UOC Universitat Oberta de Catalunya

Estudios de Ingeniería en Informática

SUBJECT:	**SIMULACIÓN (M1.205)**		
PEC Num.:	**Pràctica**		
Date of proposal:	**22/04/2018**	**Date of delivery:**	**27/05/2018**
Observations:	• The answers will be on this document, keep the original text and take care on the final **presentation**. • It is needed to **justify** all the answers. • The name of the file must be **Surname1_Surname2_Name.RTF** (o .DOCX o .PDF)		

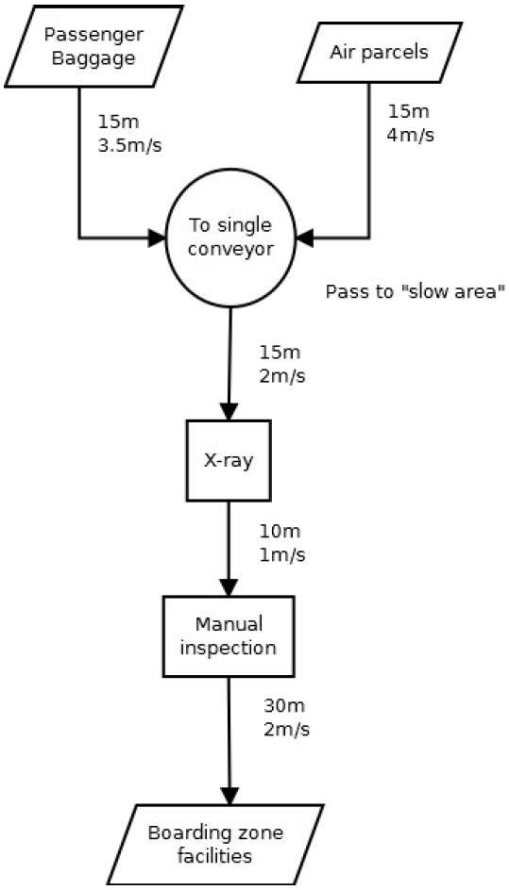
EXERCISES

In this practical you can use all the different techniques learned during the course. Define the goals of the model, the hypotheses to be used and the conceptual model. Finally implement the model with SIMIO and discuss the results.

System to model.
A conveyor system is implemented in an airport for managing the transfer of the passengers baggage and air packages from their origins to the boarding area, where packages will be collected and boarded. The model is concerned with the capacity of the security checks that are needed to be carried out between package collection and the deployment at the boarding buffer. The speed of conveyors is already set by the manufacturer. Both x-ray and manual inspection servers have limited space, and only allow up to four parallel processes (for each one). Nonetheless, improving those facilities is expensive ant the airport's authorities want to achieve good throughput values at minimum cost (minimum number of those parallel facilities). Sources for passport baggage and air parcels are different, and packages are driven by conveyors until a common conveyor is used to feed the security facilities. The times of the system elements are represented on the next table.

FACILITY	DISTRIBUTION (TIME IN MINUTES)
PASSENGERS BAGGAGE CHECK	Exponential(2.5)
AIR PARCEL SOURCE	Exponential(4)
X-RAY INSPECTION	Triangular(1.5, 3 , 5)
MANUAL INSPECTION FACILITIES	Erlang(5, 3)

On the next figure is shown the systematic representations of the part of the system that is needed to be modeled.



What is the final number of facilities that must be used on the airport? What validation techniques can be applied to assure that the conclusions are correct?

Modelling objectives:

Determine the number minimum number of facilities that must be used on the airport (due tom limited space, x-ray and manual inspection servers is limited to four parallel processes for each one).

General Project Objectives:

- Time-scale: 24 hours.
- Flexibility: Flexible, except number of x-ray and manual inspection servers.
- Run-speed: There are a few experiments to do, so a run-speed should not be a problem.
- Visual display: Simple 2D.
- Ease-of-use: Use by modeler only.

Model Outputs/Responses:

Outputs (to determine achievement of objectives)

- The input from air parcels and passenger baggage is close to the input packages on boarding zone.

Outputs (to determine reasons for failure to meet objectives)

- Difference of input packages at x-ray and ouput packages.
- Difference of input packages at manual inspection and ouput packages.

Experimental Factors:

- Quantity of x-ray and manual inspection servers.

