# Supplying the assembly line



we love to cook

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# Preface

This report is the result of my internship at ATAG Duiven, as part of my bachelor thesis in Industrial Engineering & Management. The purpose of this study, is to investigate the cause of the low output of the production line at ATAG and solving the biggest core problem.

The internship was the first time for me to apply the theory of my study into practice on my own. This was a wonderful experience and therefore I would like to thank some people who have accompanied me in this process.

First of all, I would like to thank Leo van Ulden and Gerard Jansen for giving me the opportunity to perform research at ATAG. They introduced me to almost every ATAG employee and guided me through several departments on the search for information. Not only was I allowed to involve six departments in this research, they also gave me the opportunity to implement my work. I am very grateful to all employees who helped, supported and inspired me during this internship.

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Veronique Weesie Enschede, February 2017

# Management summary

In the framework of completing the Bachelor study Industrial Engineering and Management at the University of Twente, I performed research at ATAG, Duiven. ATAG is known from their kitchen appliances. ATAG Duiven produces hobs at a small assembly line. The output from the production line is too low, resulting in a backlog of 1200 finished products in December 2016. The production target is 250 hobs a week, but this target is often not reached. Management has the impression, that indoor logistics is the reason for the fluctuation in the production output and for not reaching the capacity target. This led to the following central research question:

#### How to improve the performance of ATAG's production line by streamlining internal logistics?

Although the management thought that the cause of their low output to be the internal logistics, we performed more research to see if there are other causes. We found 17 core problems caused by six departments. All problems are listed based on their priority, according to the company guidelines. From this list problems are selected for further research. All problems in this research are somehow connected to the performance of internal logistics and the production department.

The first topic that is covered in this research, is the picking method which is not real time. Components are picked in the warehouse and brought to the production department. The picking is by using a picking list. The administrative component transfer from the warehouse to the production department is not on a real time base. Stock difference and administrative errors often occur. We found that there is a tool available to make the picking method real time, but this tool was not used. The tool is a scanner. We have done some experiments and found some software and hardware problems concerning the scanner. The software of the scanner is adaptable. We asked the IT department in Gorenje, ATAG's mother company, to look into it.

The second problem we look at, is the supplying method of components from warehouse to the production department. The production employees are gathering components themselves, resulting in long setup times and disturbances during production. The current situation is analysed in more detail, first by literature study and secondly by observing the production department and the warehouse. The conclusion is that the supplying method needs to be improved. We used several approaches to create multiple options to improve this. The approaches used to reveal multiple options are 5S, lean, theory of constraints and business reengineering. The supplying and transport methods are based on the theories of Slack, described in the book "Operation Management". The production department consists of three parts: the production line, a sealant department and the pre-assembly stations. Multiple supplying and transport options are given per section of the production department, because each requires a different approach. We defined the pros and cons of the different options. It is up to ATAG to make the trade-offs between flexibility, risk, the picking time and the setup time.

The last topic that we look at in this research is ATAG's capacity. The capacity of the production line is not known. The production target is basically a guess. To find out what the current capacity is, we start measuring the throughput time of the sealant department, the pre-assembly stations and the cycle time of the production line. We measure the cycle time at production, because there are buffers in the production line. The measurements are still running, so these results are not published in this research. The current capacity is not changed during this research. This is the reason that we implemented an eleven hour production day for at least 20 weeks, instead of the regular 8 hours a day. In this period ATAG's backlog should be reduced to zero.

We recommend to purchase a new scanner, so that hardware problems are no longer an issue. We also recommend that ATAG chooses one of the supplying methods given in this research, to reduce the setup time. If choosing one of the supplying methods is too hard, then we recommend to do experiments. Furthermore, finding out the capacity is very important. Keep the diaries until all throughput times are known for each hob type. Make sure there are multiple measurement for each hob type to have a good indication. After a new supplying method is implemented, we recommend to perform research at the bottlenecks at the production line. The bottleneck is also one of the 17 core-problems. Solving this problem could increase the production capacity, such that ATAG's is able to grow.

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# Table of abbreviations

Abbreviations	
B.A.T	Business analysis techniques
BOM	Bill of materials
IGT, IG	Combination of gas and induction hob
Hi	Induction hob
HG	Gas Hob
IGT	Combination hob (gas and induction)

# Chapter 1: Introduction

In the framework of completing the Bachelor study Industrial Engineering and Management at the Univerisity of Twente, I performed research at ATAG, Duiven. ATAG requested help to increase the output of their production line. In this chapter a brief discription of ATAG is found. After the description about ATAG the research motivation is explained and that results in a problem analysis. For the problem analysis interviews are held. The problem analysis results in 17 core problems. A few problems are chose to perform research on. The chose problems are based on guidelines and priorities. At the end of this chapter the research questions and the research plan is found.

