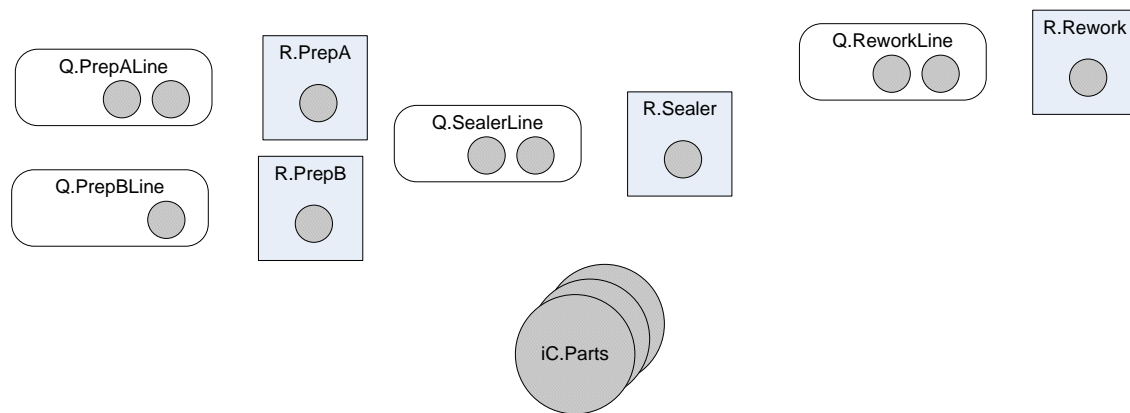


Figure 1 Electronic Assembly and Test Structural Diagram

The system consists of 4 work areas each with a queue entity and resource entity. All queue and resource entities have a scope of unary.

Entity Structures

1. **iC.Parts**: represents a part to be assembled and tested. The attribute Type identifies the part type (has a value of A or B). Role = Consumer, Scope = Class
2. **Q.PrepALine, Q.PrepBLine, Q.SealerLine, Q.ReworkLine**: represents the queues of parts in each of the four work areas of the department. Role = Queue
3. **R.PrepA, R.PrepB, R.Sealer, R.Rework**: represents the resource used to complete the tasks in each area. Role = Resource

2.1.1.1 Data Models

Data models are required for the following:

- ❖ Interarrival times of the parts A.
- ❖ Interarrival times of the batches of parts B.
- ❖ Time to complete preparation of parts A.
- ❖ Time to complete preparation of parts B.
- ❖ Time to assemble/seal/test part A units.
- ❖ Time to assemble/seal/test part B units.
- ❖ Time to rework the failed units.

2.1.2 Behavioural Diagram

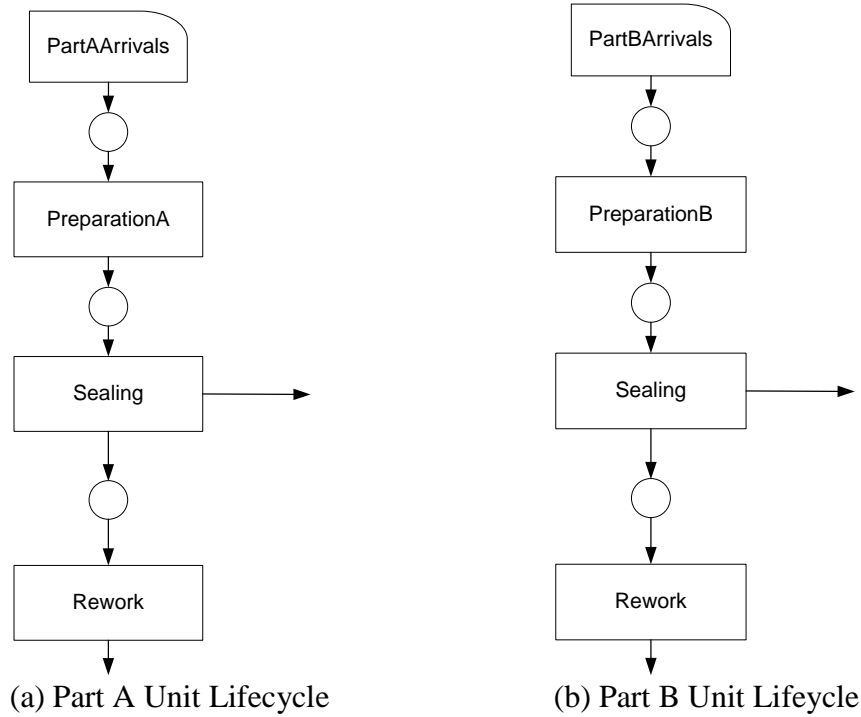


Figure 2 – Electronic Assembly and Test Behaviour Diagram

Scheduled Action Constructs:

PartAArrivals: Arrival of part A units to the assembly and test department.

