Department of Industrial Engineering
University of Stellenbosch

Simulasie 442 : Simulation 442
2025
Tut 2: Memorandum

Tutoriaal 2 *Tutorial 2*	Punt: 47 *Mark:*	Ingeedatum: **01-08-2025** (10:00) B3003 *Due date:*

Instruksies:	Formatteer alle syfers sinvol. Ontwikkel die modelle individueel. U mag in groepe van **twee** of minder werk om die vrae te beantwoord. Handig slegs een hardekopie van U antwoordstel in. Gebruik Tecnomatix en Excel vir u berekenings. **Hierdie tutoriaal en prakties is verpligtend**. **Indien u nalaat om die vereistes betyds na te kom, sal u die module sak**.
Instructions:	*Format all numbers sensibly.* *Develop the models individually.* *You may work in groups of **two** or less when answering the questions.* *Submit one hardcopy only.* *Use Tecnomatix and Excel for your calculations.* ***This tutorial and practical are compulsory.*** ***You will fail the module if you do not comply with the requirements, on time.***

Question 1 [8]

George, a systems engineer at the Cape Town Airport, faces a critical challenge. Air traffic has increased, causing aircraft delays averaging 25 minutes during peak hours and raising safety concerns. The management is considering investing in automated air traffic management systems and expanded runway capacity, but needs evidence that these changes will improve safety and efficiency.

George develops a simulation model for tracking aircraft from takeoff to landing and taxiing. The model accounts for different aircraft types, weather conditions, air traffic controller workloads, runway configurations, and other requirements. He must evaluate scenarios including automated systems, additional runways, optimised scheduling, and redesigned taxi patterns to determine the best investment strategy.

(a) What are the objective drivers for this simulation study?

(b) List three performance measures George can use for this study.

(c) How can he verify the system?

(d) How can he validate the system?

(a) Evaluation, optimisation (✓one mark for any of the two)

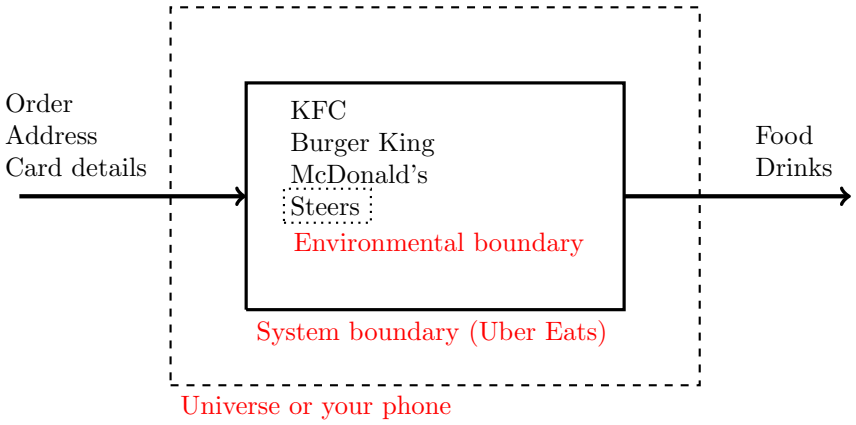
(b) Delay times ✓, throughput ✓, number of safety incidents ✓(any other valid performance measures)

(c) Test the model under various scenarios, including weather delays, emergency landings, and peak traffic periods. Ensure the simulation correctly represents air traffic controller decisions and realistically models delay effects throughout the airport system. ✓✓

(d) Compare simulation outputs with actual airport operational data. Run the model using historical flight schedules and compare performance measures with recorded airport performance data to validate its accuracy. ✓✓

Question 2 [5]

Refer to Figure 2.1 in the Simulation e-book. The figure illustrates the system and environmental boundaries of a fuel station. Now, consider the system of ordering Steers on Uber Eats and indicate where the system and environmental boundaries are, as well as the inputs and outputs of the system.
One mark for each boundary correctly indicated. ✓✓✓One mark for correct types of inputs.✓One mark for correct types of outputs.✓



Question 3 [19]

A shipping/receiving dock with six bays is used in conjunction with a production facility. Trucks arrive with supplies and leave with finished products. The inter-arrival times of loaded trucks is Expo(70) minutes. A truck that does not find an empty bay in the dock will wait outside until one is made available. The truck must then await the availability of a loaded trailer to take it to its destination. A full trailer load of the final product is produced every Expo(75) minutes and is loaded onto an empty trailer. There are always workers available for loading and unloading the trailers. These workers work from 08:00 to 20:00, daily. Jobs that are not finished will be completed the next day, i.e. work in progress stays overnight in the system. It takes Tria(56, 60, 80) minutes to load or unload a trailer.

