Group 10
Jan Haido, Pieter Koster, Joep Smits, Kevin Cacarin Cumbal, Henk Jekel, Felix Tieleman , Noureldin Ibrahim, Sameer Nizamudeen, Kelvin Jaramillo, Daniel Ding, David Chiriboga, Nan Li, Luuk Schukking, David Carrera Robles.

Morocant Drives

Production & Assembly

Jan Haido, Felix Tieleman, Noureldin Ibrahim

P&A

Introduction

In ‘Production & Assembly’ the functional production line is defined. A cell layout is chosen to be used, which is most effective for batch production, like Morocant is performing. For this cell layout to be functioning properly, a cell must be defined clearly. This includes which machines are present and in which quantities. Also, within each cell, positioning, internal storage and transport is considered.

Requirements

A set of requirements is setup to be met within the production line. Note that some of these requirements are relevant for the production line, but not relevant for this specific subsystem.

- To be compliant with the ISO 9001:2015 standards to prove Morocant Drives’ capacity to meet customer needs [1]
- Production capacity of about 2940 parts per month (average demand per month)
- A minimum of 560 extra parts can be produced per month
- Area needed for the production line should not exceed 1200 m² (15% of factory space)

Cell flow

From the product data of Morocant, one can see the patterning and similarities between different products as shown in figure (1). This machining pattern provided information regarding possible product families and thus, the final division of cells and their production processes. Figure (1) also shows which machines must be present within each cell.

In figure (1), the newest product (written in red) has a different pattern than the rest of the products within the cell. It is chosen to include this part in cell 4, since the order of machine operations can be found for the other parts in this cell as well.

The six different cells were now roughly defined. Using this information, a very rough layout was set up in close collaboration with the subsystem “Layout & Safety”. This is shown in figure (3). Within this layout, one can see the different cells present within the layout. For further elaboration on this production line layout, one can view the ‘Layout & Safety’ poster, in which also material flow from the warehouse is depicted.

Cell Definition

The cells in figure (1) need a specific definition. This includes the amount of machines present in the cell, as well as possible priority to arranging or position within the cell. This analysis includes initial estimations and assumptions to fully define the cell, thus finding the number of machines, as well as possible cell configurations regarding positioning.

Number of machines

The number of machines is an essential parameter which has a large influence on the efficiency of the production line. Using available machine time and required production time (based on demand), and assuming that the factory is working with 3 shifts each 8 hours and the setup times were taken into account, the number of machines is calculated. The amount of setup changes each month is assumed to be twice the amount of different products for a specific cell. The number of machines required are shown in table 1. The total cost of the new machines adds up to €196500. To save extra costs, some machines - indicated with green color- will be shared between multiple cells. For instance, three drilling machines will be shared between cell 1 and cell 4.

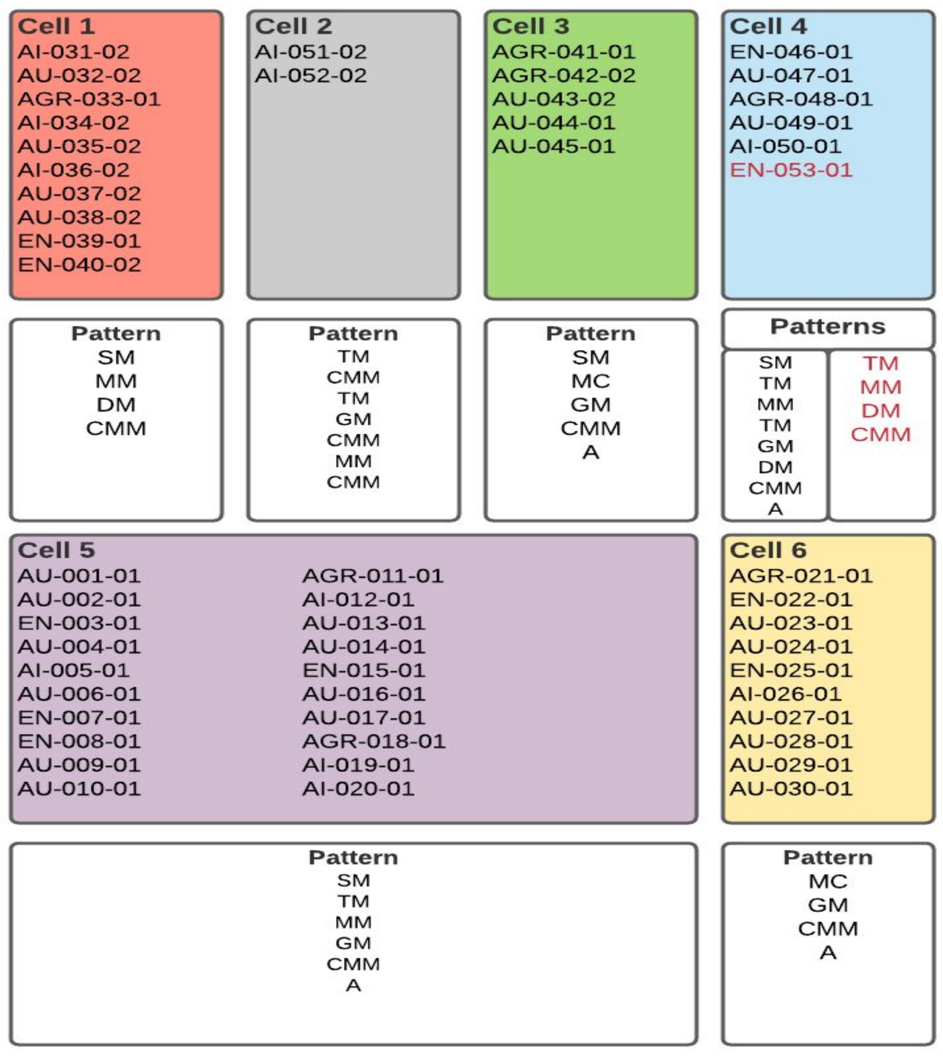

Figure 1: Product families and cell division

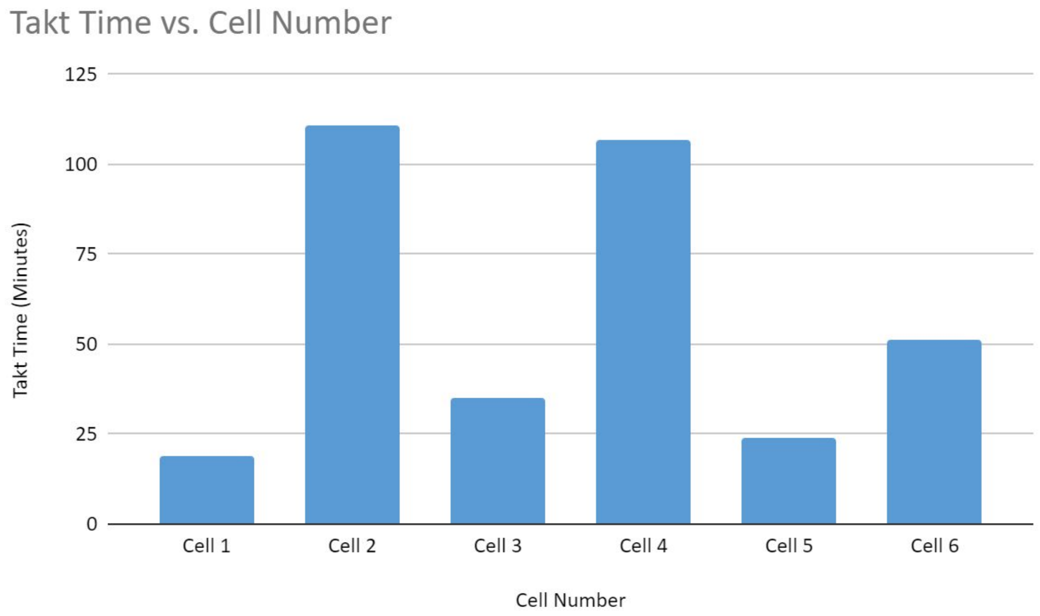

Figure 2: Takt time per cell

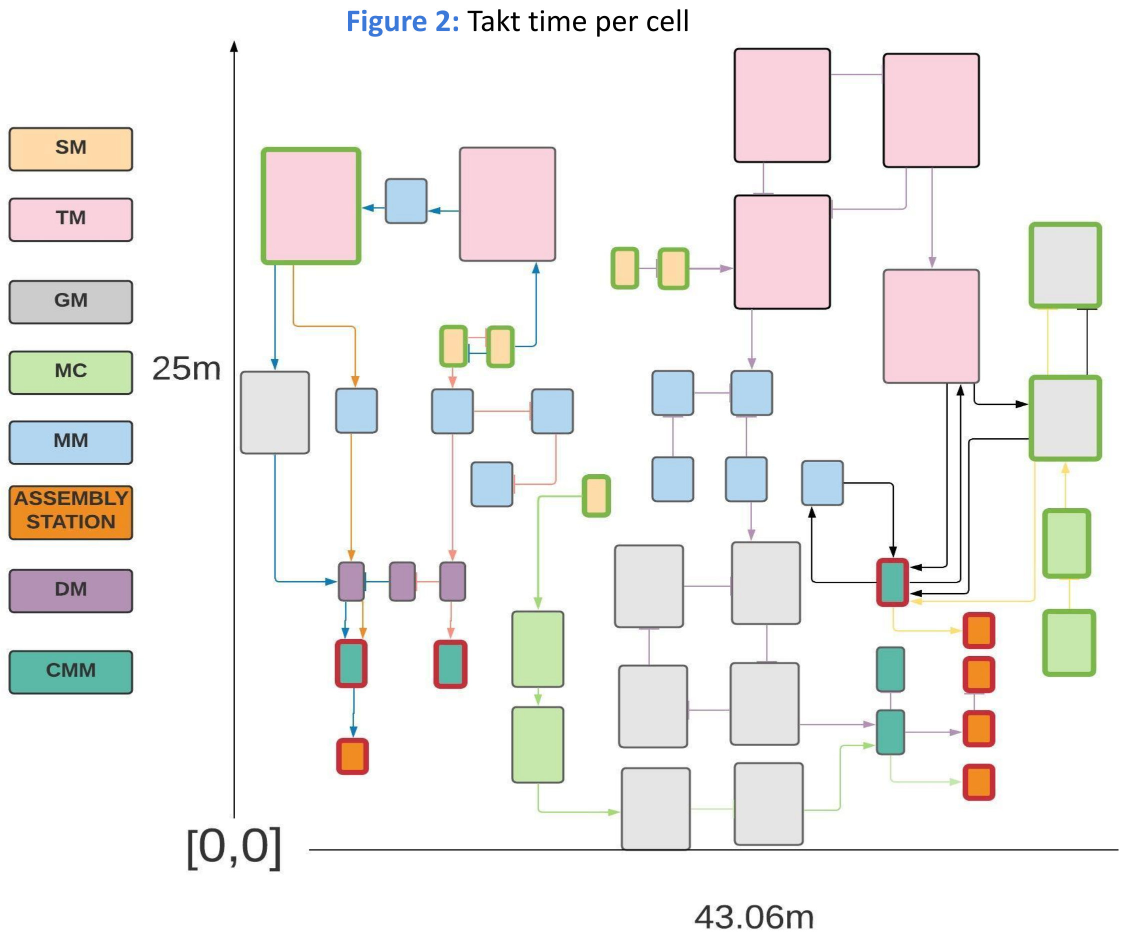

Figure 3: Simplified floor plan for production line (Cells recognized by their color coding, same color coding is used throughout this poster

	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Machines req.	Current no.
SM	2	0	1	2	2	0	5	5
TM	0	4	0	1	4	0	5	4
MM	3	1	0	4	4	0	8	5
MC	0	0	2	0	0	2	4	5
DM	3	0	0	3	0	0	3	2
GM	0	2	2	2	4	2	8	4
CMM	1	1	2	1	2	1	5	4
A	0	0	1	1	2	1	4	2
Machines are shared between different cells (simultaneously present)								

Table 1: Overview of the number of machines needed per cell

Figure (2) shows that cells 2 and 4 have the highest takt time and therefore, working hours exceed the demand by a significant difference relative to other cells. To compensate for that, shared machines between cells often involve cells 2 and 4.

