MATLAB SIMULATION:
Current Scenario

ASSUMPTIONS:

- The cycle time and MTTF follows normal distribution.
- If a machine breakdown midway through a process, the process is started from the beginning
- In case of a break down the MTTR is 6 hours with a standard deviation of 0.5 for all machines. The distribution to generate the value is normal
- No defects are produced

About the simulation model:

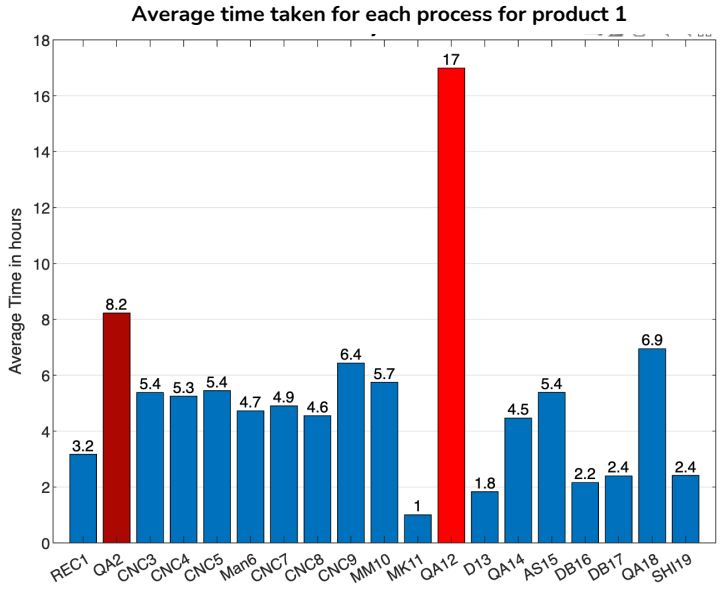
The model takes the number of components to be manufactured as its input and provides the time taken to manufacture for each of the components as the output.

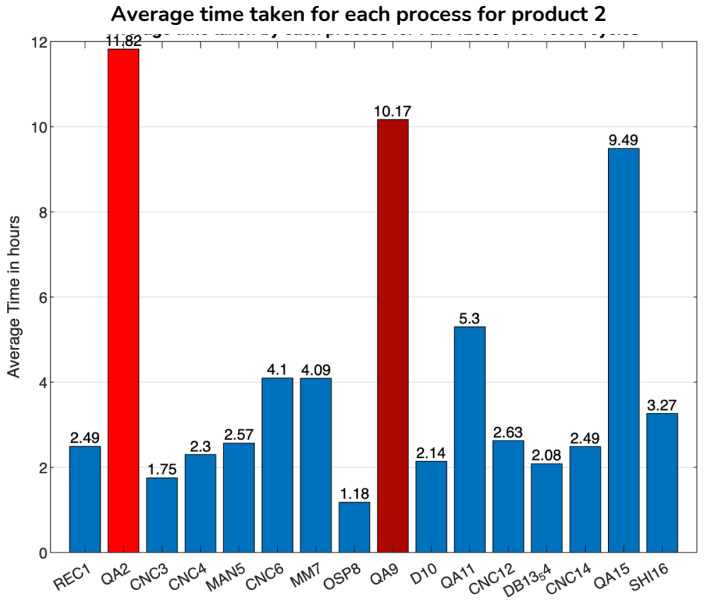
It does not give an accurate representation of the production lines due to the limited data available. Moreover adding in more factors increases the complexity of the model.

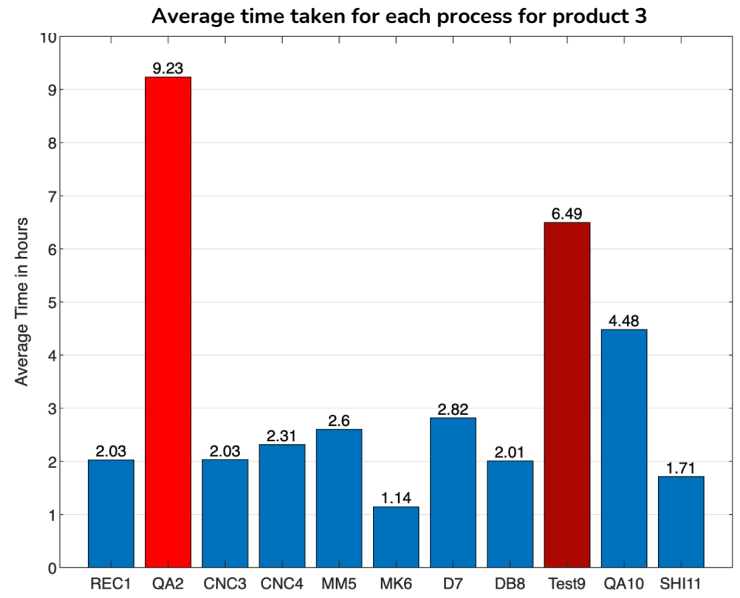
The following information can be extracted from the model:

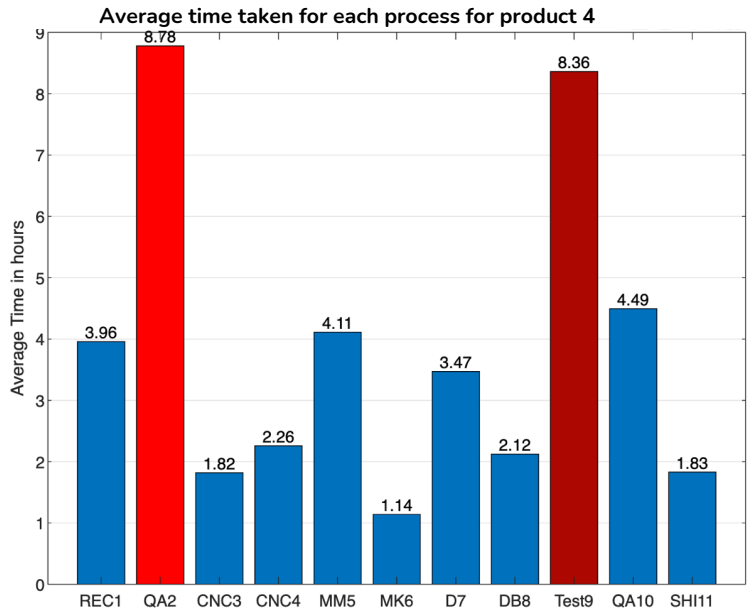
- The individual process times
- Individual and total number of breakdowns for each of the lines
- Individual and Total reliability for each of the lines
- Average time to manufacture a product
- The waiting times of component (only for Product 1)

Average times for each process









Observations:

The average time taken for each process in a product line and the overall time for **10,000 cycles** have been illustrated as bar graphs.
The **red** bar shows the highest cycle time, and the **crimson** bar shows the second-highest time.