(a) **Create a concept model of the process described above.** [11]

(b) What are the entities? [3]

(c) What are the resources? [2]

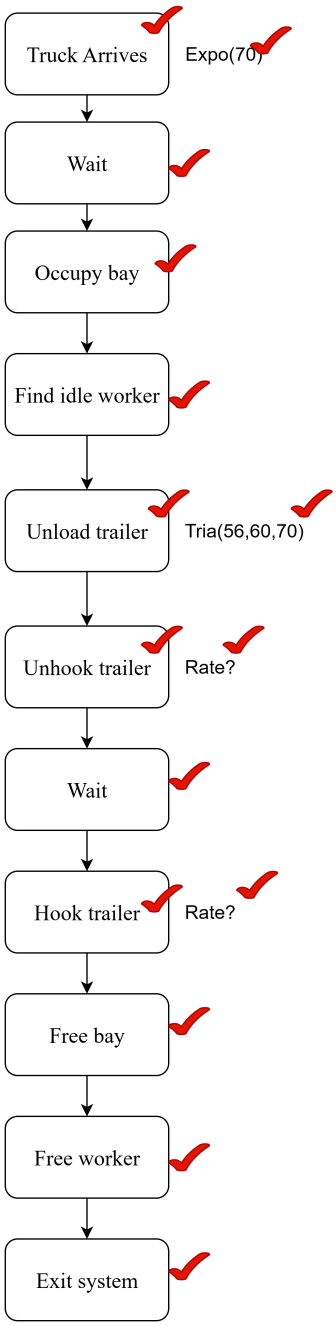
(d) List three performance measures. [3]

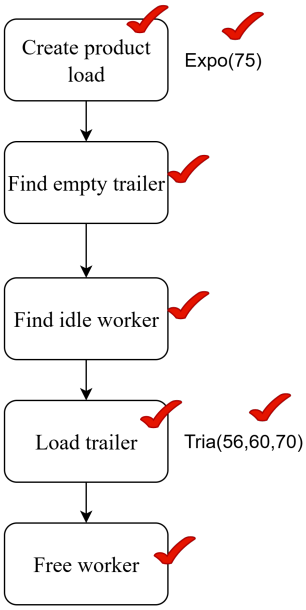
Each tick is half a mark, max ticks=22. Does not have to be exactly like the memo but it should make sense

(b) Truck ✓, trailer ✓,load ✓

(c) Bays ✓,workers ✓

(d) Bay utilisation ✓, worker utilisation ✓, queue time ✓


Truck Arrives
Expo(70)
Wait
Occupy bay
Find idle worker
Unload trailer
Tria(56,60,70)
Unhook trailer
Rate?
Wait
Hook trailer
Rate?
Free bay
Free worker
Exit system


Create product load
Expo(75)
Find empty trailer
Find idle worker
Load trailer
Tria(56,60,70)
Free worker

Question 4 [15]

This model is based on forestry operations, on high level. Forestry operations are highly complex, but in this question, we shall simplify them to model the essence of a certain process.

Trucks deliver logs to a plywood mill. On arrival, the logs are placed in a finite holding area known as the 'Bin'. A truck delivers 12 to 16 logs, of different lengths. The logs are at least 4 m long, with an additional length triangular distributed TRIA(2, 3, 4) m. The radii of the logs are lognormal-distributed with mean 150 mm and standard deviation 50 mm. The logs are peeled to create veneer. (The latter can be glued in layers to form plywood). Examples of veneers are shown in Figure 1.

Figure 1: Some veneers

A 10 m long conveyor is fed from the bin and the logs are transported one after the other on the conveyor and carried to a *cutting process*. Here the logs are cut to 2 m lengths, then conveyed on an 8 m long conveyor to a *peeler* that cuts it into veneer. An example of a (spindle) peeler is shown in Figure 2. A video of a peeler operation can be watched https://www.youtube.com/watch?v=Zj8gczpIMyQ here.

Figure 2: A typical veneer machine
(Source:https://www.idplywoodmachine.com/images/spindle%20face%20veneer%20peeling%20machine.jpg)

The peeler only accepts logs of 2 m length. The peeler peels the log to form veneer of 1 mm thick. The cutting of a log is repeated sequentially until no more 2 m length logs can be obtained from the bin. The offcut (length less than 2 m) is diverted away from the process. The cutting of a log takes between 60 to 70 seconds.

The peeling duration is a function of the volume of the log, but since the lengths are the same when peeling, the duration becomes dependent on the radius only. Suppose the peeling time is t s, the peeling rate in minutes is $P\,\mathrm{m}^3/\mathrm{min}$, the radius is r m, and the volume is $V\,\mathrm{m}^3$. Then the volume of a log is