Model Scope

Component	Include/Exclude	Justification
Entities:		
Passenger Baggage	Include	Flow through the service process.
Air package	Include	Flow through the service process.
Activities:		
X-ray service	Include	Required for experimental factor as quantity of x-ray service is needed.
Manual inspection service	Include	Required for experimental factor as quantity of manual inspection is needed.
Queues:		
Passenger baggage to conveyor queue	Include	Required for input rate to conveyor.
Air parcels to conveyor queue	Include	Required for input rate to conveyor.
Conveyor to X-ray queue	Include	Required for waiting time and queue size response.
X-ray to Manual inspection queue	Include	Required for waiting time and queue size response.
Manual inspection to Boarding zone Queue	Include	Required for waiting time and queue size response.
Resources:		
Service personnel	Exclude	Simplification: Represented by Activities (X-ray, Manual inspection).
Maintenance	Exclude	Simplification: No breakdowns or maintenance.

Model Level of Detail

Component	Detail	Include/ Exclude	Justification
Entities:			
Passenger Baggage	Quantity: number	Include	Flow through the service process.
	Arrival pattern: mean	Include	Required for flow of packages into the system.
	Attribute: nature of service	Exclude	Excluded: packages are differentiated entities.
	Routing: to single conveyor service point	Include	Connects package arrivals to other processes.
Air package	Quantity: number	Include	Flow through the service process.
	Arrival pattern: mean	Include	Required for flow of packages into the system.
	Attribute: nature of service	Exclude	Excluded: packages are differentiated entities.
	Routing: to single conveyor service point	Include	Connects package arrivals to other processes.
Activities:			
X-ray service	Quantity: number	Include	Experimental factor: Required for number of x-ray services.

	Nature: X in Y out	Exclude	Simple 1 in 1 out
	Cycle time: service time distribution	Include	Required for workload and utilization service point.
	Breakdowns/Repair	Exclude	Simplification: assume no breakdowns.
	Set-up/changeover	Exclude	Simplification: assume no set-up/changeover needed.
	Resources	Exclude	Simplification: assume no resources needed.
	Shifts	Exclude	Simplification: assume no resources needed.
	Routing: from queue to manual inspection service	Include	Flow package trough system.
Manual inspection service	Quantity: number	Include	Experimental factor: Required for number of manual inspection services.
	Nature: X in Y out	Exclude	Simple 1 in 1 out
	Cycle time: service time distribution	Include	Required for workload and utilization service point.
	Breakdowns/Repair	Exclude	Simplification: assume no breakdowns.
	Set-up/changeover	Exclude	Simplification: assume no set-up/changeover needed.
	Resources	Exclude	Simplification: assume no resources needed.
	Shifts	Exclude	Simplification: assume no resources needed.
	Routing: from queue to boarding zone facilities	Include	Last activity before sending packages to boarding zone.
Queues:			
Passenger baggage to conveyor queue	Quantity: 1	Include	Required for queue responses.
	Capacity: unlimited	Exclude	Assumption: No limit to number of packages at the queue.
	Dwell time	Exclude	Simplification: conveyor speed is set from fabric.
	Queue discipline: first-in-first-out	Include	Simplification: same priority for baggage and air packages.
	Routing to: Conveyor service	Include	Packages are send to a conveyor service
Air parcels to conveyor queue	Quantity: 1	Include	Required for waiting time.
	Capacity: unlimited	Exclude	Assumption: No limit to number of packages at the queue.
	Dwell time	Exclude	Simplification: conveyor speed is set from fabric.
	Queue discipline: first-in-first-out	Include	Simplification: same priority for baggage and air packages.
	Routing to: Conveyor service	Include	Packages are send to a conveyor service
Conveyor to X-ray queue	Quantity: 1	Include	Required for waiting time.
	Capacity: unlimited	Exclude	Assumption: No limit to number of packages at the queue.
	Dwell time	Include	Required for waiting time.
	Queue discipline: first-in-first-out	Include	Customers behaviors not being modelled.
	Routing to: service point	Include	
X-ray to Manual inspection queue	Quantity: 1	Include	Required for waiting time.
	Capacity: unlimited	Exclude	Assumption: No limit to number of packages at the queue.
	Dwell time	Include	Required for waiting time.
	Queue discipline: first-in-first-out	Include	Simplification: same priority for baggage and air packages.
	Routing to: service point	Include	
Manual inspection to Boarding zone Queue	Quantity: 1	Include	Required for waiting time.
	Capacity: unlimited	Exclude	Assumption: No limit to number of packages at the queue.