In part 124672:

- The **QA2** and **QA12** processes have the **first** and **second highest** times, respectively
- The **third**, **fourth and fifth highest times** are **Man-Mill 10**, **CNC3** and **QA18**, respectively

In part 126054:

- **QA2** and **QA15** have the **first** and **second** highest times, respectively
- **QA9** has the **third**-highest time and is a **close second.** The other processes have a relatively lower average process time.

Average times for each process (contd)

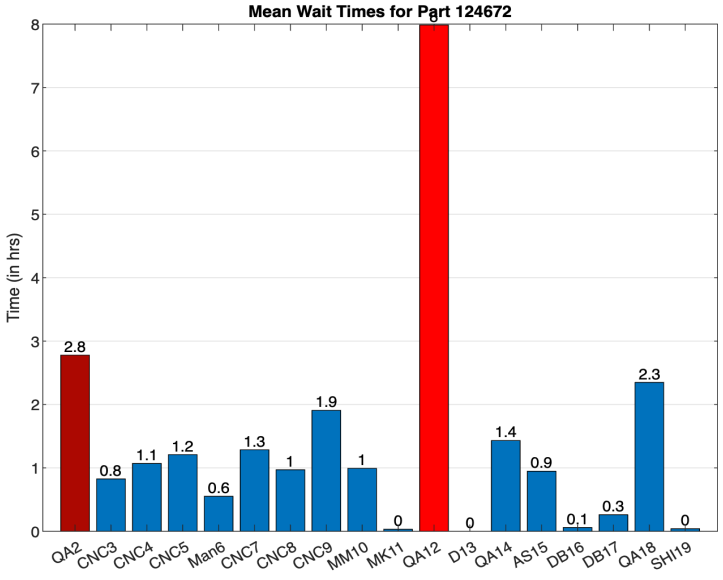
In part 121757

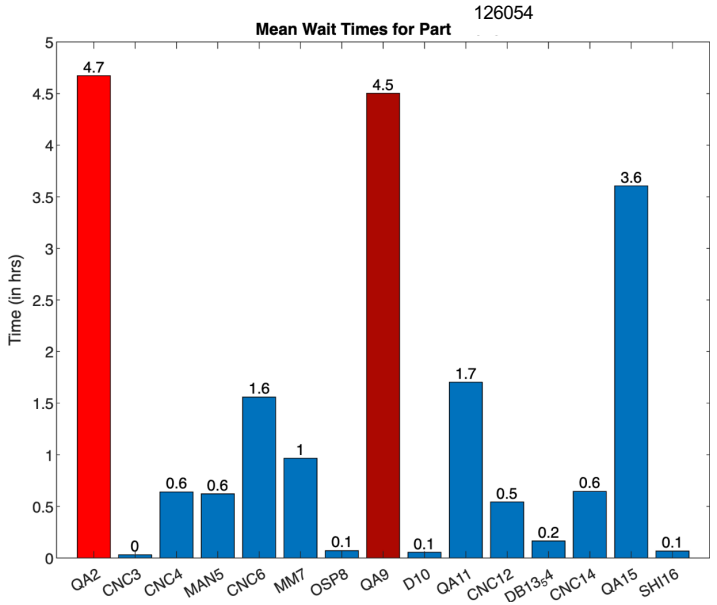
- **QA2** and **Test9** have the **first** and **second highest** times, respectively.
- **QA10** and **REC1** have the **third** and fourth-highest times. The other processes have a relatively lower average process time.