Internal machine positioning

Machine positioning is essential for a good flow throughout the factory. Within a cell, machines are closely packed together. One can see a simplified floor plan in figure (3), which was made in close collaboration with ‘Layout & Safety’. For the cause of ‘Production & Assembly’, the machines within a single cell (represented by color coded arrows in figure (3)), are as close to each other as possible to minimize the transport time. Some machines are placed further apart due to the fact that certain machines are shared between cells. Also, same machines are grouped together to prevent the production line from functioning properly when a machine breaks down.

Internal transport

Within cells, transport is required. A processed part must move between machines. In order to reduce time, a fully automated system in the form of a conveyor belt is present within each cell. This system reduces idle time (the worker retrieving the product from the previous machine and moving back to his machine) as well as employer strain.

The dimensions of this conveyer belt is dependent on the dimensions of the parts that are produced in each cell. The required dimensions (width) and capacity (mass) of the conveyor belt is mentioned below.

- **Cell 1 & 2;** Small (50 mm, 1.0 kg)
- **Cell 3:** Medium (150mm, 2.6 kg)
- **Cell 4 & 5 & 6:** Large (250mm, 12.2 kg)

Such a conveyor belt can easily be customized to such an extent that it will suit the cell, where the desired width and length of the belt is chosen properly. For each arrow present in figure (3), a conveyor belt can be applied and placed. Note that where double arrows are present, the two conveyor belts can be merged into one, that matches the size of the biggest conveyor belt necessary.

This setup is a push setup, in which as soon as a product is finished it is moved to the next process. This means that a small amount of products is stored temporarily at the machine it will be processed, before it is processed. This means that storage space is to be accounted for. Since most parts that are stored are subassemblies, the amount of storage can be small. (<0.75m^3). This storage must be present at the assembly station as well. There a larger amount of products are stored, for which we assume a larger storage space (<2m^3).

Discussion

During the creation of the product families, the division shown is the very first division made. This division in product families seemed to be the most straightforward. For this specific division, the production line was optimized. There is a possibility that a different division could be more efficient. This can be analyzed in further research.

The conveyor belts used were applied to every single point of transport between machine/machine groups. During production, one might find that for specific machine to machine transportation, there might be very low utilization of the conveyor belt. If a belt is utilized too little, this can be stored and used for future expansion.

The requirement that were set up are met. The capacity mentioned is reached by applying the number of machines specified. Using additional machines (added due to spacing, see ‘Layout & Safety’), the capacity can be reached. Also the spacing and quality requirements were met.

The calculations and results in table (1) use the assumption of 3 shifts of 8 hours in a day. In reality only 2 shifts might be used. This will result in more machines. Subsequently, this also increases the production line size and thus, the factory size. See ‘Layout & Safety’ for the estimated area.

Contact

Henk Jekel
h.a.jekel@student.utwente.nl

References

[1] ISO 9001:2015 – Certification for Quality: A Quality Management System. https://www.thecoresolution.com/iso-90012015-standard-1

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SE

Morocant Drives

Systems engineering

Henk Jekel & Luuk Schukking

Subsystem division: P&A = production & assembly
SSA&C = sequencing, scheduling, administration & communication
Q&M = quality & maintenance
Logistics
Layout & safety

Introduction

This poster describes the systems engineering process as it was applied on the current project, designing a production system and its layout for Morocant drives, later referred to as the identified issue (IU). This final presentation showed the system under design (SUD) developed to solve the IU while keeping the context and the interests of the stakeholders in mind. The systems engineering process involved the organization behind the synthesis of the SUD using systems thinking tracks to make sure that the resulting system fits its purpose. It also included the application of system design tools that helped in both the process and thinking tracks.

Customer wish-system requirements

As a first initiative, an extended context diagram of the SUD was generated, including the interests of each stakeholder. It was used as a tool to constantly review during the design of the SUD, assuring proper fit with the IU. Taking the interests of all stakeholders into account, the relative importance of each operations performance objective was defined and displayed in a radar chart, Figure 1. The context diagram and the radar chart were used as tools to investigate the IU. The next step involved defining the solution, in this case the systems functions as displayed in the functional tree diagram.

The loop of switching between the problem and solution domain was iterated multiple times and repeated for each increasing level of detail of the SUD.

Systems architecture

Next, the systems architecture was defined, cooling the SUD by providing overview. Using decomposition thinking, the SUD was split up into subsystems. The budget of each subsystem was defined in terms of requirements. Scales thinking was applied in defining the requirements, as they were quantified in order for them to be testable. In parallel with defining the requirements a testing and verification procedure was defined in the form of the test and integration plan to make sure that the SUD would fulfill all requirements. As there were a lot of uncertainties at the beginning of the design, the systems architecture and the subsystems budget were uncertain and had to be monitored during the design process. This monitoring resulted in the combination of two subsystems, sequencing & scheduling and Administration & communication as this would lead to less interfaces and a better overview.

Figure 1: Radar chart

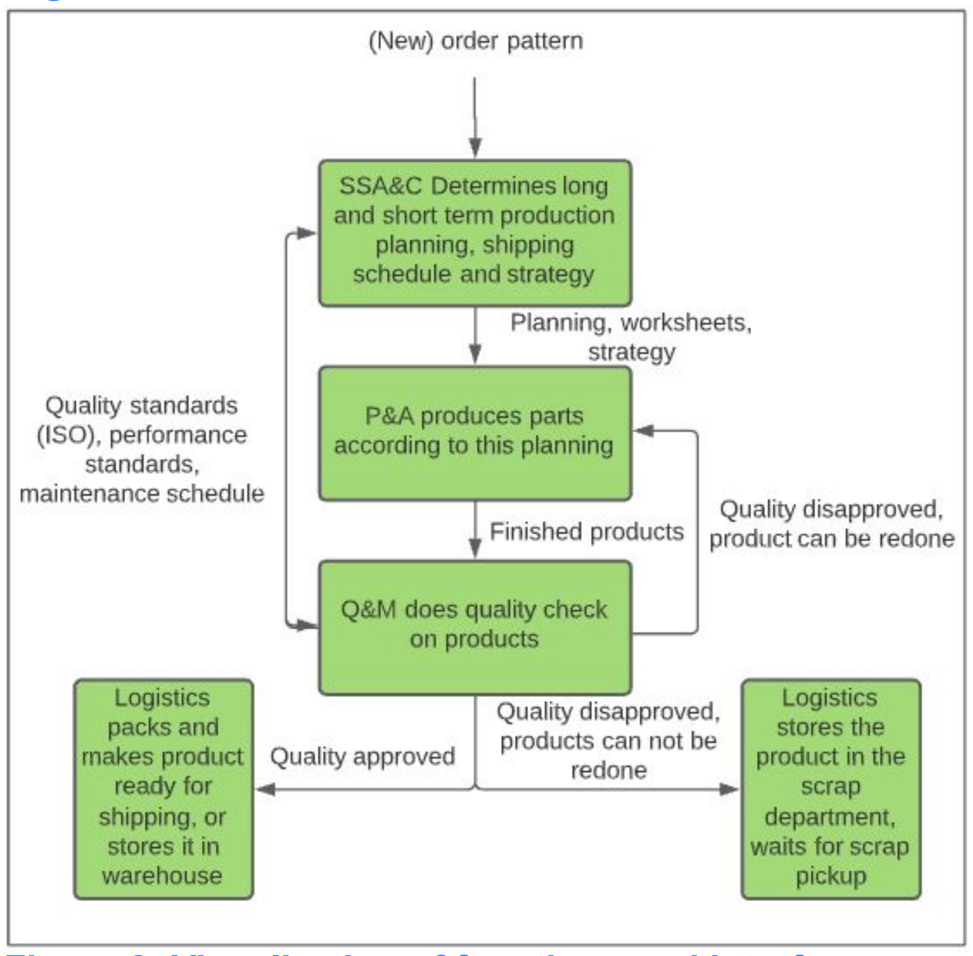

Figure 2: Visualization of functions and interfaces w.r.t. Running the production system

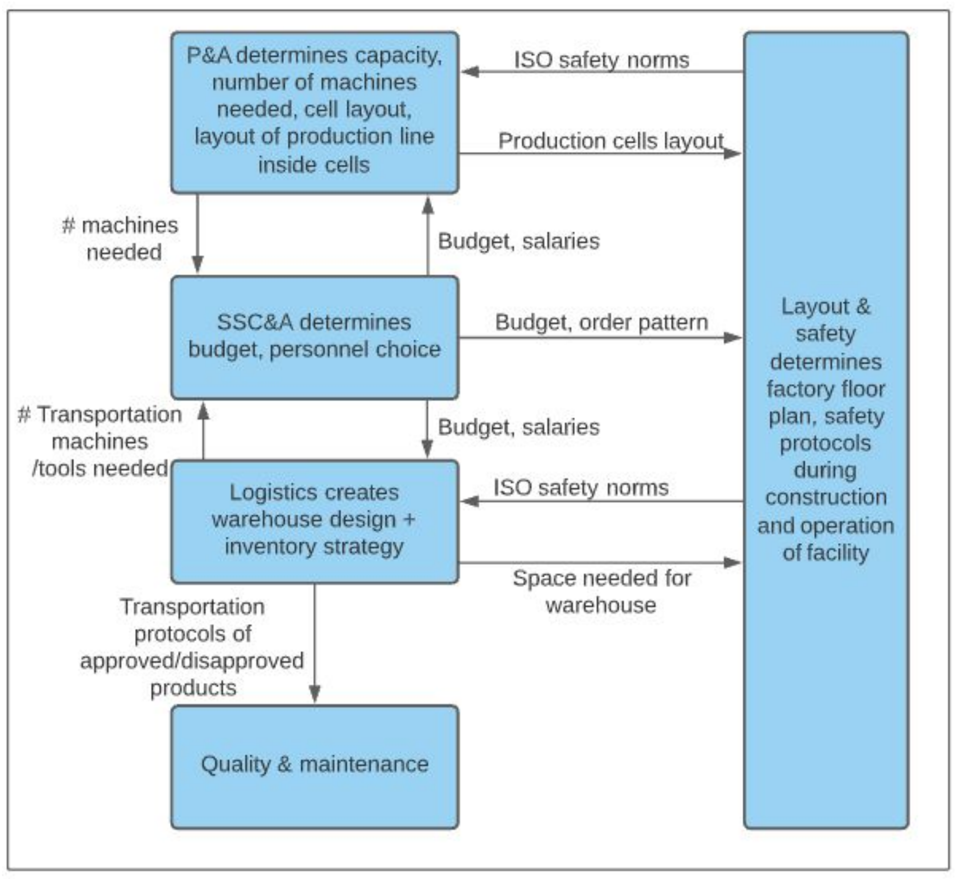

Figure 3: Visualization of functions and interfaces w.r.t. Building the production system

Failure prevention

Risk thinking was applied where the most important failure modes were considered. With the failure mode and effect analysis (displayed in Table 1) in mind during the design of the SUD, chances of failure were kept at a minimum. Rust prevention was provided by requiring each subsystem to document their progress and to share this progress with the subsystems at the other end of the subsystems interfaces under the supervision of the systems engineers. Together with the system manager, organizational thinking was applied to agree upon an organizational approach that would fit the development of the SUD. The SUD had no hierarchical structure, as decisions were based on convincing and consensus, not on authority.

