

Work Group 1: Frame Manufacturing

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1. Description of the exercise and production

The aim of this exercise is to produce frames with 20 mm metal tubes, cut, pressed and welded.

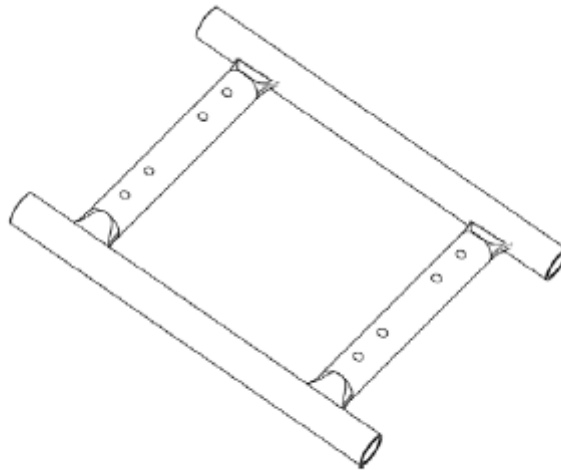


Figure 1. Final producto

2. VSM

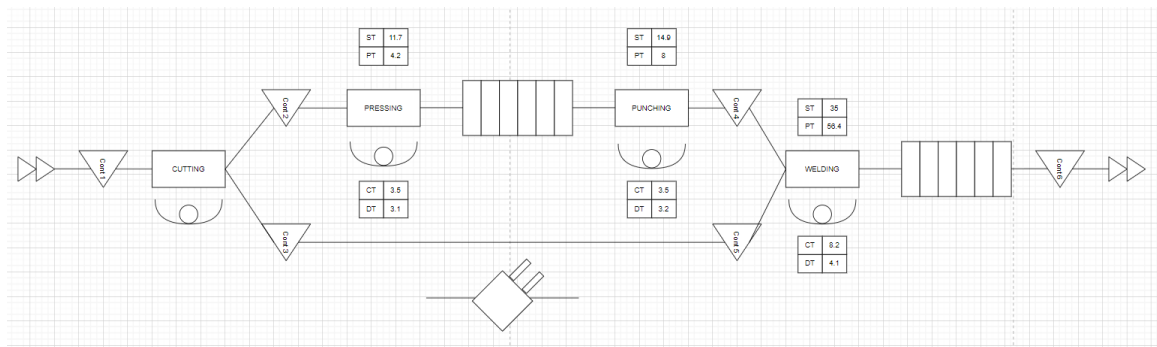


Figure 2. VSM

3. FxS Model

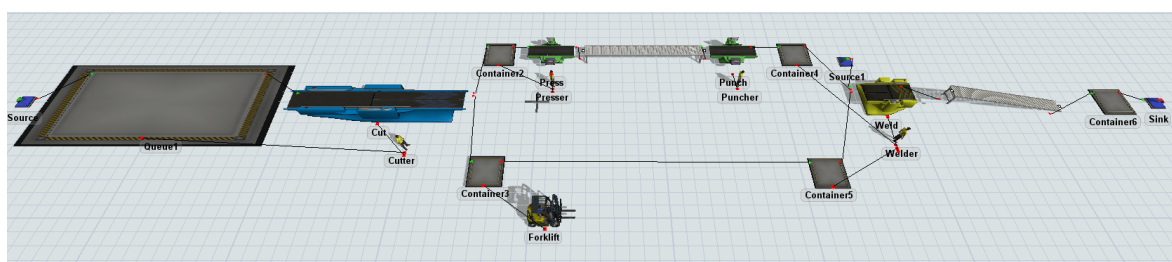


Figure 3. Flexsim model

We are going to discuss the main parameters of each element of the model.

- **Source:** We need to work with a starting point of 10 bars of 6 meters. For next events, we need to configure two types of starting items. We name those two types with the name of its future dimensions. We put the following arrival sequence on repeat.

Arrivals - Source

Arrivals: 2 Labels: 1

	ItemName	Quantity	Type
Arrival1	500	1	1
Arrival2	470	1	2

Figure 4. Arrival sequence

- **Container 1:** We work with an arrival of 10 bars. So, in this first container we need to specify the max content to 10.
- **Cutting process or machine:** We add a separator to achieve this activity. We change its properties so we can split the initial 6 m bars in 12 pieces, differentiating between 500 mm and 470 mm bars (predefined in the arrival sequence). We need to configure a trigger on exit so we can consider the difference products and where they are going to move on the model.