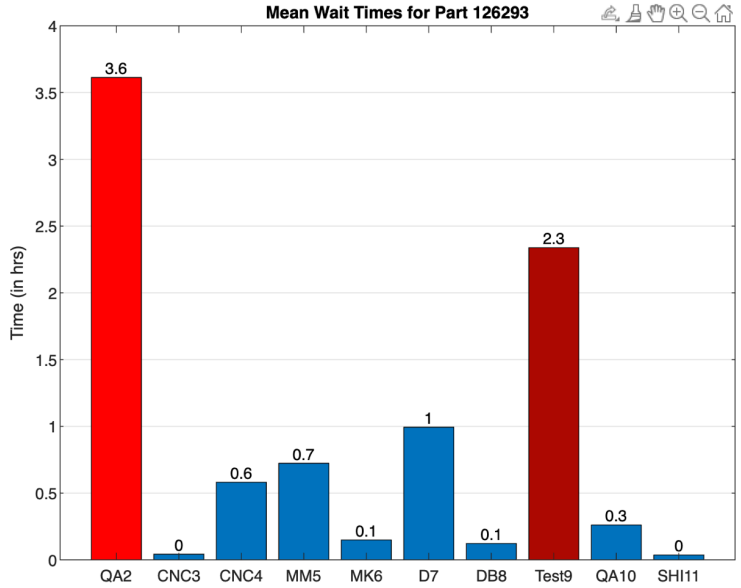
In part 126293

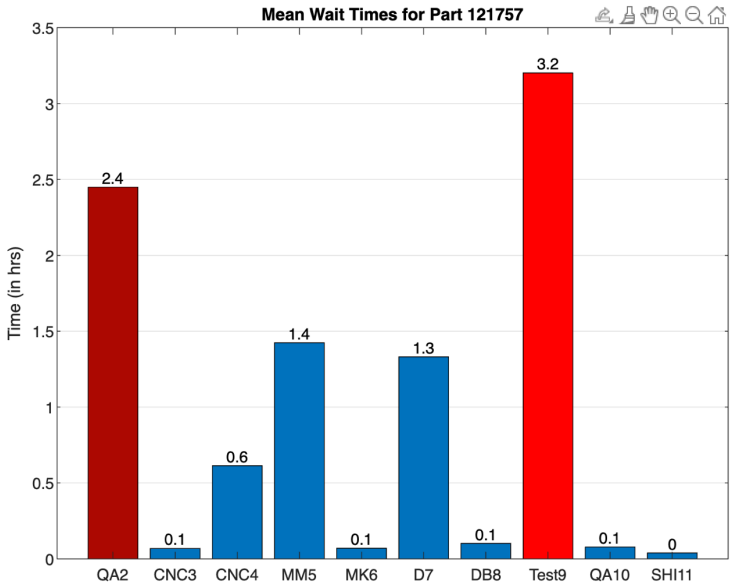
- **QA2** and **QA10** have the **first** and **second highest** times, respectively.
- **Test9** has the **third**-highest time and is a **close second.** The other processes have a relatively lower average process time.