Interfaces

It has been the systems engineers task to locate the interfaces, and to mediate at the interfaces. In doing so, subsystems could make parallel advancement while managing the uncertainties and risks of future integration. To locate the interfaces, two N^2 diagrams were constructed, the first one defining the interfaces whilst running the factory, the second one defining the interfaces whilst designing the factory. Figure 1 and 2 give a visualization of the resulting insights gained from the N^2 diagrams.

Integration

Similar to increasing the level of detail, a loop was used to integrate the subsystems to seal the SUD (composition thinking). This loop consisted of building, adjusting and modifying the components of each subsystem, and testing and verifying them with the test and integration plan. Iteration of this loop ensured proper integration into the SUD.

Discussion and conclusion

This design process followed by the systems engineers can be summarized by the vee model, Figure 4. It utilizes decomposition-composition thinking, where the two loops as mentioned above are responsible for the decomposition and composition respectively. Using the test and integration plan it was determined that the obtained SUD fulfills all requirements, resulting in a stable solution for the IU.

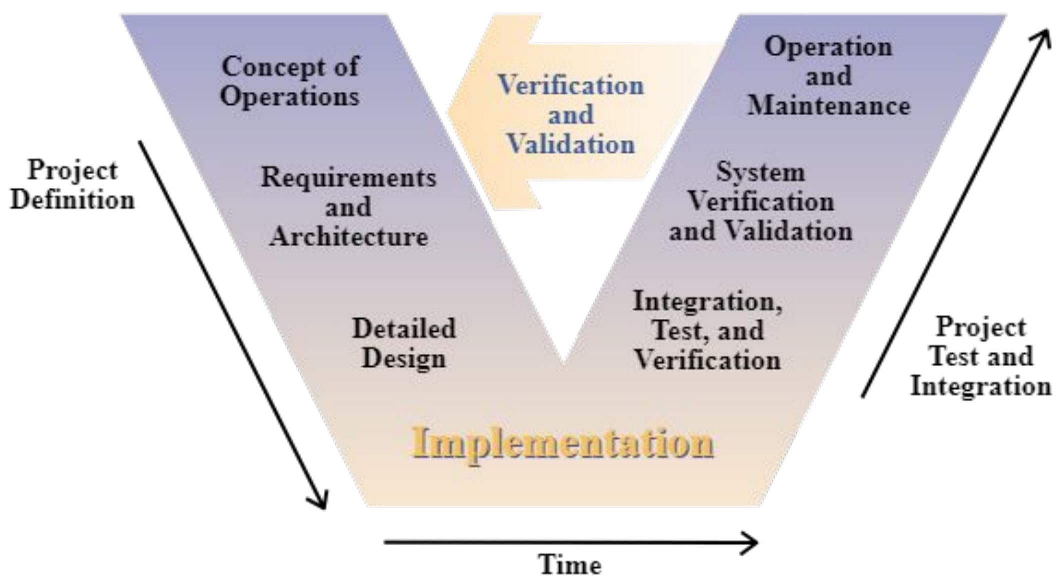

Figure 4: Vee model

Table 1: FMEA (all risks included in supplement)

Potential failure mode	Potential causes	Potential effects	Recommended actions	Severity
Design phase of system	Lack of communication between subsystems while designing	Not having enough meetings between the subsystems, not having someone who has insight of the total S.U.D.	Design flaws of production system, not being able to meet customer demands, not making profit, etc.	Hiring system engineers making sure customer demands are met. They need to define the correct interfaces and requirements for each subsystem.
Communication while production system is in operation	Miscommunication, misinformation is spread	Poorly defined interfaces between subsystems, poorly defined tasks for workers	Incorrect production, time wasted correcting these miscommunications	Properly define tasks and interfaces of subsystems, have daily strategy meetings with subsystems
Order pattern	Demand too high	Capacity too low	Not meeting customer demand; losing customers	Try to extend delivery date, increase capacity by ordering more machines or increase shift times/efficiency, amount of workers
Production	Products do not satisfy quality requi- rements	Low quality tools, low quality material, worker or machine made an error	1) Products get rejected by quality check in factory and need to be redone/become waste (time and money wasted) 2) Products get rejected by quality check of customer	Ensure high quality tooling/workers, do not take orders which quality can not be met with current production system
Maintenance	Machines fail to often, maintenance has to be done too often	Old machines, improper maintenance	Quality goes down, money is lost	Order high quality machines, do pro- per maintenance
Safety	Safety of workers is compromised	Safety norms are not met (See test plan which ISO norms), natural disaster	Injury, death of workers, destruction of facility	Ensure safety norms are met
Logistics	Delivery to customer is late, products are damaged	Improper packaging of products, un- reliable transportation company	Losing customers, losing profit	Background check and clear communication on/with transportation company, properly package products

Contact

Henk Jekel
h.a.jekel@student.utwente.nl

References

[1] G. Maarten Bonnema, K. Th. Veenvliet, J. F. Broenink, *SYSTEM DESIGN and ENGINEERING*, Boca Raton CRC Press 14-10-2015

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aido, Pieter Koster, Joep Smits, Kevin Cacarin
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Nizamudeen, Kelvin Jaramillo, Daniel Ding, David
a, Nan Li, Luuk Schukking, David Carrera Robles.

L

Morocant Drives

Logistic

Nan Li, Pieter Koster

oduction

er to better manage the logistics, a warehouse is designed ing to the current situation and future planning of the . A well designed warehouse can increase the dependability rocant Drives. This will require an investigation into the ory of each part as well as the volume of raw materials ed, so that the amount of storage can be computed. rmore, the most applicable material handling system for the ouse needs to be determined.

quirements

on the desire of system engineers and logistic ement, the following requirements should be met:

The warehouse must have adequate storage space for all parts and subparts depending on their volume and rate of purchase.
The warehouse must have adequate storage for raw materials such that they are ordered every season. (3 Months)
All packaging must have additional 25 mm in each direction for safety measurements.
The total area of factory and warehouse should be within 8000 m^2.

erview of Logistics

Figure 1 below shows an overview of the processes involved in logistics, as well as the stakeholders.
During the design process, the highlighted operational processes are of focus.
A third party logistics company is responsible for the transportation of the finished goods to the customers. Furthermore, raw material and purchased parts are delivered by the suppliers.

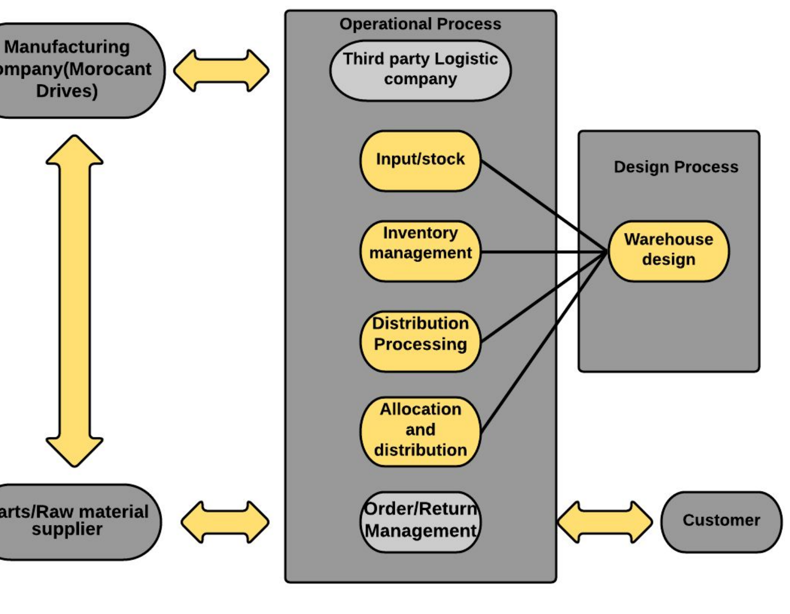
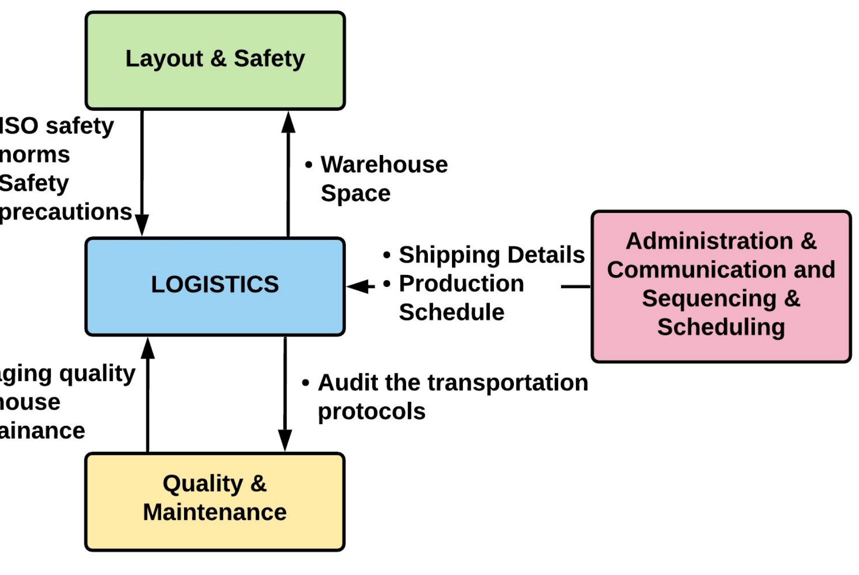


Figure 1: Overview of Logistics

rfaces

ure 2 illustrates the interface between the logistics and other tems. The arrows pointing to logistics indicate the ingoing es and the arrows pointing to other subsystems indicate g.



igure 2: The interface with other subsystem

rage Calculations

ach product both the maximum number of orders per and average number of orders per month for each part the datasheet. Assuming that the lead time is the time en two deliveries, the maximum and average lead time for art can also be calculated. The safety stock is calculated

Max Lead Time * Max Sale) - (Average Lead Time x ge Sale)[5]

tal inventory level is 2x the reorder point[1], where the r point is the sum of the average stock and safety stock.

The total inventory level is approximately 3.3x the safety stock. The safety stock amount is stored in the final product warehouse, and the raw material for 3 months is stored in the raw material warehouse. An exception is made for the new large++ parts, for which 150 is stored in the raw material warehouse. This is due to storage area restrictions in the raw material warehouse.

Storage Capacity

In order to estimate the amount of storage space required, the amount for each size to account for has been estimated. The amount of the storage is defined according to the safety stock. The total volume here is the total volume of storage after the packaging, since the productions can not be stored exposed in the warehouse.

Size	Amount	Total Volume(with package m^3)
Small	3461	1.839
Medium	1592	9.44
Large	524	12.387
Large++	250	28.876

Table 1: The storage of the productions

Storage Design Decisions

The following storage items are used to safely and efficiently store the products and raw material. When packaging parts in boxes, an additional 20 mm is required for protective envelopes, bubble wrap, void fill and tissue paper, and 5mm for manoeuvrability. Single wall boxes are used for small and medium size parts and double walled boxes are used for the rest. Furthermore, a new box is used for integrated packaging.
Based on the boxes[2], the suitable pallets[1] and shelves[3] are chosen as follows:

Items	Specification	Dimension [L*W*H] (mm)
Pallet	EuroPallet 3	1,000*1,200*144
Box	Small	81*81*81
	Medium	181*181*181
	Large	287*287*287
	Large++	487*487*487
	New	1,000*1,000*1,000
Shelf	Racks CJX-ZC02	4,000*1,300*6,000

Table 2: The storage items

Final Warehouse Design

Safety Factor

Because some worst case scenarios can not be foreseen for the warehouse, a safety factor is introduced. The safety factor is assumed to be 1.5. This safety factor will be applied in the calculations of the design.

