

EX3- QUEUEING THEORY

Verdi Spa

Verdi SPA has a final demand of 500 pieces/ hour.

The process is composed of an assembly line and a final packaging stage.

The assembly line is composed of 3 stages in series, decoupled by stock. There is no setup in the assembly line. The product, at the beginning of the process, is checked by an automatic quality control stage. 15 % of the products provided by the supplier are identified as scrap. The 85% of the products provided by the supplier are good, so they can be processed by the assembly line. After stage 1 there is another quality control and, 20% of the time, items worked in stage 1 are categorized as nonstandard, so they have to be reworked by stage 1. Once stage 1 reworks this 20%, it will be considered ok, so it can go to stage 2. After stage 2 there are 3 different cases:

1. The product is damaged so it becomes scrap (not possible to recover it) (5% of the products worked in stage 2).
2. The product is slightly damaged, so it can continue the process but it will be sold in a secondary market at a lower price, and because of this it will continue with a lower priority just on stage 3. (15% of the products worked in stage 2). In the packaging stage, products do not have different priorities. In stage 3, good products have non-preemptive priority on slightly damaged products.
3. The product is of good quality.

Stage 3 is quite a simple process, so it doesn't give any quality problems.

The packaging stage is composed of two different machines that work in parallel. Each one can work 300 pieces/hour. The input of the packaging stage must be 500 pieces/hour. The products are processed by FIFO and the configuration is a single queue with two servers (the two machines). The three stages of the assembly line are manual and each one is composed by an operator.

The table below is related to the service rates.

Service rates	Pcs/hour
Stage 1	700 p/h
Stage 2	600 p/h
Stage 3	600 p/h
Packaging (each machine)	300 p/h

1. You are required to model the system, highlighting all the important parameters.
2. Calculated W_s of the system (not considering scraps paths).
3. Comment on the impact of using different priorities in stage 3.
4. Calculate average WIP before each stage of the assembly line.
5. How much is saturation in stage 2?

Meccanica Spa

MECCANICA Spa is a little manufacturing company. The customers ask the company for a rate of 100 pieces per hour.

The selection is composed of 3 types of products: type A (50% of the demand), type B (30% of the demand), and type C (20% of the demand).

The production system is simple, it is formed by:

- 1) Milling (2 milling machines. Service rate: 90 pieces per hour).
- 2) Drilling (3 drilling machines. Service rate: 75 pieces per hour).
- 3) Testing (1 testing machine). The service rate of the operator dedicated to the testing machine is 160 pieces per hour.
- 4) Packaging (1 packaging line with one operator able to package 130 pieces per hour).

The assumption is that all the service times are described by a negative exponential distribution.

The flow is the same for each type of product:

MILLING → DRILLING → TESTING → PACKAGING

In particular, at the milling stage, both the machines can work all types of products and the company decided to dedicate one machine to type A products and the other machine to products of type B and type C.

In the drilling stage, there are three identical machines, each one dedicated to working on one type of product.

The testing machine reveals that sometimes type B and type C products have to be worked again because of an error during the drilling process. These products have to be processed again by the drilling machine and the re-working time is the same as the first time.

On average, 20% of type B and 10% of type C products that are introduced in the system have to be worked twice.

About the twice worked pieces, 85% are good and 15% are rejected and trashed.

At the packaging stage a product of type C has a priority: when a server is free type C product is next to be processed.

Shape Meccanica S.p.a. System, define relevant parameters (arrival rates, service rates, queue type, inactivity time of resources), and map all the flows and paths of products.