PartBArrivals: Arrival of part B units (in batches) to the assembly and test department.

Activity Constructs:

PreparationA: Preparation of part A units in Prep A area.

PreparationB: Preparation of part B units in prep B area.

Sealing: Assembly/sealing and testing of all units in sealer area.

Rework: Repair and testing of failed units in rework area.

2.2 Detailed Conceptual Model

Structural Components (Entity Structures)

Consumer Class: Part	
The units that are completed in the assembly and test department. Two types of units are processed, Part A units and Part B units.	
Attributes	Description
Type	Set to A for part A units and B for part B units.
ArrivalTime	Set to the time that the part arrives in the department.
TimeEnteredQueue	Set to the time that a part enters a queue. Used to determine the waiting times in each area the part traverses.

Resource Unary: PrepA	
The preparation area where part A units are prepared.	
Attributes	Description
Busy	Set to TRUE when the area is busy with a unit and FALSE otherwise.

Resource Class: PrepB	
The preparation area where part B units are prepared.	
Attributes	Description
Busy	Set to TRUE when the area is busy with a unit and FALSE otherwise.

Resource Unary: Sealer	
The sealer area where units are assembled, sealed, and tested.	
Attributes	Description
Busy	Set to TRUE when the area is busy with a unit and FALSE otherwise.

Resource Class: Rework	
The rework area where units are repaired and retested.	
Attributes	Description
Busy	Set to TRUE when the area is busy with a unit and FALSE otherwise.

Queue Unary: PrepALine	
The line of part A units waiting in the Preparation A area.	
Attributes	Description
N	The number of parts A in the line.
List	The list of parts A in the line.

Queue Unary: PrepBLine	
The line of part B units waiting in the Preparation B area.	
Attributes	Description
List	The list of parts B in the line.
N	The number of parts B in the line.

Queue Unary: SealerLine	
The line of units waiting in the Sealer area.	
Attributes	Description
List	The list of parts in the line.
N	The number of parts in the line.

Queue Unary: ReworkLine	
The line of units waiting in the Rework area.	
Attributes	Description
List	The list of parts in the line.
N	The number of parts in the line.

Data Modelling Components

Constants		
Name	Description	Value
PartAArrMean	Mean of interarrival times in minutes of part A units.	5
PartBBatchArrMean	Mean of interarrival times in minutes of batches of 4 part B units.	30
PrepAMin,PrepAMode,PrepAMax	The min, mode, and max values of preparation time in minutes of part A units.	1, 4, 8
PrepBMin,PrepBMode,PrepBMax	The min, mode, and max values of preparation time in minutes of part B units.	3, 5, 10
SealAMin,SealAMode,SealAMax	The min, mode, and max values in minutes for assembly/seal/testing time of part A units in the sealer area.	1,3,4
SealBScale,SealBShape	The Weibull scale and shape parameters used in determining the assembly/seal/testing time in minutes of part B units in the sealer area.	2.5, 5.3
ReworkTimeMean	The mean of the rework time in minutes of units.	45

Data Modules		
Name	Description	Data Model
PartAInterArrival()	Interarrival times for Parts A.	Exponential(PartAArrMean)
PartBBatchInterArr()	Interarrival time of the next batch of 4 part B units.	Exponential(PartBBatchArrMean)
PrepATime()	Time to prepare part A units.	Triangular(PrepAMin,PrepAMode,PrepAMax)
PrepBTime()	The time to prepare the part B units.	Triangular(PrepBMin,PrepBMode,PrepBMax)
PartASealingTime()	Time to assemble, seal, and test part A units.	Triangular(SealAMin,SealAMode,SealAMax)
PartBSealingTime()	Time to assemble, seal, and test part B units.	Weibull(SealBScale,SealBShape)
PassTesting()	Returns TRUE if a part passed testing and FALSE otherwise.	91% of units pass testing.
PartSalvaged()	Returns TRUE if part is salvaged (pass testing) in the rework area, and FALSE otherwise.	80% of parts in the rework area are salvaged (pass testing).
ReworkTime()	Time to rework a part in the rework area.	Exponential(ReworkTimeMean)

Inputs		
Variable	Description	Scheduled Action
Input Entity Streams		
uPartA(t)	Arrivals of part A units.	PartAArrivals
uPartB(t)	The arrival of batches of part B units.	PartBArrivals

Output Components

OUTPUTS	
Trajectory Sets	
Name	Description
TRJ[Q.PrepALine.N]	The length of the line in the preparation area A.
TRJ[Q.PrepBLine.N]	The length of the line in the preparation area B.
TRJ[Q.SealerLine.N]	The length of the line in the sealer area.
TRJ[Q.ReworkLine.N]	The length of the line in the rework area.