Average Wait Times for each process



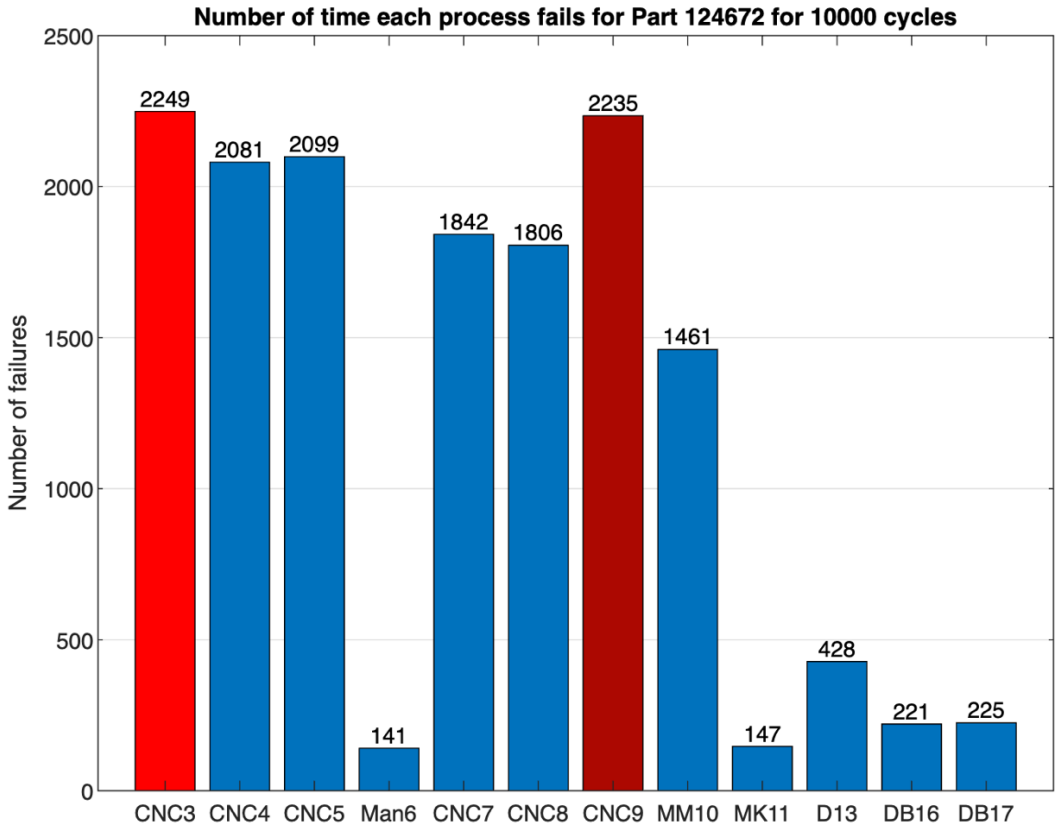


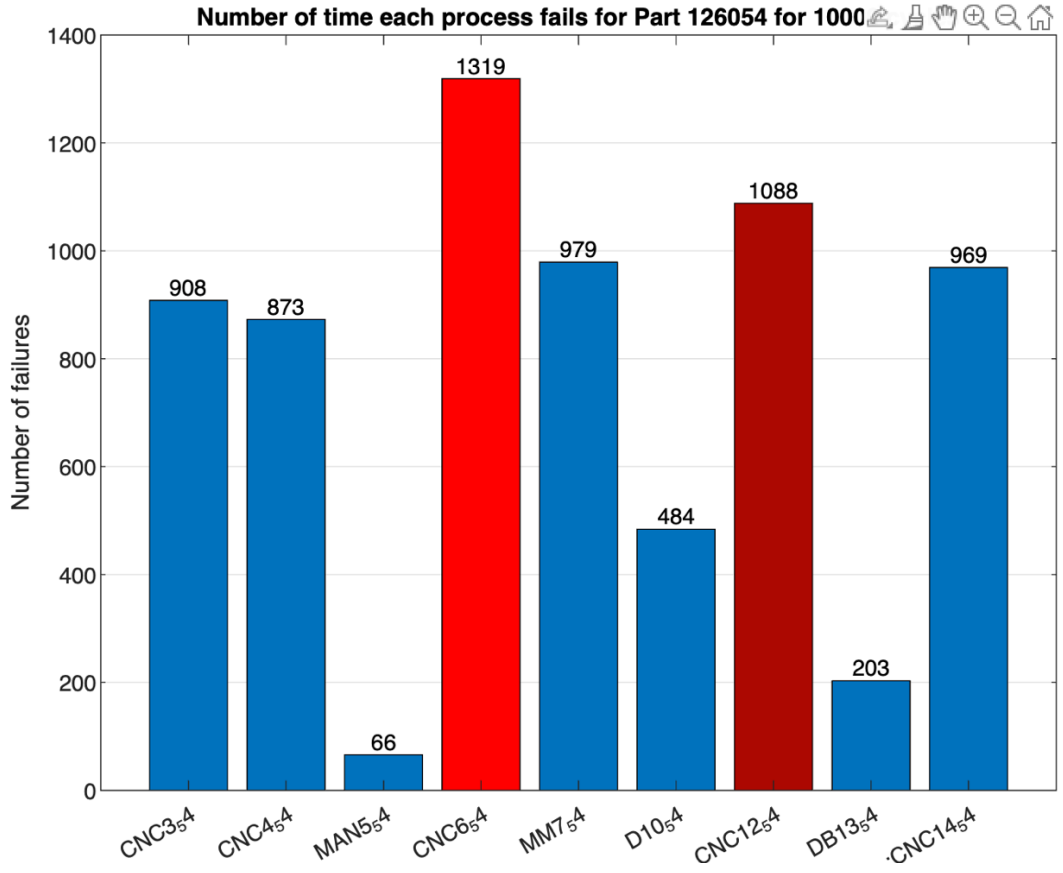




- It is evident from the graphs that the main bottle-neck in all the product lines are QA and TEST
- These have the longest wait-times