Final Product Warehouse:

The final design of the products warehouse is illustrated in figure 3. When entering the warehouse, parts first go through a packaging and palletizing processes. The layout and procedure for these processes are shown in figure 4. Parts enter the warehouse from the factory by the conveyor belt. These parts will be placed into their corresponding packaging. A palletizer will then place the packaged parts onto pallets.

Reach trucks will then transport the pallets to their shelf destination. When an order is ready to be transported, it must first go through secondary packaging. Here, the orders are removed from the pallets, and packaged together.

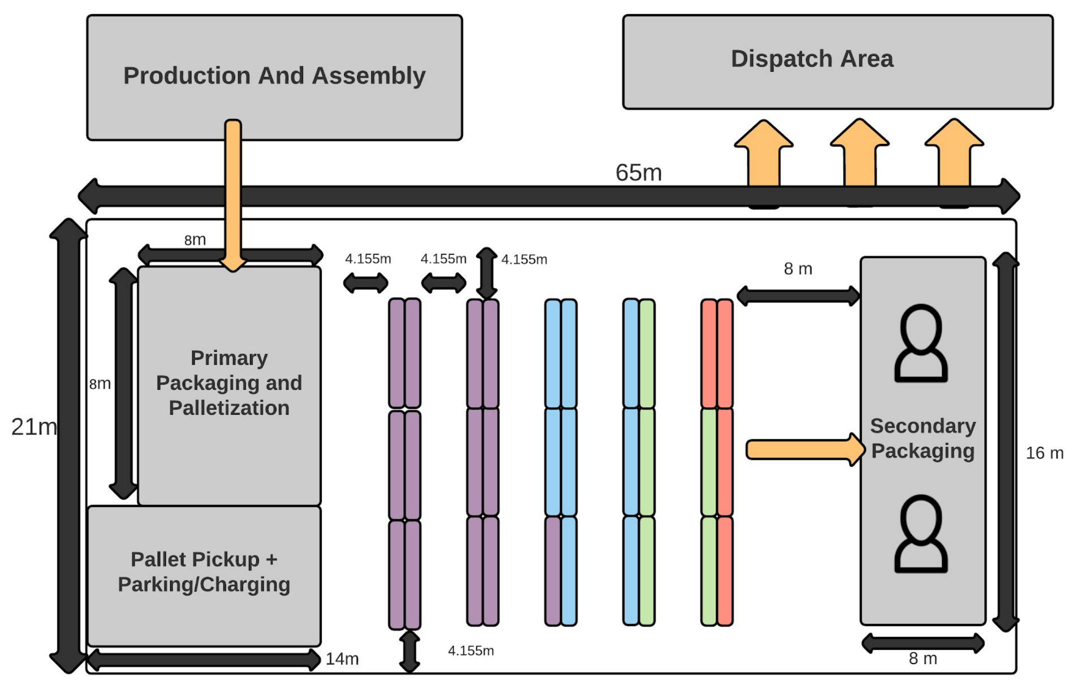


Figure 3: Warehouse for the Products

Raw Material Warehouse:

Figure 5 shows the final design of the raw material warehouse. This warehouse stores 3 months worth of material required for the factory to run. Furthermore, it has storage for an order of 150 large++ parts each month. Based on this delivery, the raw material warehouse contains 3 loading docks.
Furthermore, the conveyor belts that connects the factory to the warehouse should be able to carry the largest parts, in addition, the conveyor belts that connects the loading docks and warehouse also should be able to carry the largest parts. The purpose of this regulation is to increase flexibility and efficiency in the sorting and distribution processes.
In addition, the process from the loading docks to the conveyor belt is carried out by manually driven forklifts and the sorting between the holding area and the corresponding shelves is done by automated reach trucks.

The key for the diagrams for both warehouses is illustrated in figure 4.

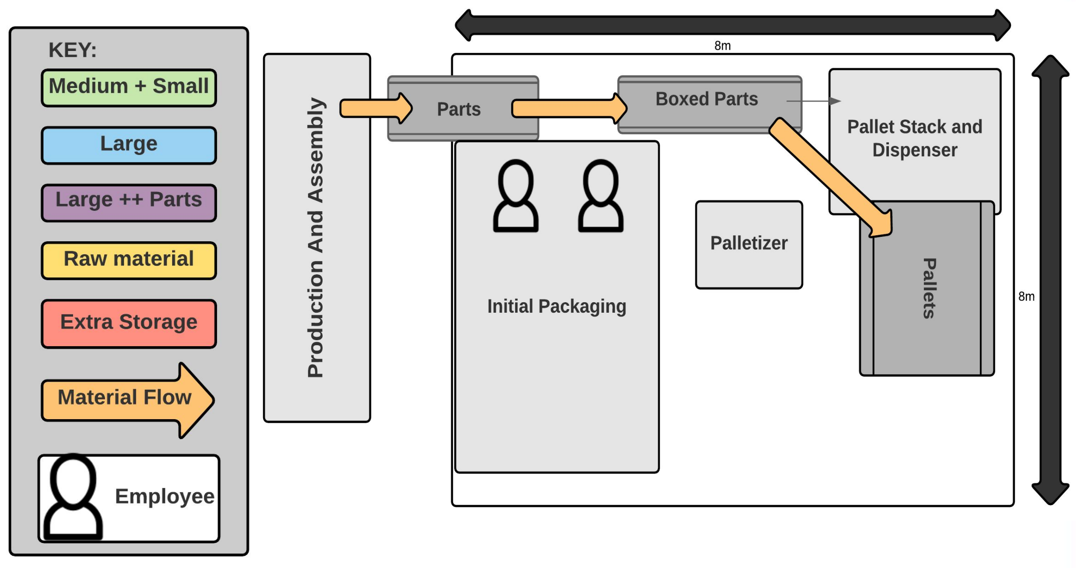


Figure 4: The Key and Primary Packaging and Palletization

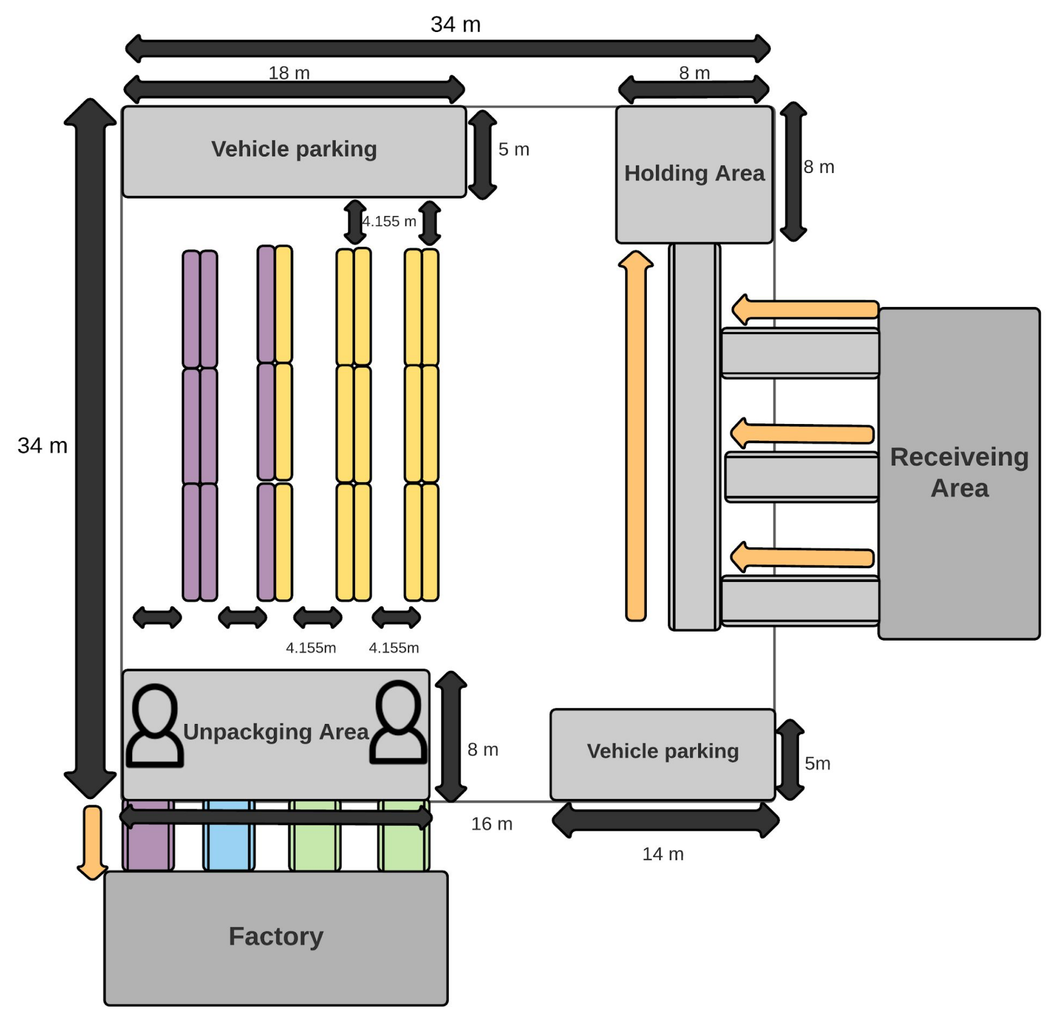


Figure 5: Warehouse for Raw Material

Material Handling System

During the sorting and distribution process, reach trucks are used to transport pallets to and from the shelves. Reach trucks can reach up to seven meters, which is enough for the six-meter high shelves used in the warehouse.
Reach trucks can be automated, so that efficiency can be increased, and the cost of personnel can be reduced. Furthermore, conveyor belts are used to transport products into and out of the warehouses.

Discussion

Figure 1 shows the logistics analysis diagram, it shows the overview of the logistics system. The interface between logistics and the other subsystems is illustrated in figure 2, the arrows mean the ingoing and outgoing. Based on the calculation, the storage capacity and the items needed for warehouse storage are illustrated in table 1 and table 2. Furthermore, the details of the calculations are shown in section "Storage calculations".

According to the final calculation, the warehouse design is divided into two sections, the raw material warehouse and the products warehouse. The layout of the two warehouses and the dimensions are illstructured in figure 3 and figure 5. Moreover, figure 4 shows the details of the "primary packaging and palletization" block and the keys of the design.

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Jekel
kel@student.utwente.nl

References

[1]: Slack, N., Chambers, S., & Johnston, R. (2010). *Operations management*. Pearson education.
[2]: LaPack. *LaPack - Epal 3 Pallet*. Available at: <https://lapack.nl/lapack-pallets/euro-pallets/epal/epal-3-pallet/>
[3]: Boxtopia. 2021. Cardboard Box Size Guide | Box Dimensions & Measurements. Available at: <https://www.boxtopia.co.uk/cardboard-box-size-guide>.
[4]: Storage Racks CJX—ZC02. Available at:< http://www.chinashelves.group/storage-racks-cjxzc02-15965920879234372.html>
[5]: AbcSupplyChain. 2021. 6 Best Safety Stock Formulas on Excel | AbcSupplyChain. Available at: <https://abcsupplychain.com/en/safety-stock-formula-calculation/> .

