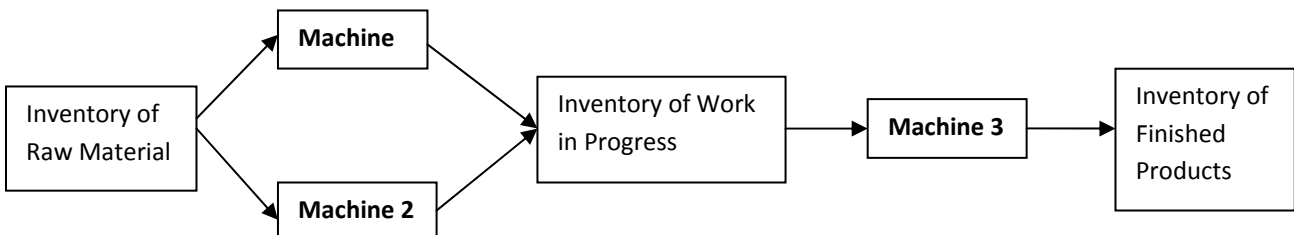


Case 3 – Production Planning

Case material for VBA Programming in Business Economics by Sanne Wøhlk

In this case, we consider a production line which is outlined as follows:



In the beginning of the planning horizon, a number of jobs are available in the *Inventory of Raw Material*. Each product must be processed on either Machine 1 or Machine 2 (only on one of them). Note that the processing time for each job need not be the same on the two machines. After this processing, the jobs enter the *Inventory for Work in Progress*. Next, all jobs must be processed on Machine 3 and finally they enter the *Inventory for Finished Products*.

A job number is assigned to each job in the Inventory of Raw Material. In the following, j is used as job number. For a job j , M_j^1 denotes the processing time at Machine 1 (if the job is processed on this machine). Similarly M_j^2 and M_j^3 denotes the processing time on machine 2 and 3, respectively.

Assuming that the beginning of the planning horizon is time 0 (zero), D_j is the Due-time of job j (i.e. the time at which the job must be finished). Let S_j be the time at which the processing of job j begins at either Machine 1 or 2, and let T_j be the time at which the processing of job j is completed at Machine 3. The Elapse Time is defined as $E_j = T_j - S_j$. The delay $Delay_j$ of job j is defined as 0 (zero) if $T_j \leq D_j$ and as $T_j - D_j$ if $T_j > D_j$. Finally, let W_j denote the time job j spends in the Inventory of Work in Progress.

Planning the production:

- In order to plan the production, the following things must be considered: Which jobs should be processed on Machine 1 and 2, respectively? (they must all be processed on Machine 3).
- In which order should the jobs be processed on Machine 1 (and 2 and 3)?

To answer these questions, we setup the following rules:

For Machines 1 and 2, there are two strategies:

- A. When a Machine is ready to process a new job select the job j from the Inventory of Raw Material which has the smallest Due-time D_j and process the job on that machine.
- B. Consider the jobs in decreasing order by $\max\{M_j^1, M_j^2\}$. For each job j in that order assign the job to the machine with $\min\{M_j^1, M_j^2\}$ (i.e. the machine where the processing time is smallest).

For Machine 3, the following strategy is used:

- I. When Machine 3 is ready consider the jobs that are currently in the Inventory of Work in Progress. Select the one with the smallest Due-time D_j .

Data:

Consider the file of this case. In the main sheet of the file you see the following:

- In cell C1: An integer indicating the number of jobs to be processed.
- In cells C3: An integer indicating the number of iterations in a simulation study.
- In columns A through E (starting in row 7): Job number, Due-time, and processing times for as many jobs as given in cell C3.

The Button with the text *Generate Data* executes a sub called *GenerateData*, which generates the number of jobs given in cell C1. The code of *GenerateData* is found in Module 1.

Definition of Production Plan:

In the following, when you are asked to make a production plan, you are asked to make a table, that for each job shows

- If the job is processed on Machine 1 or Machine 2
- What time the processing starts and finishes at Machine 1 or Machine 2
- What time the processing starts and finishes at Machine 3
- How long time the job is in the Inventory of Work in Progress
- The total Elapse Time of the job
- The Delay of the job

Measures:

To measure the quality of a production plan, the following measures should be calculated.

1. Number of delayed jobs (i.e. number of jobs with $\text{Delay}_j > 0$)
2. Average delay
3. Average delay of delayed jobs
4. Average Elapse time
5. Average time that the jobs are in the Inventory of Work in Progress
6. The Make-Span, i.e. the time at which the last job finishes at Machine 3

For all of the above measures, a production plan with a small value is preferred. There are several other measures that could be used.

In your program, you should write a number of macros to do the following:

1. Make a production plan for the jobs given in columns A through E. In this production plan, strategy A should be used to schedule the jobs on Machine 1 and 2 and strategy I should be used to schedule the jobs on Machine 3.
2. Make a production plan for the jobs given in columns A through E. In this production plan, strategy B should be used to schedule the jobs on Machine 1 and 2 and strategy I should be used to schedule the jobs on Machine 3.
3. With a given set of jobs, perform a comparison of 1) and 2) by making both production plans and construct one or several charts that shows the quality of the production plans.
4. In order to give a better indication of the relative performance of 1) and 2), make a simulation study to compare the two methods. The number of repetitions should be read from cell C3. Information about the quality of the production plans should be collected and displayed in a way good for presentation when the simulation is performed.