	Dwell time	Include	Required for waiting time.
	Queue discipline: first-in-first-out	Include	Customers behaviors not being modelled.
	Routing to: service point	Include	

Resources:

n/a

Assumptions

- There is no breakdowns or repairs and neither maintenance resources.
- Machine repair and set-up are rare and there is no need to be modelled.

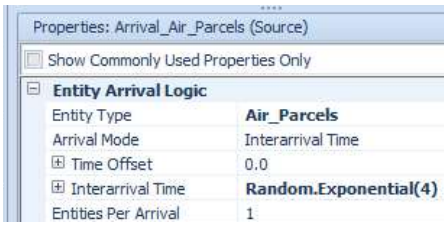
Simplifications

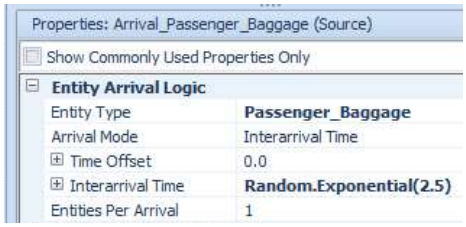
- Same priority for baggage and air packages when enter the simple conveyor service.
- Conveyor speed is set from fabric.
- There is no set-up/changeover modelled.
- There is no modelled any resources, the service is provided by service points (single conveyor, x-ray, manual inspection).
- Without resources there is no need for shifts.
- No limit to the number of packages who can wait in the queue for service.

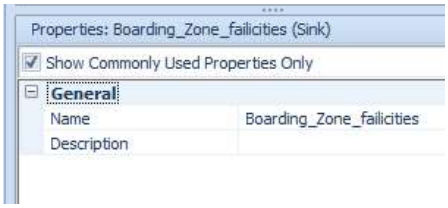
Model Coding

I use SIMIO software to configure the model. I describe each component in detail:

Entities, Sources and Sinks:
There are two sources and one sink. The entity Air parcel is assign to Arrival_Air_Parcels Source and the Passenger Baggage is assign to Arrival_Passenger_Baggage Source. The arrival rate for each source is defined in the exercise and configured as shown below. A sink is used to model the exit model and where the packages are send.

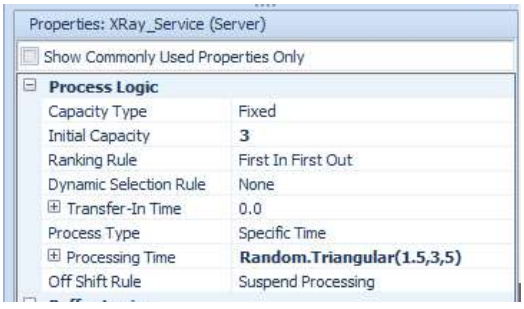






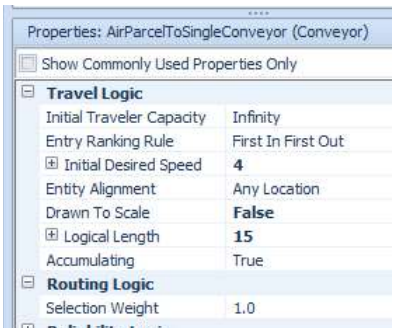
Activities (X-ray service, Manual inspection service):

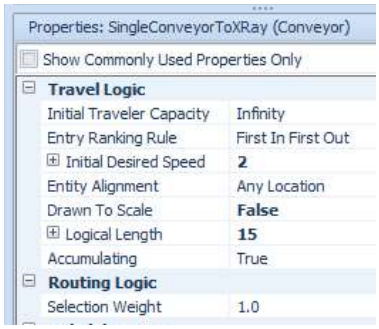
To configure the processing time for each service I use what is defined by this activity. For the initial configuration each service point is assigned a quantity of 1.

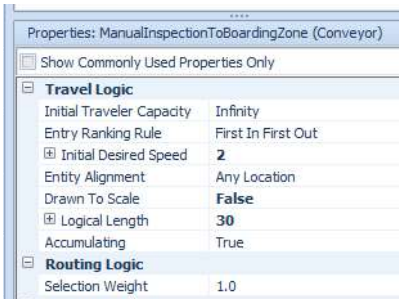


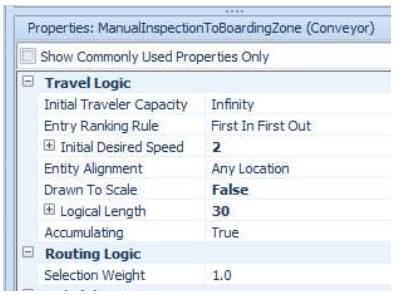
Queues:

I use a Basic Node to connect the conveyors from air parcels and passenger packages to send them to the x-ray service. I also use a conveyor to connect the x-ray service to manual inspection and manual inspection with boarding zone facilities.