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Q&M

Morocant Drives

Quality & Maintenance

Daniel Ding & Joep Smits

Introduction

This subsystem focuses on ensuring quality and discussing the maintenance approach. The quality control involves sample testing of the dimensional quality and fit of the products as well as limit testing of the material properties. The raw materials and the processes itself are checked, to make sure the quality matches the customer specifications. To ensure optimal continuity and flow of the production process, maintenance is also discussed and will involve determining the optimal method of maintenance along with the types of preventive maintenance to be applied.

Subsystem requirements

The requirements are quantified such that they can be tested using a test and integration plan. The requirements regarding quality and maintenance are set:

- Ensure that the ISO norms mentioned in section ***ISO-Norms*** are met.
- Have a quality rate of at least 95% (Cpk > 1.5).
- Have a performance rate of at least 90%.
- Have an OEE of at least 70% to have a productive manufacturing process.
- The maintenance of the machinery should not affect the final delivery date.
- The percentage between the amount of products returned and the total produced products should not exceed 5% [1].

Key-driver analysis

Figure 1 shows, how having sufficient maintenance and quality control, contributes to achieving the key-drivers of the full system. It can be seen that the costs key-driver is influenced by having both sufficient maintenance and quality control. The quality key-driver is mostly driven by assuring proper quality control. Delivery speed flexibility is influenced by machine maintenance and quality assurance. Lastly, product- and delivery reliability is governed by quality control and maintenance.

Quality

Ensuring quality is a paramount step to satisfy the customer and reduces organizational wastes, a lean approach is used. This approach emphasizes the smooth flow of items, synchronized to demand to identify waste. Lean manufacturing systems creates a customer-focused environment and focuses on continuous incremental improvement.

In figure 2 it is shown how the organizational quality assurance is related to the customer side of the quality assurance process. What can be seen is that, before a product is delivered, the quality is measured by the organization in a few processes. This increases the likelihood of a satisfied customer, thus sufficient quality. When the part is delivered, the customer level is considered. The customer is able to give feedback on the product by rated feedbackforms, returning parts, warranty claims and end-of-life. This feedback process is used to determine the gap between the organizational requirements of the part and the customer requirement of the part.

Figure 4 shows the material flow chart concerning the quality checking, one can see here that rejects are not directly removed and scrapped from the process, but can be reworked. Also, qualitatively insufficient packaging can be redone.

ISO-Norms

The ISO-norms of relevance are the ones that concern the quality of the customer and the relation of the customer to the organization. In this case, ISO-9001 is of most importance as it ensures proper quality management within the organization. The 10000-series are important elements of the ISO-9001 norm (See figure 3)

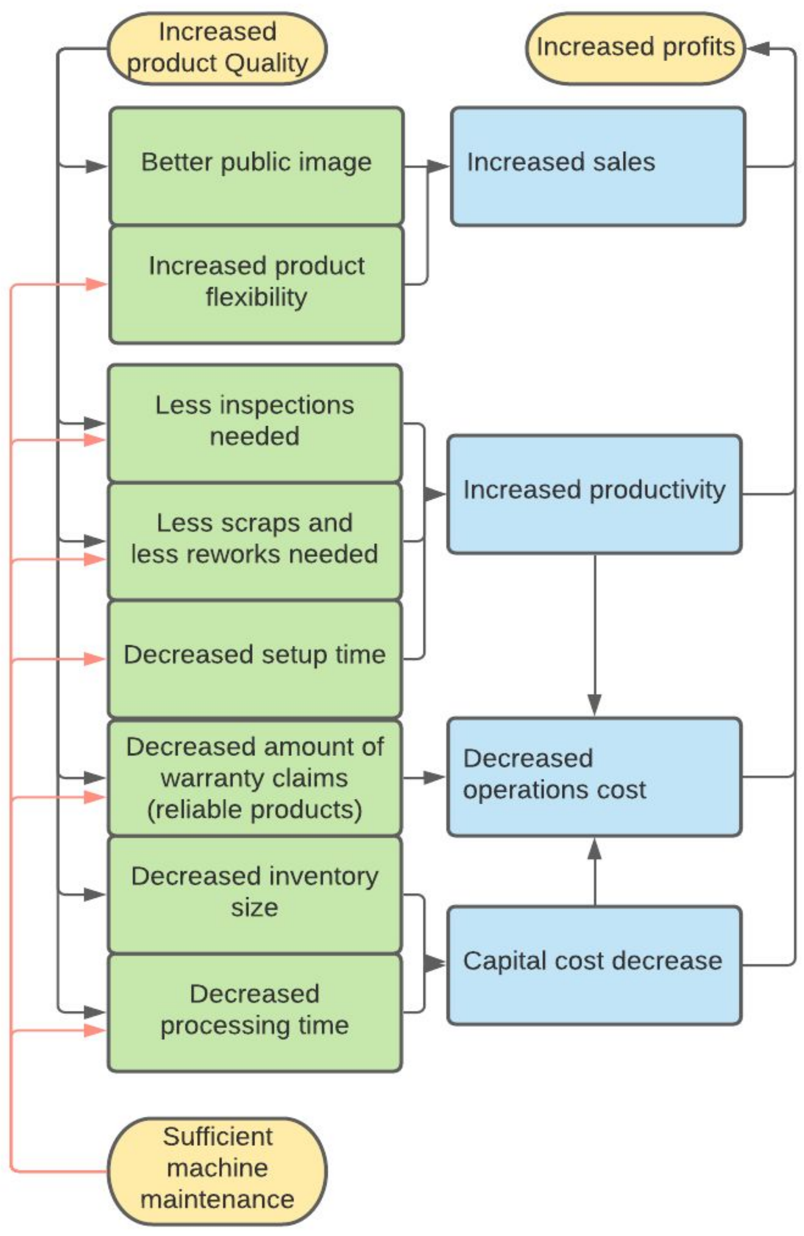

Figure 1: Handling indicators for the key-drivers

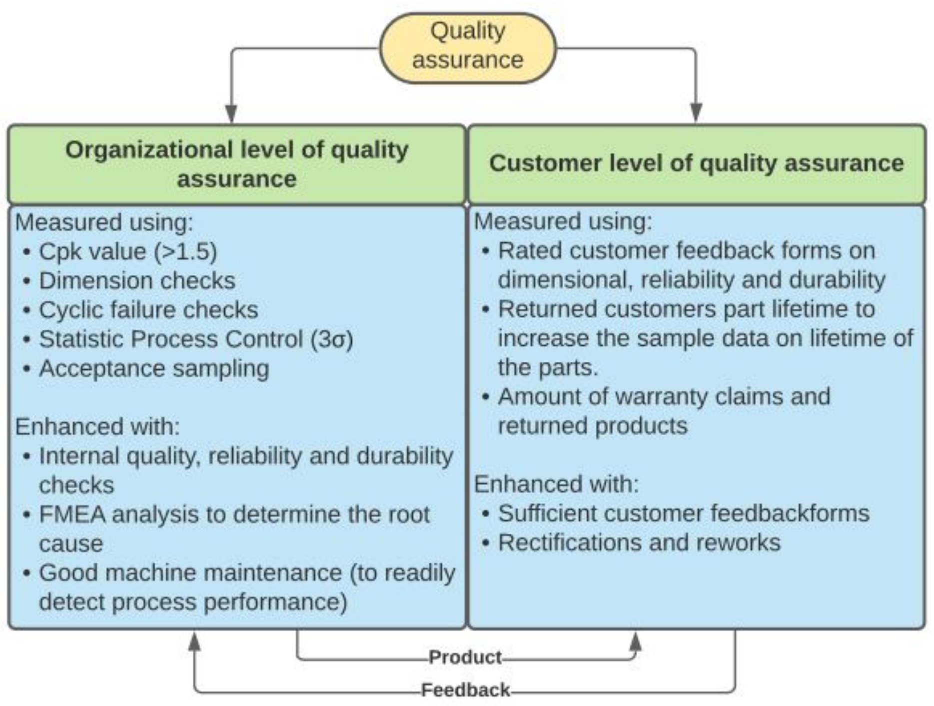

Figure 2: Quality assurance between organization and customer

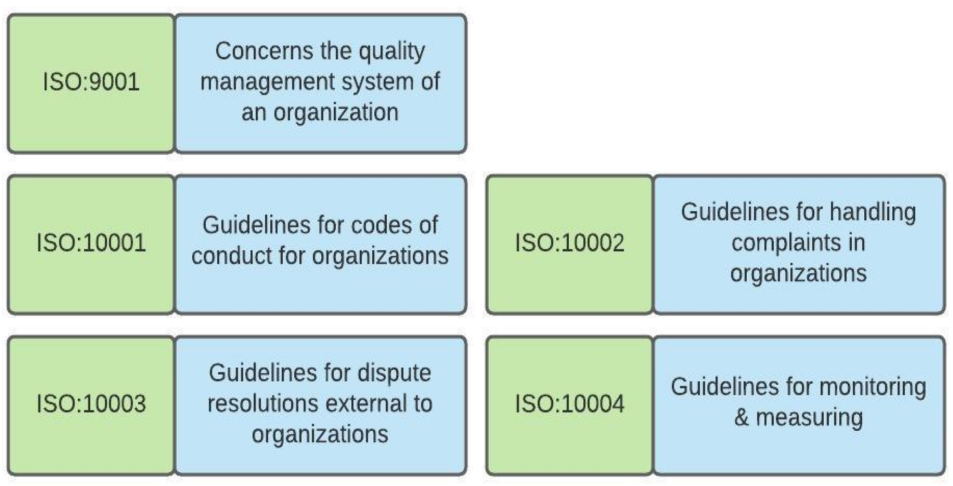

Figure 3: The relevant ISO-norms [3]

Maintenance

Correct maintenance contributes to increased company profits and satisfied customer, as can be seen in figure 1. In order to ensure correct maintenance a Total Production Maintenance mindset (TPM, a lean tool) is used [2]. The main goals of TPM are given in figure 5.

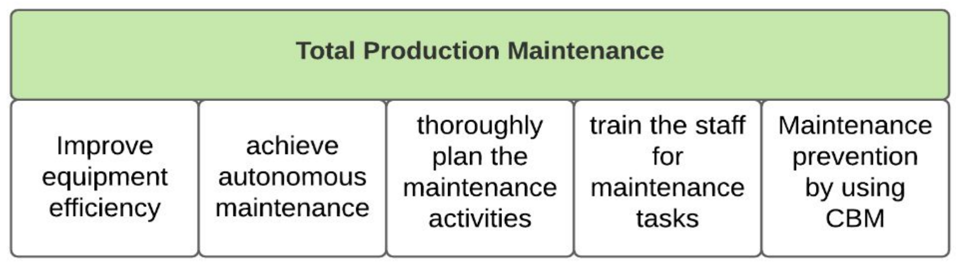

Figure 5: The goals of TPM

Using Condition Based Maintenance (CBM) within the TPM mindset ensures high utilization of the machines, but means that sensors and inspections are necessary of the machinery in order to monitor their condition. By training the production staff to work with their respective machinery, bad machinery condition can be detected sooner with less inspectional staff. This is part of "train the staff for maintenance" and "achieve autonomous maintenance" bullet-points. However, having routine preventive maintenance means that the workload on maintenance increases, but the costs of machine breakdown decreases [2]. Also, vibration sensors are used to sense machinery wear and quality indicators are also used to determine if there are deviations between some of the same parts (hinting on a defective or insufficiently maintained machinery). In order to simplify and reduce maintenance time, some precautions can be taken;

- Use standard, universally applicable materials and tools
- Use fasteners instead of welds on machinery
- Operators are able to perform maintenance
- Enough room around machinery to perform maintenance
- Regularly replaced parts are standardized
- The chosen machines are designed such that the regularly replaced parts are cheap and easily reachable

Also, looking at the supplied availabilities of the machines, (a mean of 82%), a performance rate of 90% and a quality rate of 95%, an OEE of 70% is guaranteed, which is required.