$$V = (\pi \times R^2 \times 2)\,\mathrm{m}^3.$$

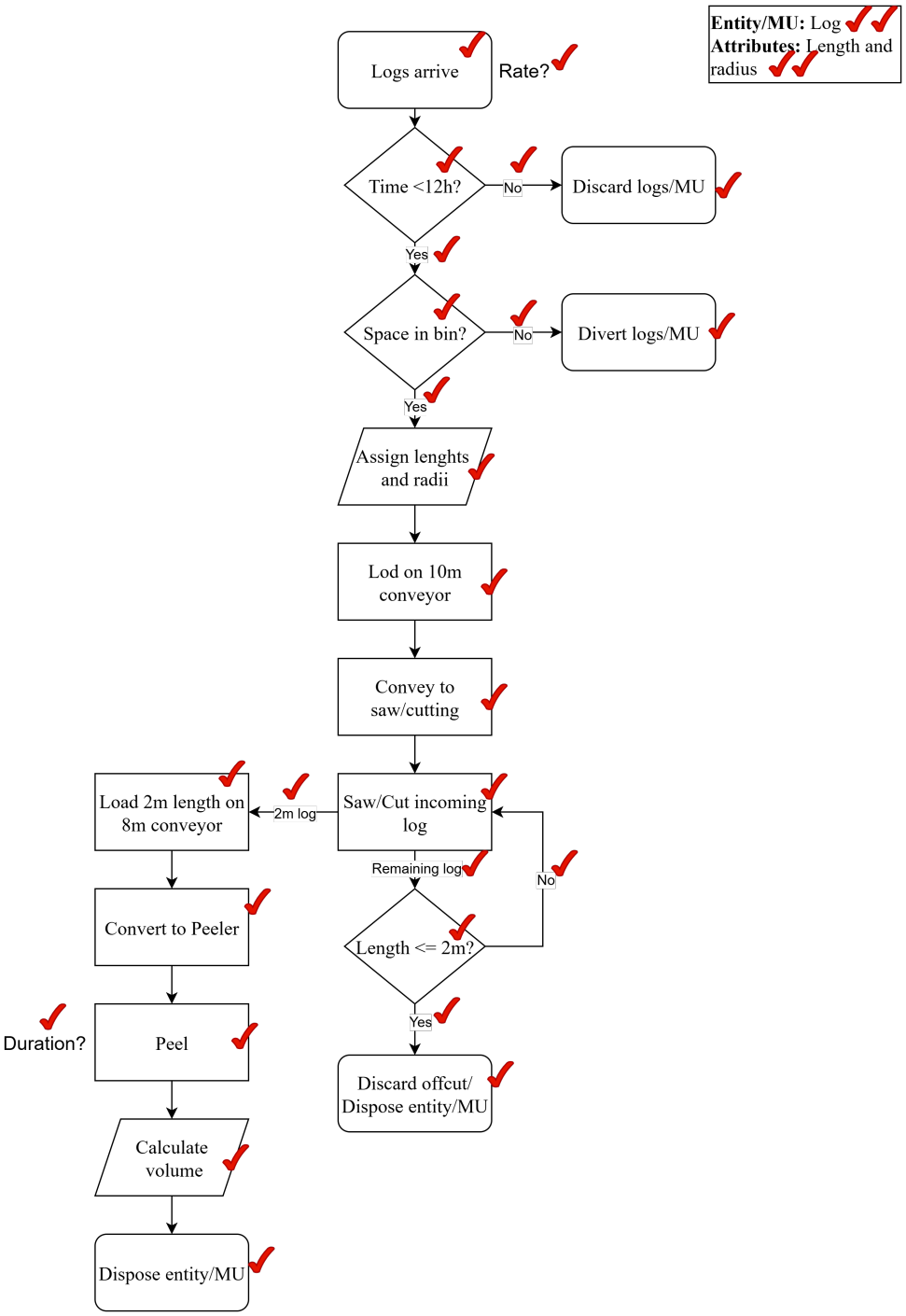
The time to peel the volume V is determined by

$$\begin{aligned} t &= V\,\mathrm{m}^3/P\,\mathrm{m}^3/\mathrm{min}/60\,\mathrm{s}/\mathrm{min} \\ &= 120\pi \times R^2\,\mathrm{s} \\ &\approx 377 \times R^2\,\mathrm{s}. \end{aligned}$$

The saw mill operates for 12 hours, then closes the gate and no more logs are received. The work-in-progress is completed before the plant operations stop for the day, meaning that overtime is inevitable. When trucks arrive at the bin and the bin is full, the trucks with the loads of logs are diverted to another destination and they are effectively lost.

Create the concept model for the saw mill process described, also

state the entity and attributes. Each tick is half a mark, max ticks=30. Does not have to be exactly like the memo but it should make sense


Entity/MU: Log
Attributes: Length and radius
Logs arrive
Rate?
Time <12h?
No
Discard logs/MU
Yes
Space in bin?
No
Divert logs/MU
Yes
Assign lenghts and radii
Lod on 10m conveyor
Convey to saw/cutting
Saw/Cut incoming log
2m log
Load 2m length on 8m conveyor
Remaining log
No
Length <= 2m?
Yes
Discard offcut/ Dispose entity/MU
Convert to Peeler
Duration?
Peel
Calculate volume
Dispose entity/MU

Total: Cross-check: 47