Bar graphs for the number of failures in each product line





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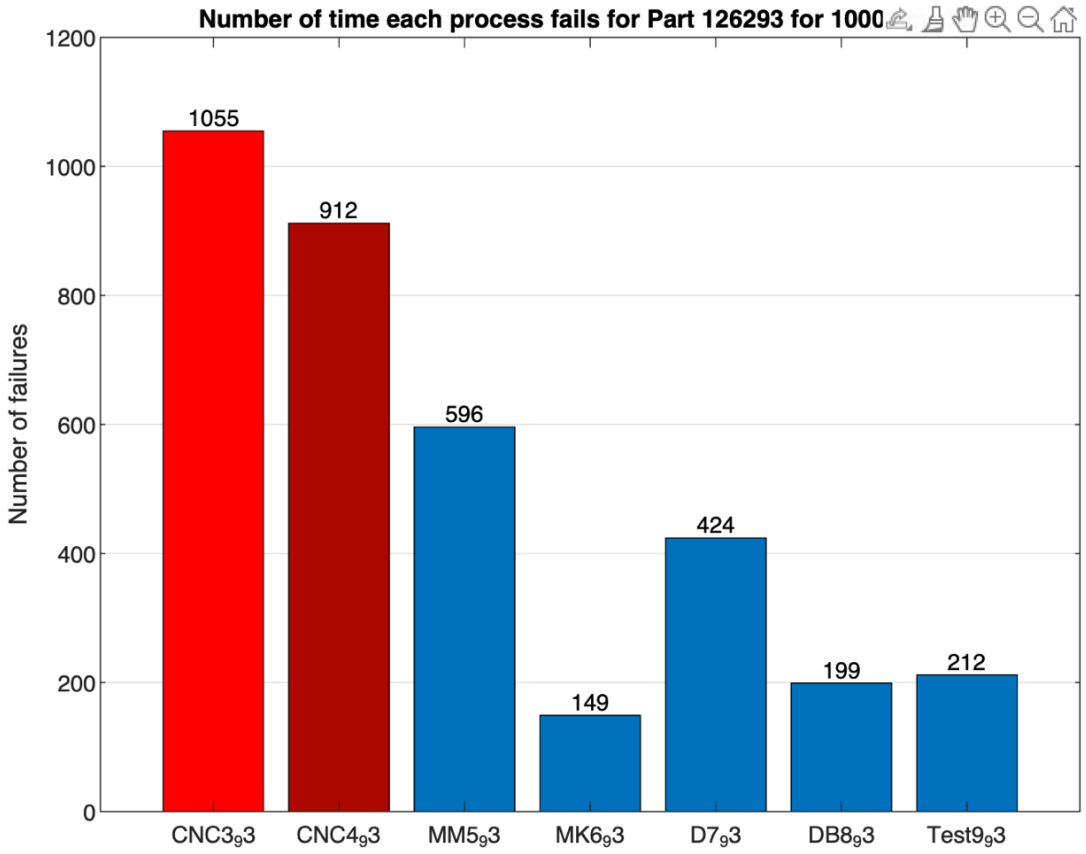