Separator

Separate Mode: Split

Quantity: 12

Processor

Max Content: 1 ☒ Animate Items

Setup Time: 0 s

☐ Use Operator(s) 1

Process Time: normal(6, 1.5, getstream(current)) s

☐ Use Operator(s) 1 ☒ Same as Setup

Output

Send To Port: Port By Case

☒ Use Transport

current.centerObjects[1]

Figure 5. Properties of the separator

- Container 2, 3 4 and 5: They are very similar, the only differences are the operator or forklift to move the bars and the type of bars which they store. We put 1000 bars as max content to see which of the operations is the bottleneck. We specified a batch size of 12 elements, as the divisions of the 6 m bars.
- Forklift: We need a forklift to move the batches of the 500 mm between containers 3 and 5.
- Pressing and punching workstations: We defined the times and link the operator need in each station. And we added a conveyor between these activities to move the bars.

The screenshot shows the 'Processor' configuration window with the following settings:

- Max Content:** 1
- Animate Items:** ☒
- Setup Time:** 14.80 s
- Use Operator(s):** ☒ 1
- Process Time:** 4.20 s
- Use Operator(s):** ☒ 1
- Same as Setup:** ☒
- Operator:** current.centerObjects[1]
- Priority:** 0.00
- Preemption:** no preempt

Figure 6. Pressing properties

The screenshot shows the 'Processor' configuration window with the following settings:

- Max Content:** 1
- Animate Items:** ☒
- Setup Time:** 18.40 s
- Use Operator(s):** ☒ 1
- Process Time:** 8 s
- Use Operator(s):** ☒ 1
- Same as Setup:** ☒
- Operator:** current.centerObjects[1]
- Priority:** 0.00
- Preemption:** no preempt

Figure 7. Cutting properties

- Welding station: We need to add an additional source so that the combiner works as it is design. We put “invisible boxes” in that source to simulate the exercise. Then, we need to specify the source, and inputs, the last ones with the number specified. And as the other activities, we need to add the times.

Combiner

Combine: Join

Components List

	Target Quantity
From Input Port 2	2
From Input Port 3	2

Processor

Max Content: 1 ☐ Animate Items

Setup Time: 39.10 s

☒ Use Operator(s) 1

Process Time: 56.40 s

☒ Use Operator(s) 1 ☒ Same as Setup

Operator: current.centerObjects[1]

Priority: 0.00 Preemption: no preempt

Output

Send To Port: First available

☐ Use Transport

Input

Ports

Input Ports

- 1: Source1
- 2: Container4
- 3: Container5

Figure 8. Combiner properties.

- Container 6: As it is defined in the instructions the final batch needs 20 final products.

To analyse the model, we use a dashboard of Output/hour where we can see the number of products done in each process and the final products.

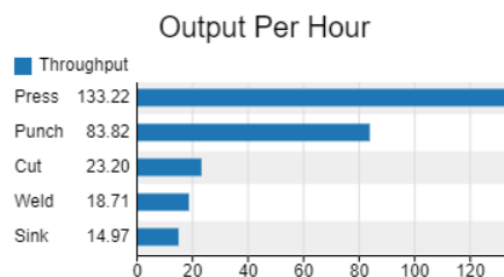


Figure 9. Outputs/hour process of the model

Clearly, the bottleneck of the production line is the welding. To increase the productivity, we need to invest in that process. Other significant changes that we can do or study are: cutting the bars in the length needed at that moment, changing the transportation, etc.

4. Improvements

We are going to focus on increasing the number of welding stations and welders so that we can reduce the bottleneck mentioned before. We tried with different variations, but in the end having two is enough. Increasing it more only creates new bottlenecks and problems.

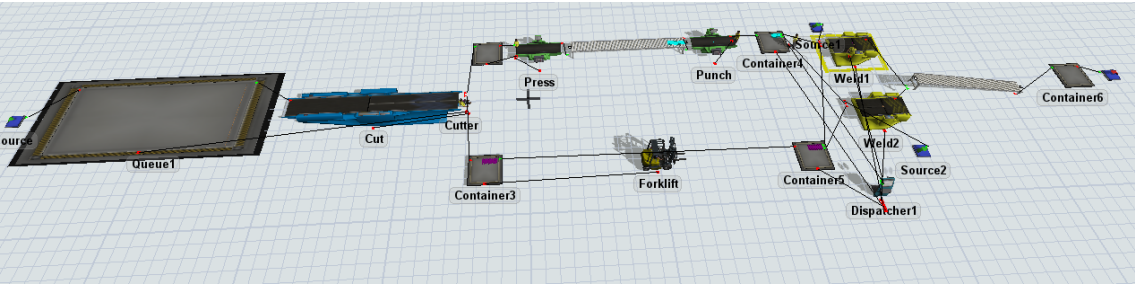


Figure 10. Improved model with two weld stations

The final model needs the implementation of a dispatcher so that two operators can optimize both weld stations.