Sample Sets			
Name	Description		
PHI[PrepAWaitingTimes]	The waiting times of parts in Q.PrepALine.		
PHI[PrepBWaitingTimes]	The waiting times of parts in Q.PrepBLine.		
PHI[SealerWaitingTimes]	The waiting times of parts in Q.SealerLine.		
PHI[ReworkWaitingTimes]	The waiting times of parts in Q.ReworkLine.		
PHI[CycleTimesShipped]	Cycle times of units shipped with no rework.		
PHI[CycleTimesReworkShipped]	Cycle time of units shipped after rework.		
PHI[CycleTimesScrapped]	Cycle times of scrapped units.		
Derived Scalar Output Variables (DSOV's)			
Name	Description	Data Set Name	Operator
MeanCycleTimeShipped	Average time shipped units (with no rework) spent in the system.	PHI[CycleTimesShipped]	AVG
MeanCycleTimeShippedRework	Average time shipped units which required reworking spent in the system.	PHI[CycleTimesReworkShipped]	AVG
MeanCycleTimeScrapped	Average time scrapped units spent in the system.	PHI[CycleTimesScrapped]	AVG
MeanPrepAWT	Average waiting time of parts in the Preparation A area.	PHI[PrepAWaitingTimes]	AVG
MeanPrepBWT	Average waiting time of parts in the Preparation B area.	PHI[PrepBWaitingTimes]	AVG
MeanSealerWT	Average waiting time of parts in the sealer area.	PHI[SealerWaitingTimes]	AVG
MeanReworkWT	Average waiting time of parts in the sealer area.	PHI[ReworkWaitingTimes]	AVG
MeanLineLengthPrepA	Average line length of parts in the preparation A area.	TRJ[Q.PrepALine.N]	AVG
MeanLineLengthPrepB	Average line length of parts in the preparation B area.	TRJ[Q.PrepBLine.N]	AVG
MeanLineLengthSealer	Average line length of parts in the sealer area.	TRJ[Q.SealerLine.N]	AVG
MeanLineLengthRework	Average line length of parts in the rework area.	TRJ[Q.ReworkLine.N]	AVG

Behavioural Components

Time units: Minutes

Observation interval: Steady state study.

User Defined Modules	
Name	Description
SealingTime(Type)	Returns the sealing time according to the part type. If Type is A (Part A unit), then DM.PartASealingTime() is used to determine the sealing time, otherwise (i.e. Type is B) DM.PartBSealingTime() is used.

Initialize
R.PrepA.Busy ← FALSE R.PrepB.Busy ← FALSE R.Sealer.Busy ← FALSE R.Rework.Busy ← FALSE Q.PrepALine.N ← 0 Q.PrepBLine.N ← 0 Q.SealerLine.N ← 0 Q.ReworkLine.N ← 0

Behavioural Constructs are to be completed in Part 2 of the Exam.

ABCmod Standard Modules

- **InsertQue**(QueueName, Item): Inserts Item into a queue entity called QueueName according to the declared queuing protocol associated with QueueName.
- **InsertQueHead**(QueueName, Item): Inserts Item at the head of a queue entity called QueueName.
- **Ident** ← **RemoveQue**(QueueName): Removes the item which is at the head of the queue entity called QueueName. Ident is the identifier for the returned item.
- **InsertGrp**(GroupName, Item): Inserts Item into the group entity called GroupName.
- **RemoveGrp**(GroupName, Ident): Removes an item from the group called GroupName. Ident is the identifier for the item to be removed from the group.
- **Ident** ← **RemoveGrpAny**(GroupName): Removes an arbitrary item from the group called GroupName. Ident is the identifier for the item removed from the group.
- **Put**(PHY[y], Val): Places the value Val into the sample set called PHY[y]
- **Ident** ← **Derive**(EntityStructureName): Derives an entity with identifier Ident from the entity structure called EntityStructureName.
- **Leave**(Ident): It frequently occurs that a specific entity's existence within the model comes to an end. This module explicitly indicates such an occurrence and its argument is the identifier of the entity in question. The module is typically invoked within the SCS of the terminating event of an activity instance.
- **Terminate**: An instance of a (Triggered) Extended Activity construct that undergoes an intervention must necessarily terminate. This is made explicit by ending the SCS of each intervention sub-segment with a reference to the Terminate module.