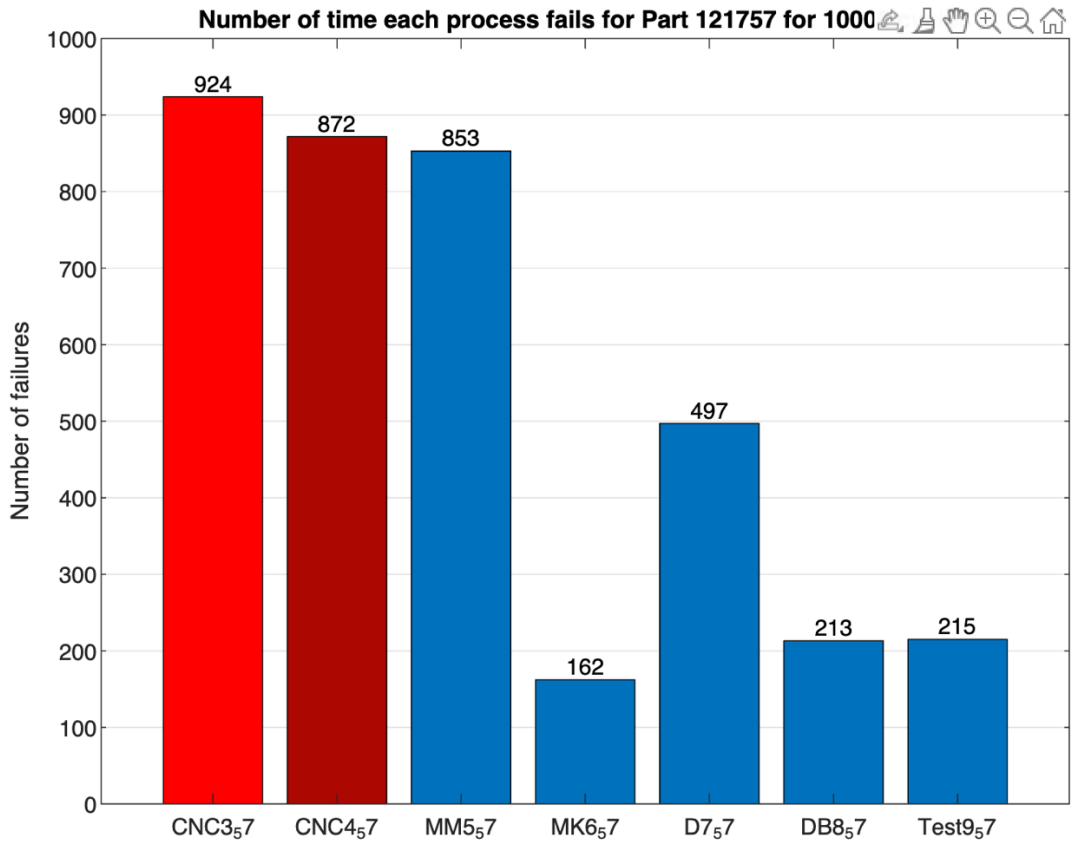
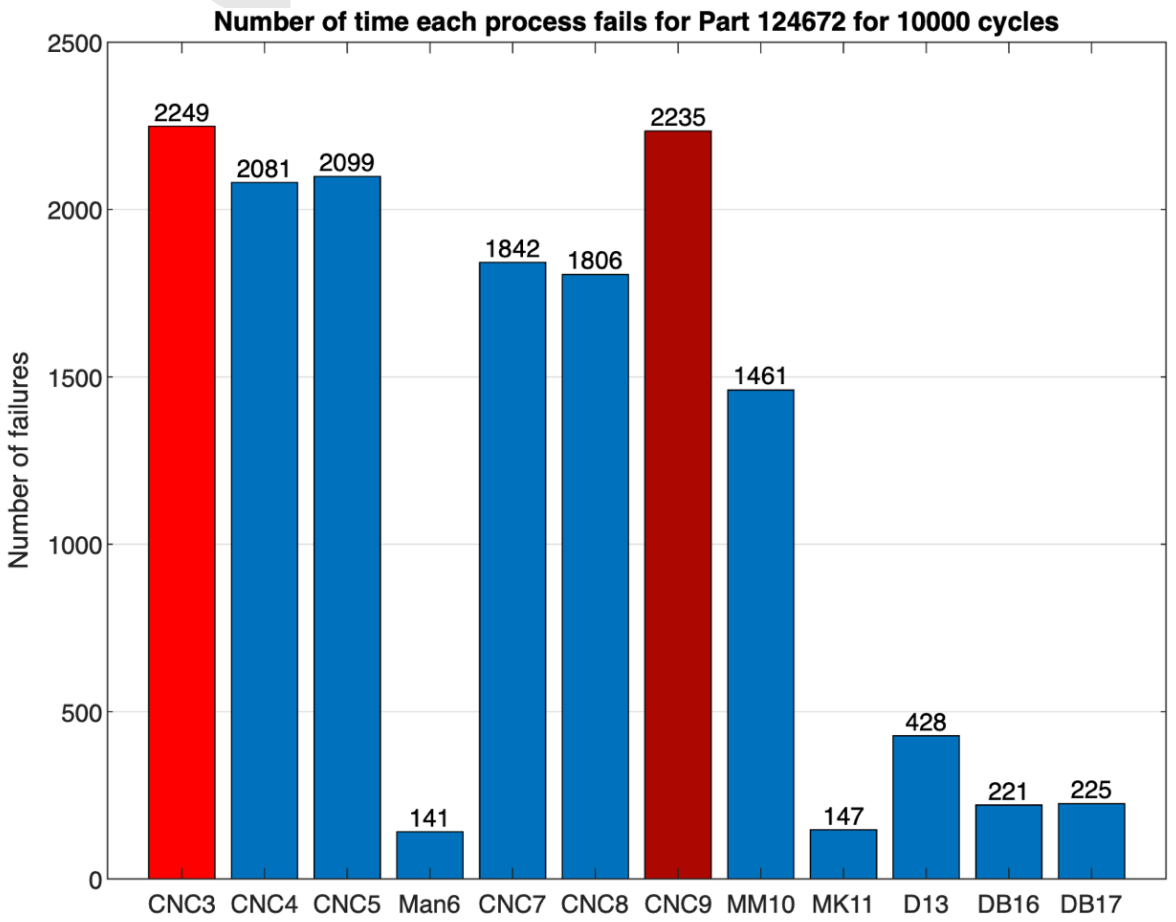
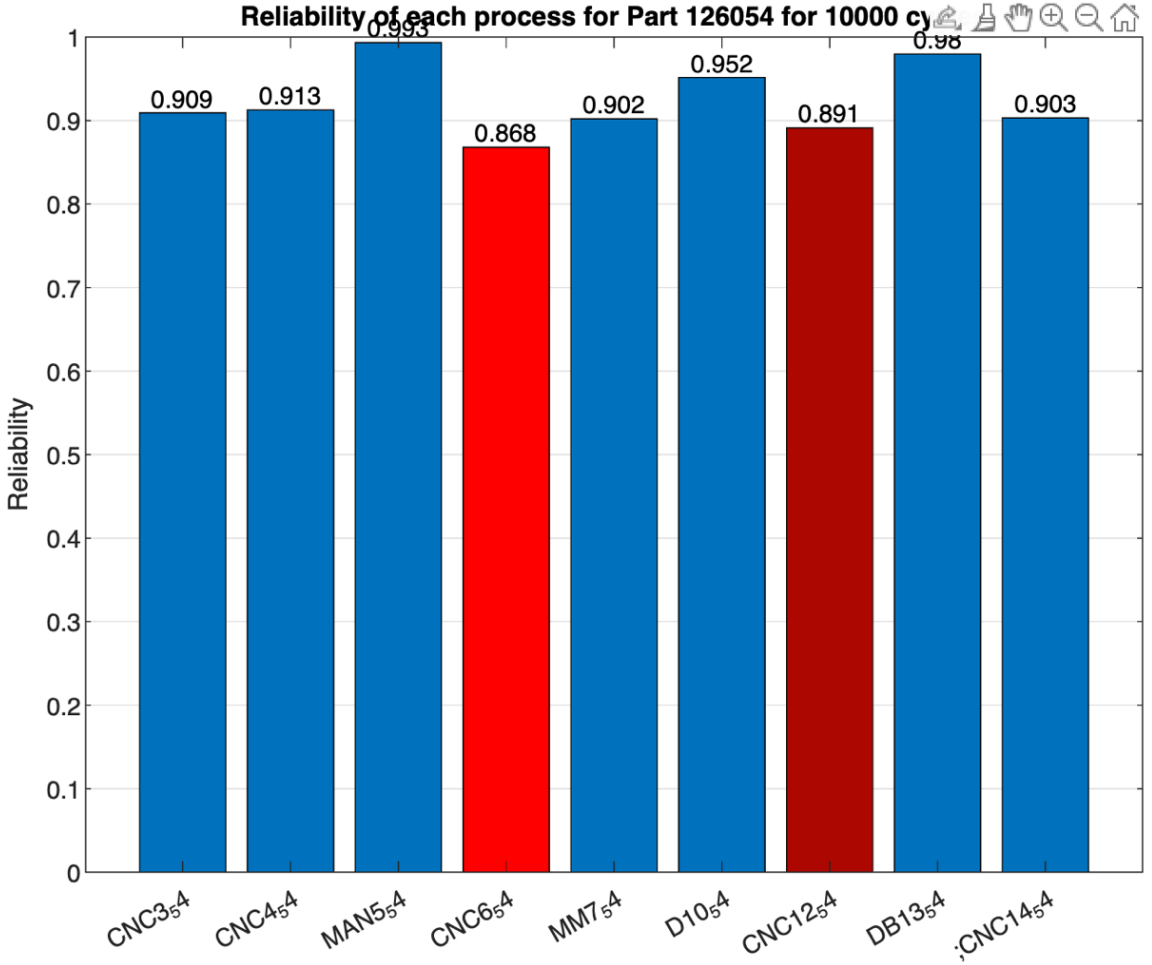