Interfaces with other subsystems

Received:

- Informing about the damaged parts/assemblies that need to be checked. *(Production and Assembly)*

Outgoing:

- Product/Machine adjustments, handling of parts to maintain quality. *(Production and Assembly)*
- Maintenance schedule, way of transport to maintain quality *(Sequencing & Scheduling)*

Discussion

Figure 2 shows the points on which product quality is checked and figure 4 shows how this is done on the factory level. Ensuring sufficient (but not too much) quality will increase profits, as can be seen in figure 1. The standards that need to be met are given as ISO norms in figure 3.
Maintenance-wise, a lean mindset is employed with TPM to increase productivity slowly, but gradually. And with the use of CBM, utilization of the machines is increased and the employed personnel is given responsibility over their machines, positively impacting group work. Also, high utilization ensures that the delivery date is not impacted by the maintenance of the machinery. What can be seen is that for both the quality as the maintenance aspects of the plant, a lean approach is employed for reasons given in the relevant chapters.

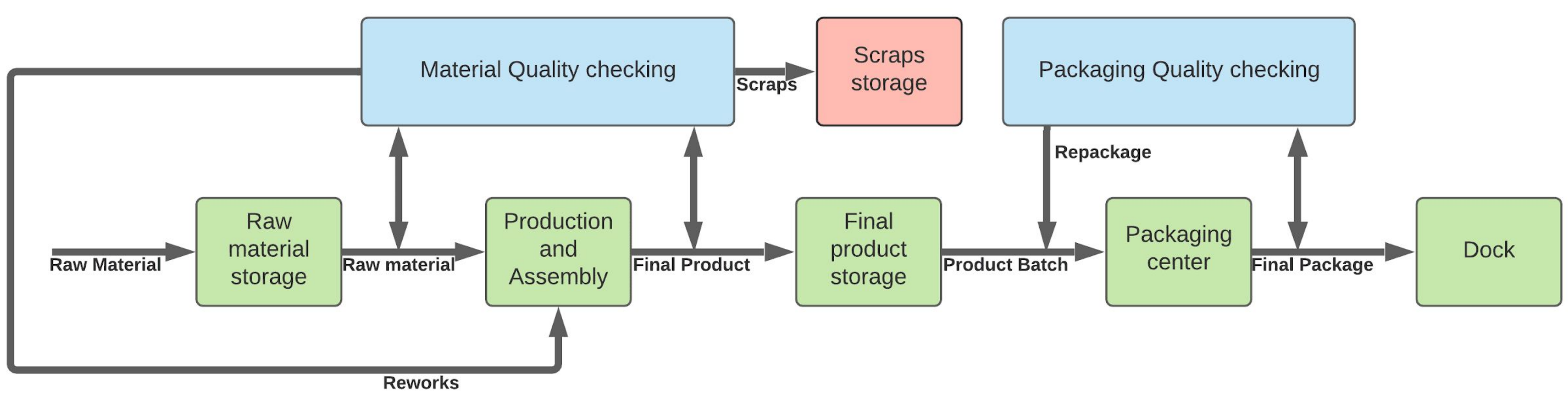

Figure 4: Material flow chart for quality checking

Contact

Henk Jekel
h.a.jekel@student.utwente.nl

References

[1] Khalid Saleh, "E-commerce product return rate - Statistics and trends", https://bit.ly/3stl7ge
[2] Slack, N., Chambers, S., & Johnston, R. (2010). *Operations management*. Pearson education.
[3] Lozano, A. R. P. (1997). ISO 9000 and the total quality management models. *Library management*.

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Group 10
Jan Haido, Pieter Koster, Joep Smits, Kevin Cacarin Cumbal, Henk Jekel, Felix Tieleman , Noureldin Ibrahim, Sameer Nizamudeen, Kelvin Jaramillo, Daniel Ding, David Chiriboga, Nan Li, Luuk Schukking, David Carrera Robles.

L&S

Morocant Drives

Layout & Safety

David Chiriboga, Kelvin Jaramillo, Sameer Nizamudeen

Introduction

This subsystem looks into the flow of products across the entire facility. As a consequence the entire factory layout will be determined. The overall safety measures for the entire facility will also be discussed here.

Subsystem requirements

The subsystem requirements can be divided into 2 parts, layout requirements and safety requirements.

Layout Requirements:

- Conveyor belt must be be able to transport all the different sized parts (small, medium, large),
- The amount of loading vehicles/robots should be sufficient for the production schedule
- All equipment and offices should be within 8000 m^2
- Walk paths must be wide enough for two personnel to work simultaneously (121.9 cm wide) [4]

Safety Requirements:

- All machinery must comply with safety regulation EN ISO 12100 [1]
- Architecture of the facilities must fulfill regulations, complying to Directive 89/654/EEC [2]
- Fire alarm and fire extinguishers must meet regulations [2]
- First Aid kits and emergency exit must be clearly indicated and accessible from any location of the facility, complying to Directive 92/58/EEC [3]
- Sufficient number of First Aid kits and emergency exits for all scenarios, complying to Directive 92/58/EEC [3]
- Workers must be educated on basic First Aid training
- Workers must be trained to safely operate machinery

Layout

The goal of this section is to provide insight into the flow of materials throughout the system and display the overall layout of the system. The system was divided into 13 facilities which are shown below:

A - Raw Material Storage	I - Production and Assembly Area
B - Final Product Storage	J - Equipment Storage
C - General Offices	K - Distribution/ Packaging Center
D - Dock	L - Storage room
E - Break Room	M - Parking
F - Conference Room	
G - Check-in	
H - Restroom	

From here, a relationship chart (not in poster) was made to understand which facilities are important to be kept close to one another as well which ones should be kept apart. Area estimates for all the 13 facilities were also determined. With this information Figure 1 was constructed which shows the flow of different materials across the facilities. In Figure 1, the blocks representing each facility are drawn to scale and are also organised in such a way that facilities that have strong relationships are kept close to each other.

A detailed layout was created by filling in the area located for each facility with what objects will be placed in them. The detailed layout is shown in Figure 3. In the production and assembly area the arrows represent conveyor belts for the input of raw materials (green) and the output of final products (red). A more detailed layout of the production and assembly area is shown in Figure 2. All machines are drawn to scale.