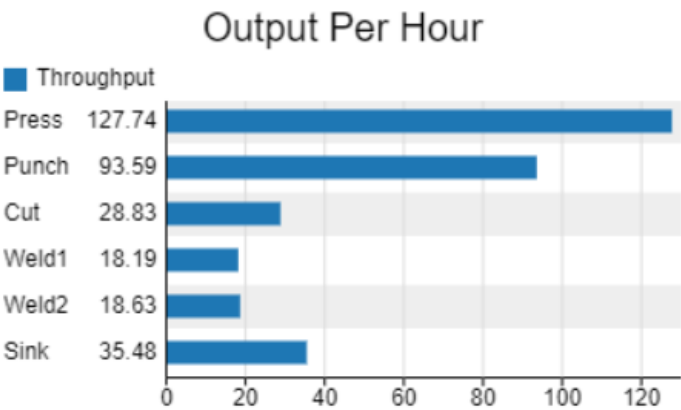


Figure 11. Output/hours of the improved model (two weld stations)

We reduce the bottleneck mentioned before and nearly duplicate the production. But in the end the pressing-punching line is overbooked, and the conveyor is full, which does not optimize the production and installation.

As we have done previously with the weld station, we are going to duplicate the punching stations so that we can improve even more the production.

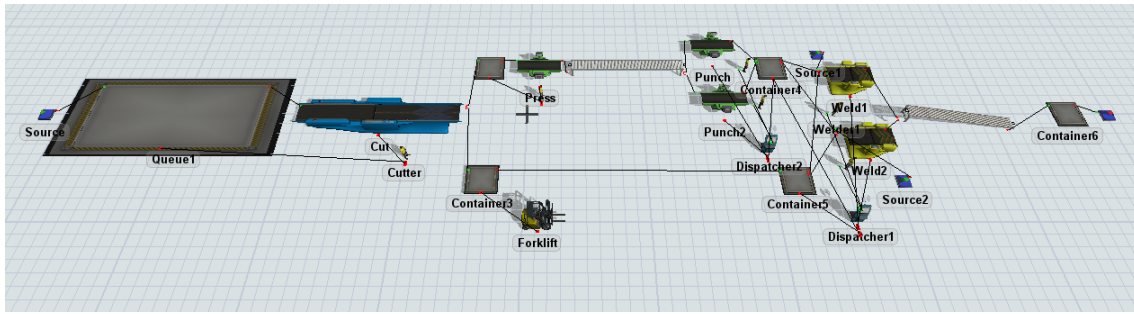


Figure 12. Improved model with two weld stations and two punching stations.

The results of this model are recopilated on the nest figure.

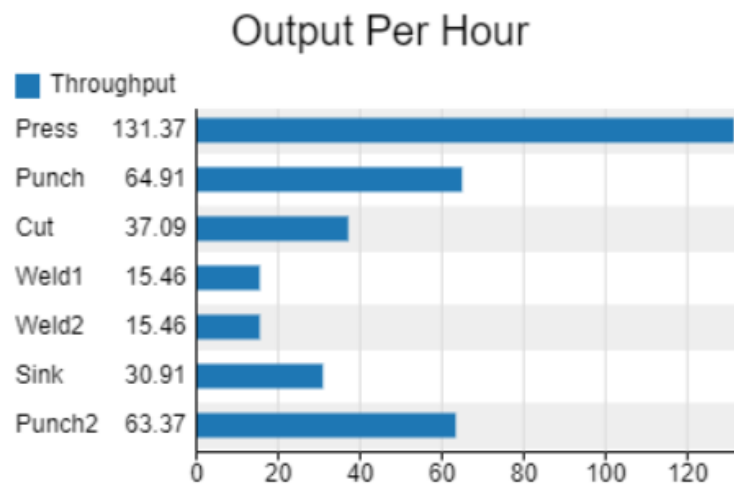


Figure 13. Outputs/hour second improved model

This last improvement does not affect at all in the number of final products, but it improves the workflow. The conveyor does not have more bars than it should, and adding bouth punching stations it is like the pressed bars, improving that part of the production line. But it keeps being a bottleneck on the welding processes.