Simulation

The first simulation with 1 unit of each service, shows that only 287 packages of 902 are processed.

Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average Total
Sink	Boarding_Zone_faili...	InputBuffer	Throughput	NumberExited	Total	287,0000
Source	Arrival_Air_Parcels	OutputBuffer	Throughput	NumberExited	Total	336,0000
	Arrival_Passenger_...	OutputBuffer	Throughput	NumberExited	Total	566,0000

In the second simulation with 2 units of each service, the ouput improves but only half of packages are processed.

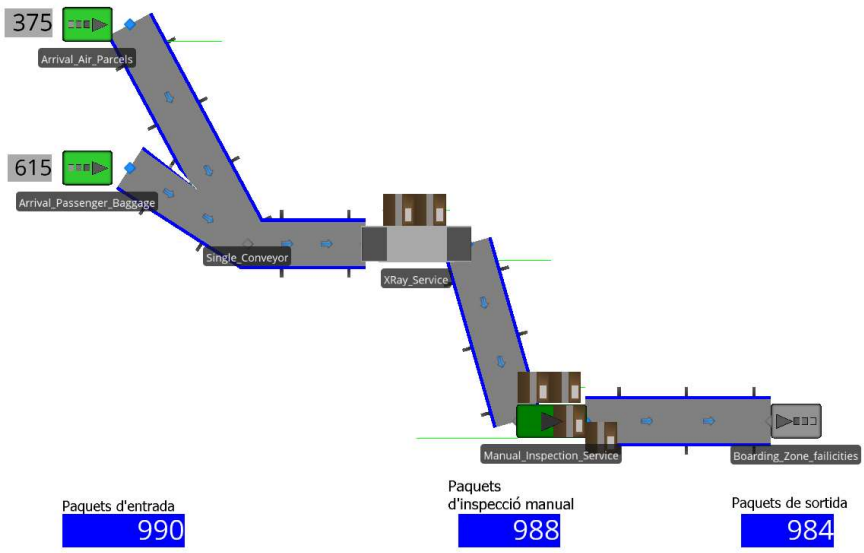
Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average Total
Sink	Boarding_Zone_faili...	InputBuffer	Throughput	NumberExited	Total	559,0000
Source	Arrival_Air_Parcels	OutputBuffer	Throughput	NumberExited	Total	366,0000
	Arrival_Passenger_...	OutputBuffer	Throughput	NumberExited	Total	571,0000

In the third simulation with 3 units of each service, the model process 873 of 941 arrived.

Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average Total
Sink	Boarding_Zone_faili...	InputBuffer	Throughput	NumberExited	Total	873,0000
Source	Arrival_Air_Parcels	OutputBuffer	Throughput	NumberExited	Total	342,0000
	Arrival_Passenger_...	OutputBuffer	Throughput	NumberExited	Total	599,0000

Depends on requirements to meet the objectives to determine that three units of each service could be enough and 75 packages inside the system at the end of simulation.

Beside I consider that 75 packages inside the system could be enough, I set the goal of this model to minimize the packages inside the system. With 3 units of Xray and 4 manual inspection we have a model so that only 6 packages are inside the system at the end of simulation, as shown in the diagram below.



At that last iteration, almost every packaged inside the model is being dispatched to the boarding zone. The number os Xray and Manual Inspection service are:

- 3 Xray service.
- 4 manual inspection service.

I also add in another file the SIMIO simulation.

Validation techniques

For the exercise I use different validation techniques:

Conceptual Model Validation:
Considering the assumptions that there is no breakdowns, repairs are rare and should affects very few times and the simplifications I consider the model is quite reliable. The simplifications and assumptions I made have low impact except there I no breakdown for any element on the model and repair time.

To improve the model reliability we should consider to mode the characteristics with more impact, like breakdowns for path and x-ray machines.

White-Box validation
I consider given data at these exercise, the distribution time of the system elements ant the systematic representation with lengths paths ant speeds, is enough to model.
I use inspecting Output Reports to determine the utilization model and increase the service numbers until the output packages reduce to a few packages.

Experimentation Validation
Increasing the number of Xray service ant manual inspection service is been used to improve the result model.