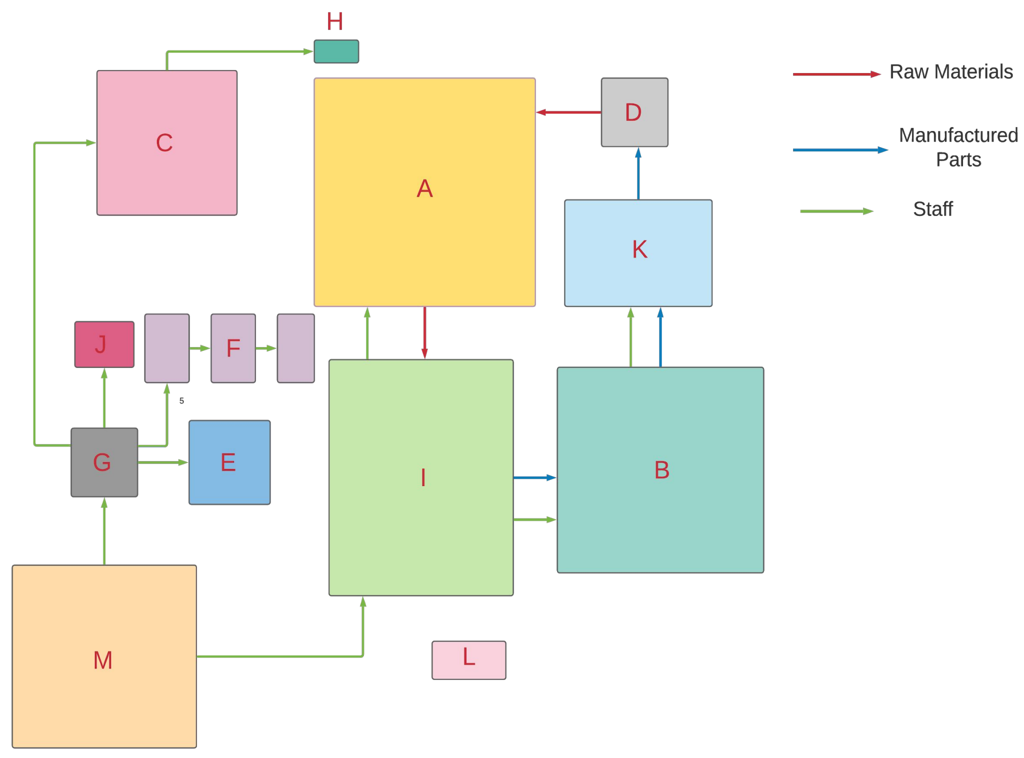

Figure 1. Flows and area estimations

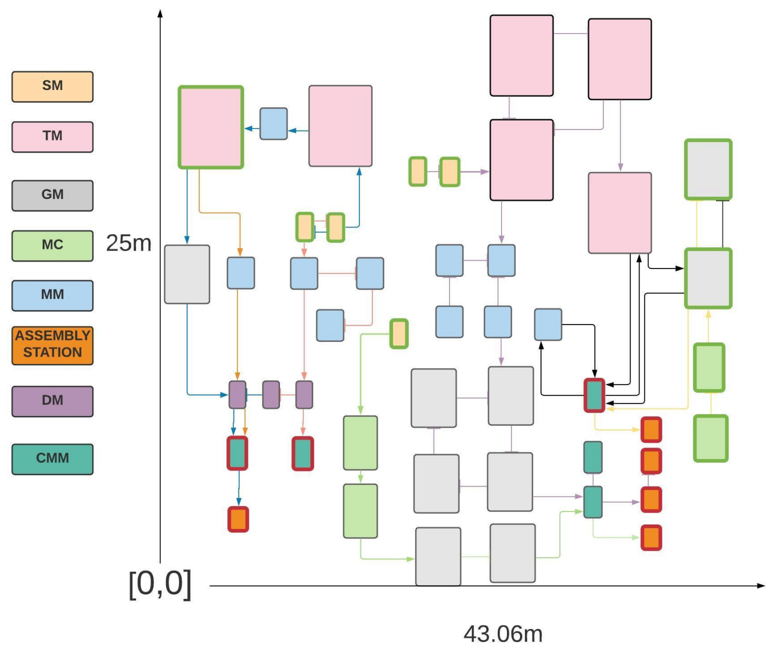

Figure 2. Production and assembly facility

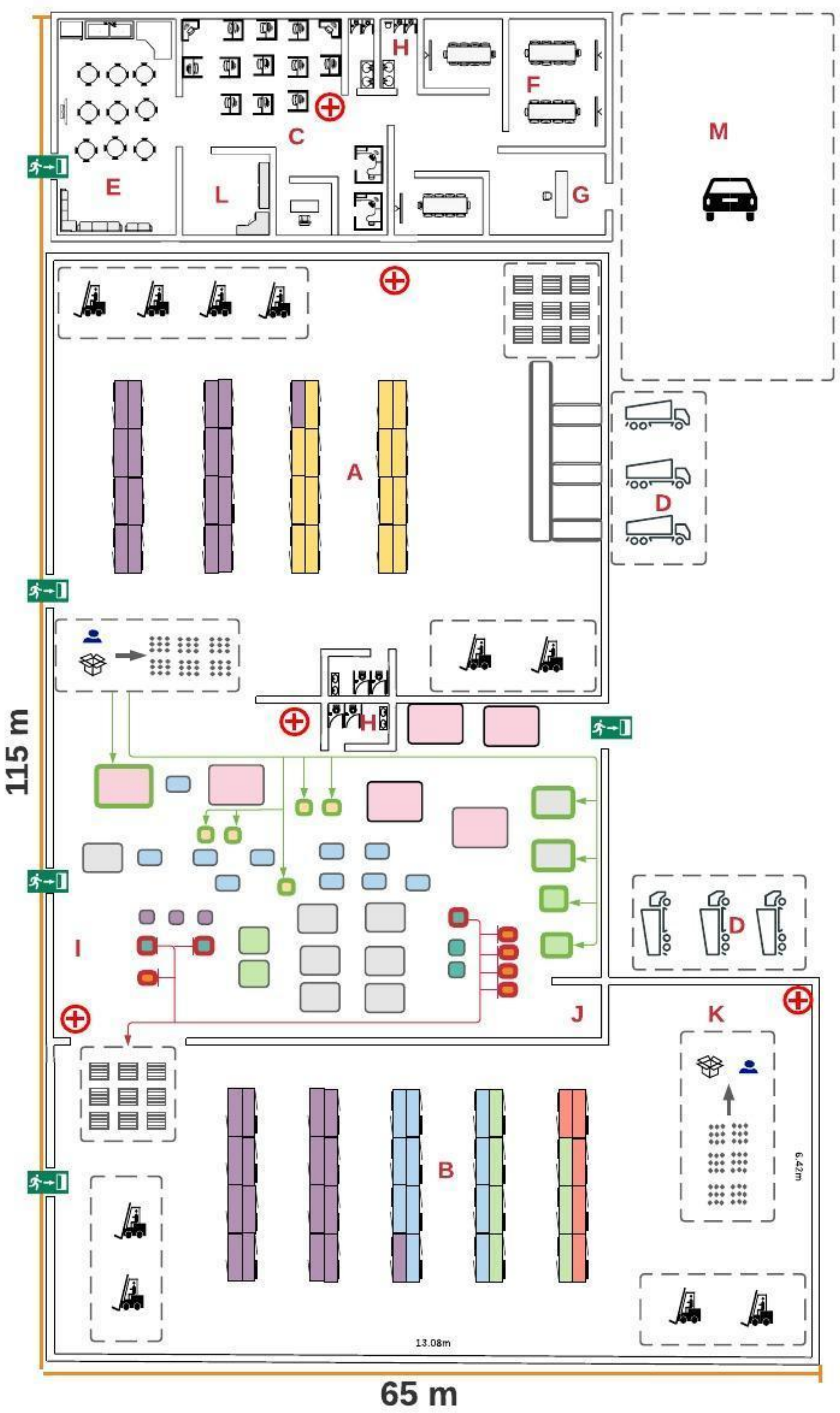

Figure 3. Layout of factory for Morocant Drives

Note: As was mentioned in the P&A poster, a 2 shift configuration requires more area. This area was calculated to be 300m^2 and will still keep the total area below the required 8000 m^2

Characteristics of production/assembly area Figure 3.

- The configuration of the machines is a combination of functional and cell layout
- Machines with green edge represent the initial point of a production line
- Machines with red edge represent the final point of a production line
- The different color of the arrows represent different production families.
- Similar machines are located close to each other to avoid stopping a production line if one machine breaks

Safety

The goal of the section is to analyze the hazards present in the company and present a systematic approach to eliminate or control them with the implementation of a safety protocol and regulations based on european standards, ISO norms and Dutch law.

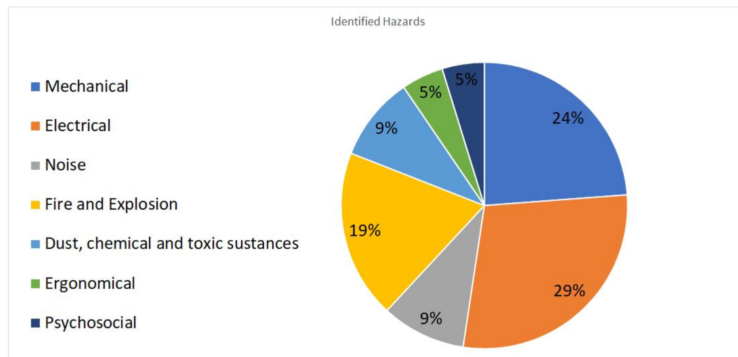

Figure 5. Identified Hazards in the Company

Figure 5 shows the hazards present in the company based on the activities that will be performed by the different departments.As it was expected since we are dealing with a manufacturing company the biggest hazards are mechanical and electrical due to the heavy machinery.

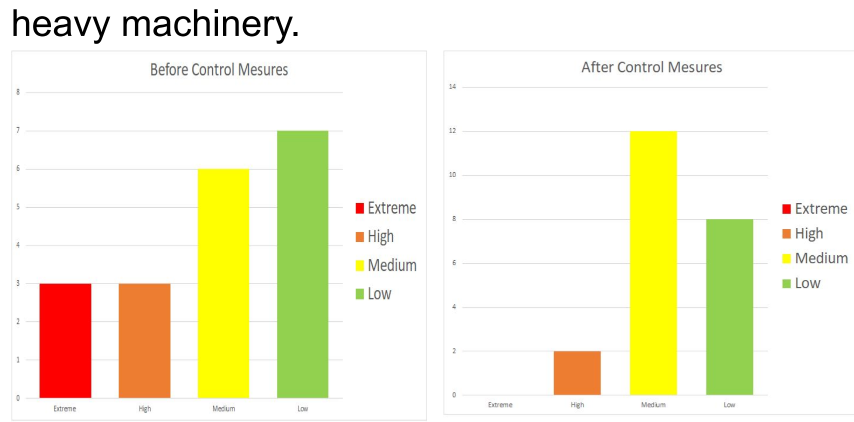

Figure 6. Analysis of Reduction of Risks Applying Safety Control Measures

After identifying the hazards we need to quantify the risk that they bring to the facility and based on that implement safety control measures to eliminate or reduce them. The quantification method provided by Covello and Merkhoher was used and the results are displayed on Figure 6. The main measures that needed to be implemented to have reasonable risks indicators were:

1.- Use of work safety equipment and ergonomics

2.- Emergency exits, fire extinguishers, first aid kits and signage

Once they were implement risks were reduced as seen on the left side graph

Discussion

The layout and safety protocols of the company are presented in this poster and successfully meet the established requirements, the most important being organising the different facilities within the 8000m^2 with proper safety measurements. The main interfaces used were with the Production & Assembly' department to design the production line and with the 'Logistics' department to design the storage of raw materials and final products.

Contact

Henk Jekel
h.a.jekel@student.utwente.nl

References

[1] MACHINERY SAFETY REQUIREMENTS. (n.d.). TÜV SÜD. https://www.tuvsud.com/en/industries/manufacturing/machinery-and-robotics/machinery-safety
[2]Directive 89/654/EEC. (n.d.). EU-OSHA. https://osha.europa.eu/en/legislation/directives/2
[3]Directive 92/58/EEC. (n.d.). EU-OSHA. https://osha.europa.eu/en/legislation/directives/9
[4]Two Person Pedestrian Path Dimensions & Drawings. (n.d.). Dimensions.Com. https://www.dimensions.com/element/two-person-pedestrian-path#:%7E:text=The%20minimum%20width%20for%20a,72%20inches%20(182.88%20cm)

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Group 10
Kevin Cacarin Cumbal, Henk Jekel, Felix Tieleman, Noureldin Ibrahim, Sameer Nizamudeen, Kelvin Jaramillo, Daniel Ding, David Chiriboga, Nan Li, Luuk Schukking, David Carrera Robles.

Morocant Drives

Sequency , Scheduling , Administration & Communication

SSAC

Kevin Cacarin Cumbal, David Carrera Robles

Introduction

This subsystem will focus on the best order in which the products should be manufactured. The main function of the sequencing, scheduling administration and communication (SSAC) will be to provide efficient management of the request parts to guarantee the quality desired and achieve the deadlines. This subsystem will evaluate distinct sequencing process to select the best method with the lower average lateness to achieve the delivery schedule.

Requirements .

- Selected a sequence polling based on average lateness.
- ISO 9001 Communication
- Establish salary of workforce based on the Netherlands regulations to employees.
- Estimate the amount of full time workers and part time employees.
- Employees have a maximum of 8 working hours.
- Based on the demand choose the amount of part-time employees
- Work 48 weeks per year with 2 shift per day.

Functions

- Select the most appropriate sequence polling
- Administrate orders and space to storage it
- Manage average salary of the employees.
- Determine the quantity of employees necessary to keep the industry operating.

Workers and Salary

The staff required to keep the company running is made up of permanent employees and part-time workers. Part-time workers will be required when the company must meet the greater demand. According to the Netherlands' Government [1], the minimum wage as of 1 January 2021 is € 1,684.80. The general distribution of personnel required for the production and their average wage (assuming 3 years of experience) is shown below. An average of the total labour cost per month is approximately € 287 200 for 55 total time workers.

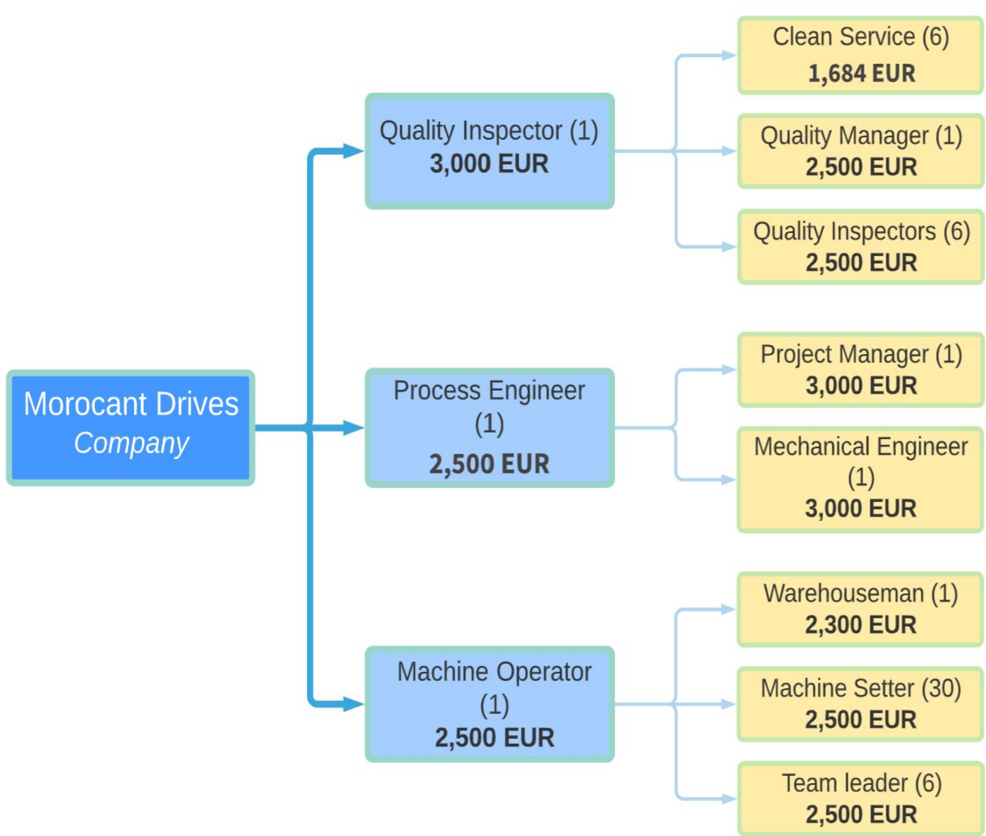

Figure 1: Salary of workers

Workforce

In order to manufacture and achieve the deadlines employers are required. They are fundamental to perform activities such as: calibrate de machines, establish communication with suppliers, transport the parts between sections , cleaning, etc. Moreover, depending on the demand part-time workforce will be used. With the data provided an estimation of amount of part time worker is shown in picture below.