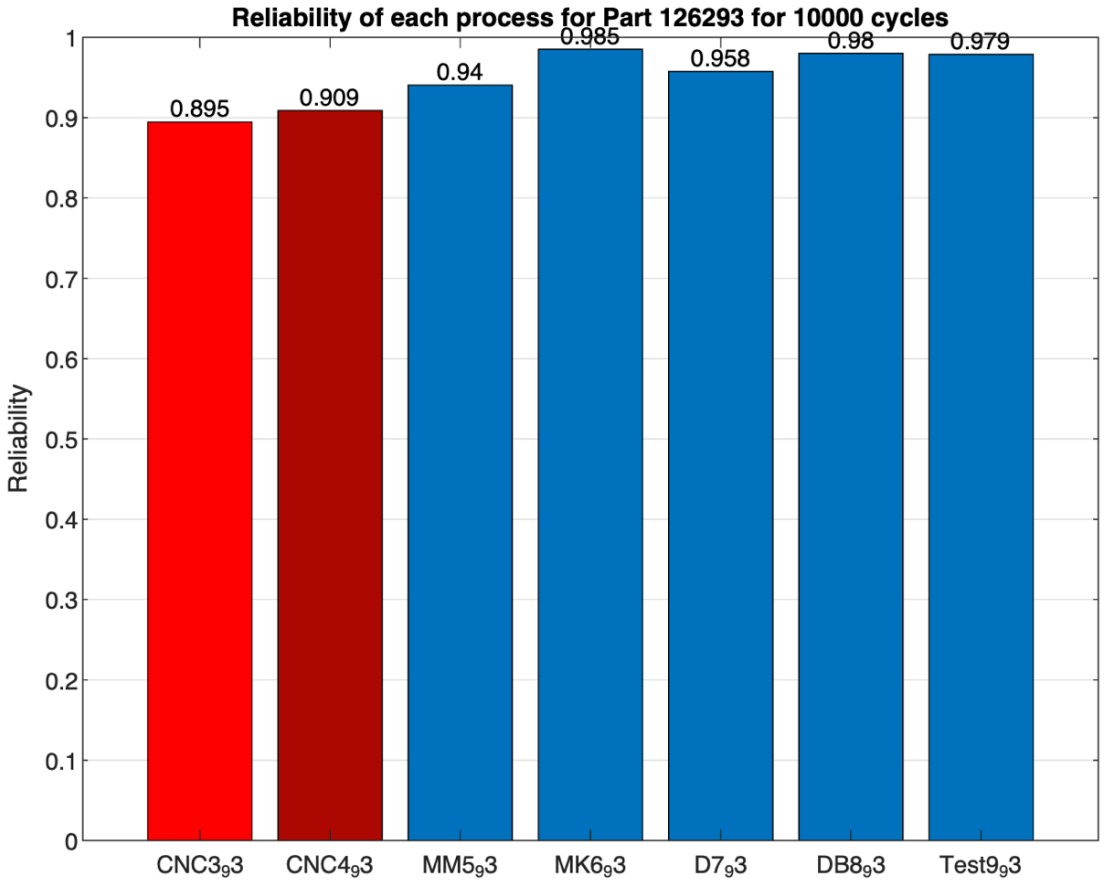


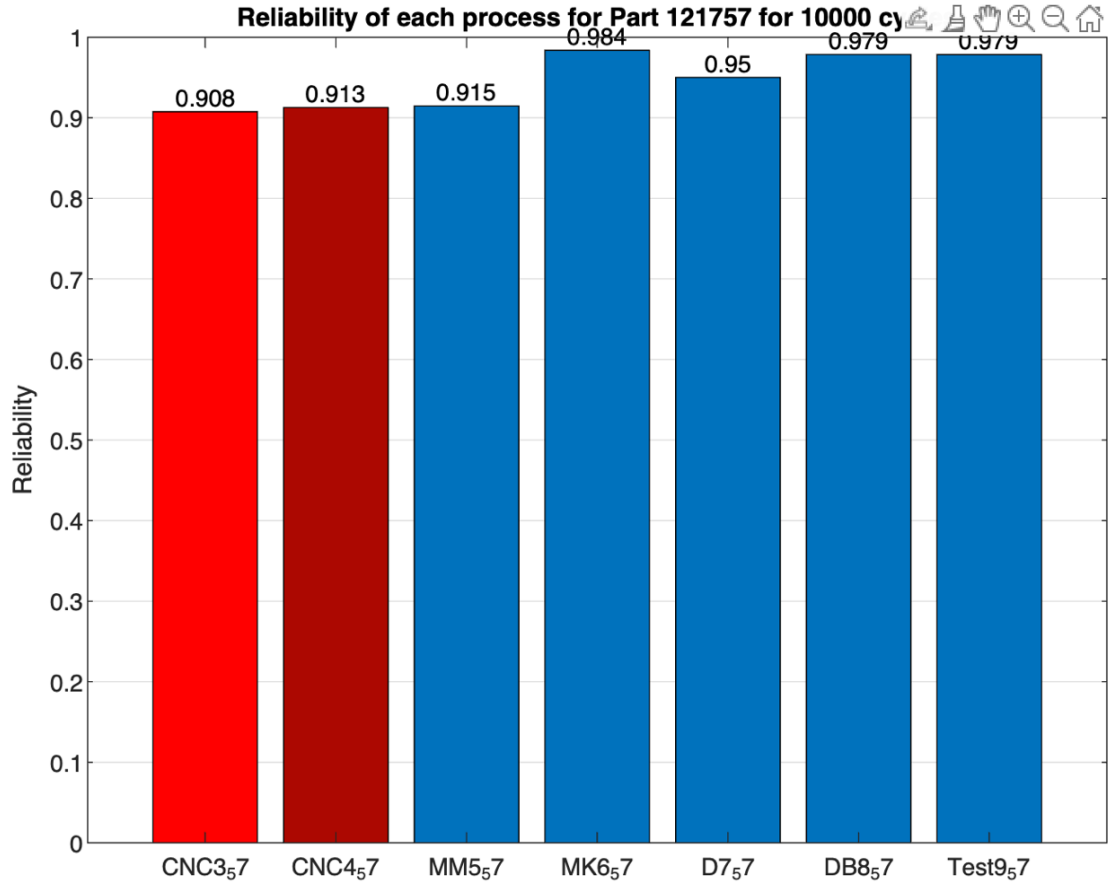
Bar graphs for the the reliabilities of each machine



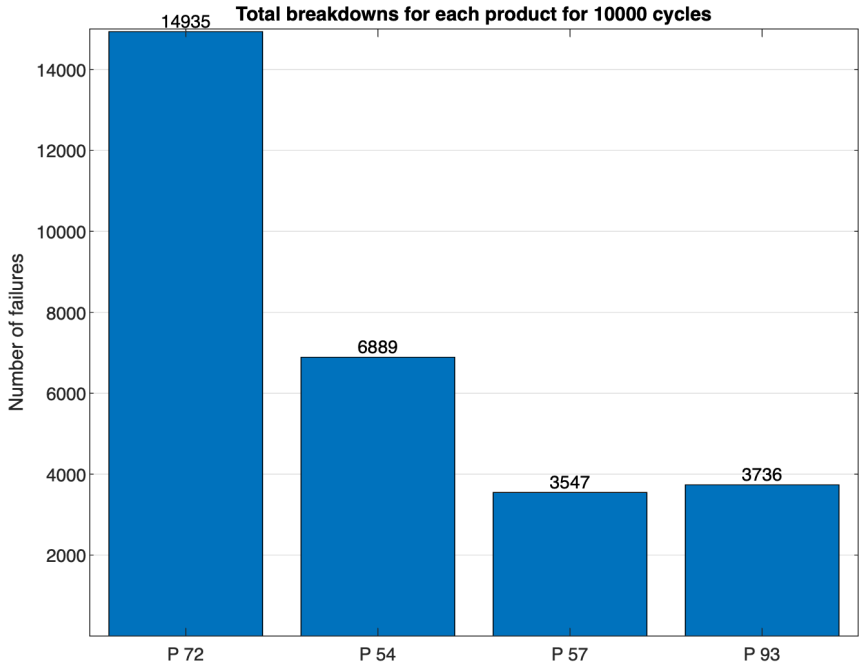


Bar graphs for the the reliabilities of each machine





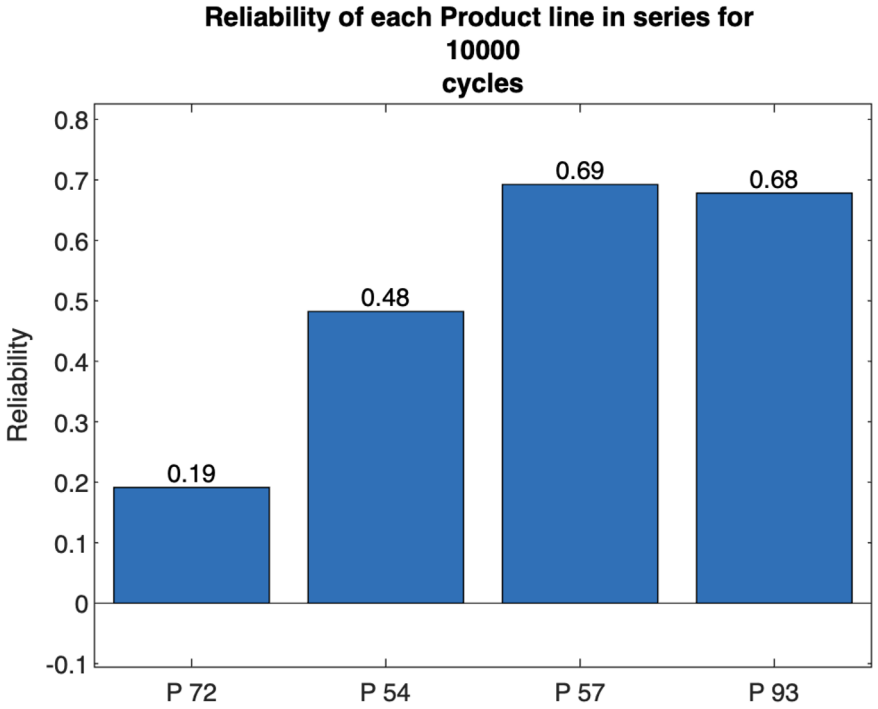
Bar graphs for total number of failures and the total reliability in each product line