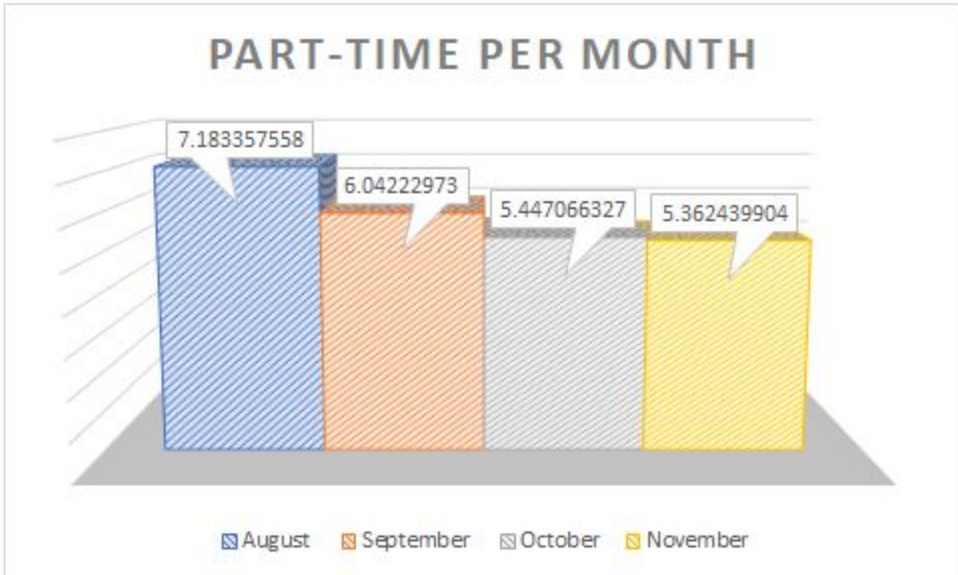

Figure 2: Part Time workers per month.

Parts

The actual order from the customers is 10669 parts to delivered in 4 months. This value is the total number of parts, however, the demand varies each month. The parts to be manufactured vary in size(small, medium, large and large ++). The graph below summarizes the data of the order and display the information of the number of parts required per month and the size of the parts order in that month.

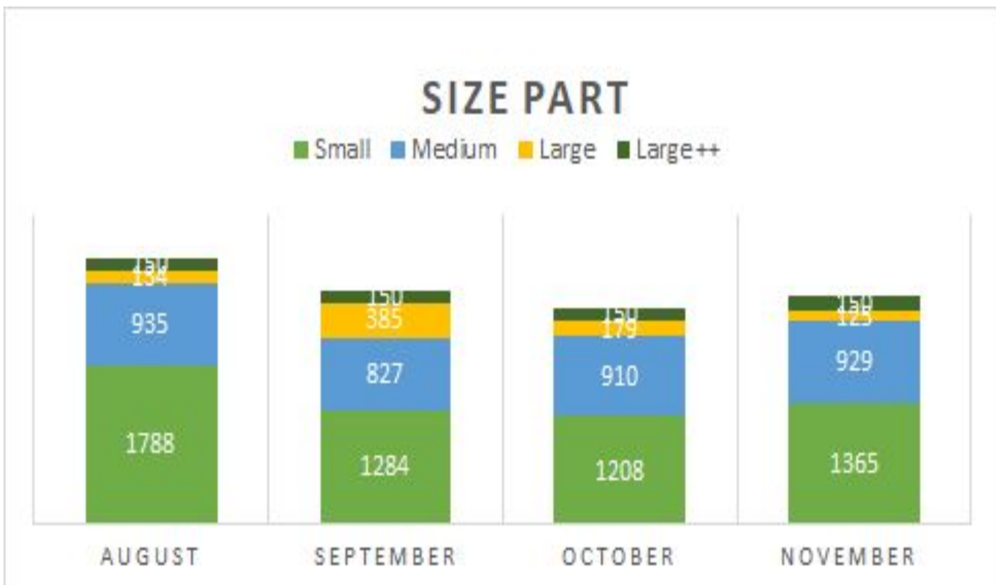

Figure 3: Demand of Size part per month

Variety

From the catalog of the type parts of the company. In this order were required 41 of types of parts. The next graph show the average order parts per month.

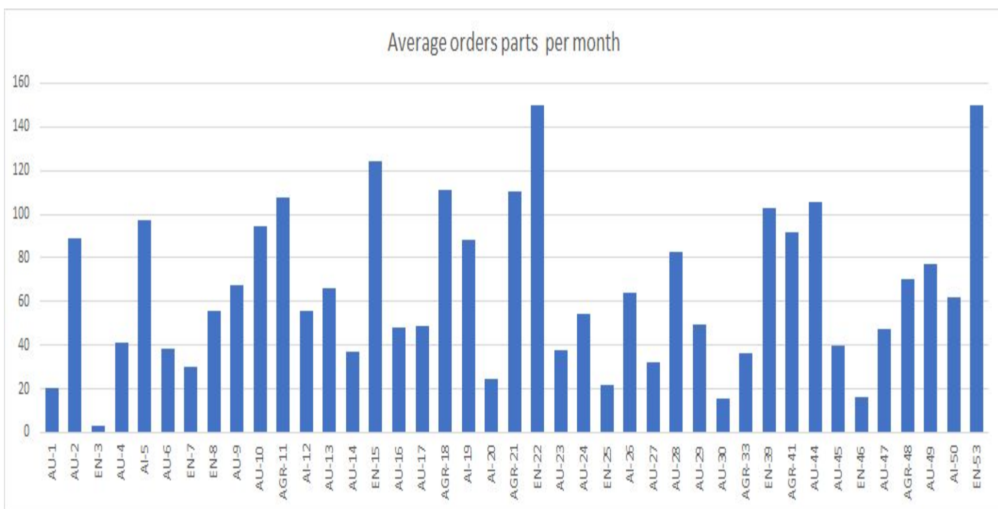

Figure 4: Average of Orders per month

Sequence Polling

The orders received by Morocant driver should be processed and manufactured in an appropriate way. In order to ensure that all deadlines are met.
Previously was mentioned that the orders are going to be divided into 7 families which shares the same manufacturing processes. For each family was selected due date configuration which prioritize the deadline. The estimation for the start production day,assuming the max capacities of the machinery and with the throughput time.The start date is on July 11th.

Inventory chart

Morocant drives will be able to manufacture the demand from their customer. In order to achieve this goal the warehouse should be provided enough raw material. The maximum warehouse capacity for raw materials is 28 m^3. From the data sheet the approximate volume of the parts to be produced in one year is 80.26 m^3. Using the inventory chart it is possible to find the amount of times that is need refill the warehouse.

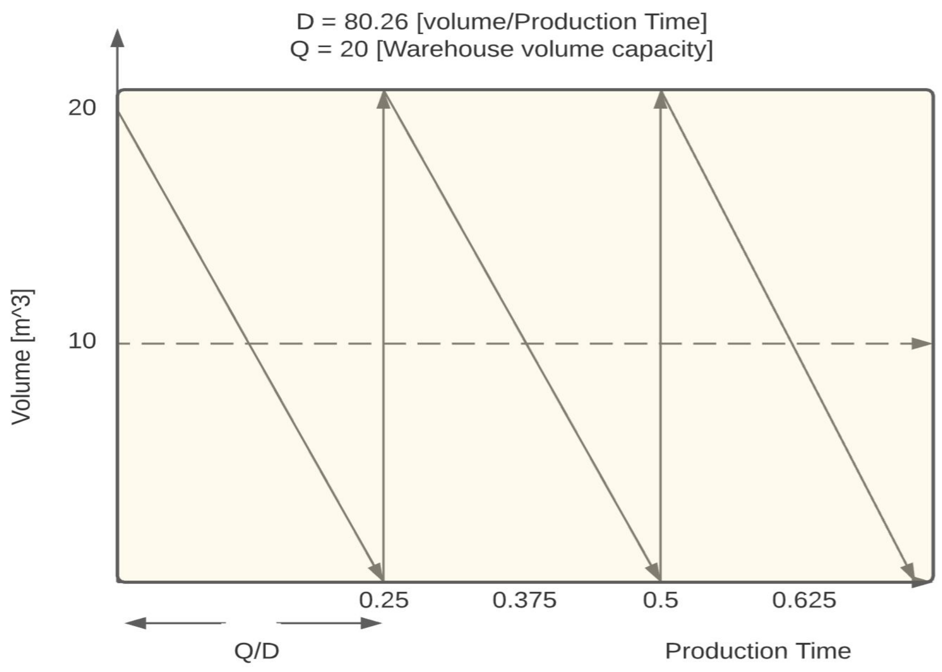

Figure 5: Inventory Chart

Schedule

The company will operate 48 weeks per year to fulfil the demand. In two shifts per day, each shift of 8 hours with a break time of 30 minutes which can be divided into two breaks of 15 minutes and considering a shift maximum of 30 minutes. The possible schedule for the employees is shown below.

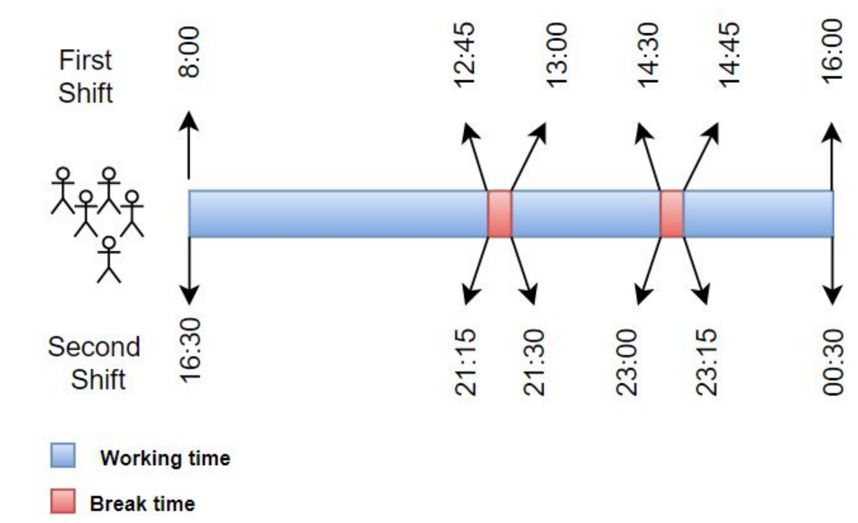

Figure 6: Workers Schedule

Discussion

The administration of Morocant drivers required to manufacture the parts, the charges, salaries and amount of personeel is shown in figure 1. Based on the demand the amount of part-time worker is displayed in figure 2. The variety of the products manufactured per month is shown in figure 4 and the distribution of the parts by size per order month is in figure 3. To accomplish with the delivery date, 12 extra machines are needed. The sequence of production is divided in 7 families, with those settings and due date configuration, taking as start manufacturing day July 11, there is not delay for the customer orders . The warehouse has an available space of 28 m^3 which makes possible to fulfill with the demand every month.

Contact

Henk Jekel
h.a.jekel@student.utwente.nl

References

[1] Ministerie van Sociale Zaken en Werkgelegenheid, “Amount of the minimum wage,” *Minimum wage | Government.nl*, 12-Jan-2021. [Online]. Available: https://bit.ly/3wdfrZX

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