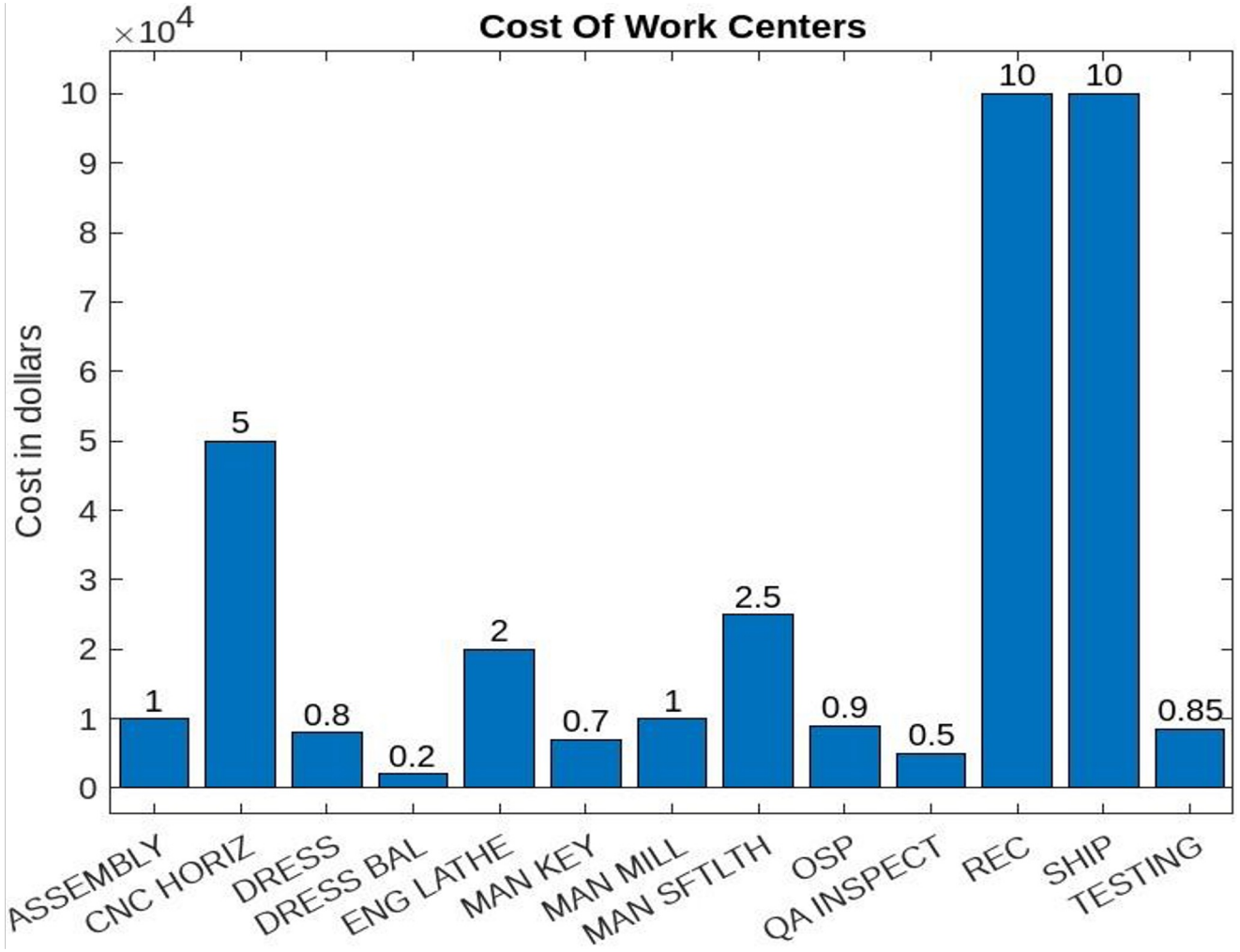
The highest number of failures corresponds to the lowest reliability in the above graphs. The CNC machines tend to fail the most in all the production lines.

From the graphs, we can infer that the **testing equipment** has high reliability, **0.977** for product line **121757** and **0.979** for product line **126293**.
So the testing process should be analysed to optimise it and decrease its overall time.

The reliability of the whole product line for each part is shown. The values were calculated using the series reliability formula.



Inference



QA has the highest time in all the product manufacturing lines.

The cost of the QA workstation is **5000$**, which is illustrated in the workstation cost graph below.
The QA times can be decreased by investing in a better QA workstation.
Alternatively the machine operators can be trained assuming it involves a bit of manual work.

If the QA is being done manually, **machine vision technology** can be used to automate the process, which decreases the variation of time taken and increases efficiency. The cons for this would be:

- A high initial investment
- The time taken to train the machine vision model
- Potential downtime of the device/machine

Other than QA, the following can be improved:

In product lines 121757 and 126293, the **Testing** has the highest times in their respective product lines apart from QA. More information on this is given in subsequent slides.

Inference

- The lowest reliable CNC machines in Product 1’s manufacturing line has a reliability of 78% whereas the CNC machines in the other product manufacturing lines have a reliabilities above 85%.

- This is despite using the same model of CNC machines for all the product lines (due to the same breakdown times and standard deviation). The reason for the low reliability is due to the longer average process times of the CNC machine’s

- Investing in better CNC machines with higher reliability when running for longer periods of time can improve the throughput of Product 1’s manufacturing line