### 1.1 About ATAG Nederland B.V.

ATAG is known from their kitchen appliances since 1948. In that period everyone cooked only with iron stoves, see Figure 1.1. That soon changed with ATAG's new invention, the 2-flame gas cooker. ATAG became a great brand. In 2000 ATAG merged with Pelgrim and ETNA under the name of ATAG Nederland B.V. This trinity is still visible in the product brands ATAG Nederland B.V. sells.

In 2008, ATAG Nederland B.V. merged with a Slovenian company. That made ATAG part of the Gorenje Group. Nowadays the Gorenje Group produces kitchen appliances like: dishwashers, fridges, hobs (Dutch: kookplaat), hoods (Dutch: afzuigkap) and more.

ATAG needs a strategy to maintain to be a major player in the kitchen industry. That results in the need to develop fast to stay ahead of their competitors. That means continuously anticipating and responding to the latest developments and developing more user friendly products. The development of products takes place in their workshop in Duiven. To complete their strategy, ATAG focuses on their clients. This means delivering a product fast, being costumer friendly and have an install and repair service. ATAG makes this possible together with 400 employees. No wonder that this company won a lot of awards. The latest awards ATAG won are the national business succeed award in 2015 and the red dot design award in 2016.



Figure 1-1 Iron stove ETNA

ATAG is responsible for developing hoods and hobs. Examples are shown in Figure 1.2 and 1.3 below. Unfortunately, ATAG is missing the expertise in production. This is because, most of the productions is located in Slovenia, Gorenje. ATAG flew many times to Gorenje to see how their products were made and what kind of problems they had during production. To improve the expertise and experience of production, they decided to make a pilot production line for hobs. When ATAG develops a new hob, they try to build it themselves first at their pilot line. This helps them to make quick adjustments to the product or to create a different production method that suits the new product. The pilot line became a great success! Finished products rolled out of the pilot production line and were ready to sell. If ATAG is able to make products themselves then why should they not? A small assembly line was born.

They make three types of hobs: gas, induction and a combination of the two. Due to customisation and the different safety procedures in several countries around the world, they produce 55 different hob types under different brand names.

They have plans to move their entire company to a different location by 2021. The plan includes more space for production.





Figure 1-2 Hood WS12211EM source ATAG.nl

Figure 1-3 combination hob with gas and induction IG9571MBA source ATAG.nl

### 1.2 Motivation for research

The production orders for hobs are increasing. The sales history tells us that in the period October 2015 until October 2016, ATAG sold 9877 hobs. Unfortunately in this number there is a production backlog of 1324 in week number 48 this year, as is shown in Figure 1.4 below. The graph also shows the production history over the last 13 weeks. Notice the fluctuation of the production quantity displayed as red blocks. In week number 40 and 41 the production department produced six days instead of five.



Figure 1-4 Production output of hobs per week in 2016 in red and the backlog in yellow

The forecast is promising for the upcoming years. ATAG expects a total of 12933 orders in 2017. The overview is shown in Appendix 1: products made in Duiven. The production target is 250 hobs per week. The production department normally works 8 hours a day, 5 days a week and 48 weeks a year. That means that the capacity should be 12000 hobs a year. It means that the forecast of next year is more than their capacity. Moreover, management has the impression that indoor logistics is the reason for the fluctuation in the production output and not reaching the production target. This led to the following central research question:

How to improve the performance of ATAG's production line by streamlining internal logistics?

Looking at the production history, sales history and forecast, some questions are raised:

- Are there other problems causing the low production output?
- What is the cause of the fluctuation in production?
- How could the backlog become this high?

To find out if the logistics are the true problem and if there are more problems than thought, I held interviews with managers of multiple departments that could influence the production output.

This resulted into the problem analysis displayed in Chapter 2. Based upon these findings we present our research design in Chapter 3.

# Chapter 2: Problem analysis

In this chapter we present our problem analysis. The managers provided us with data and they talked about the problems they experienced. The departments that influence the production output and are described in this chapter are:

- 2.1 Supply chain department
- 2.2 Purchasing component department
- 2.3 Warehouse department
- 2.4 Production department
- 2.5 Quality department
- 2.6 Research and development department

Below, we reveal per each department the problems encountered in the following way: First, we give a brief function description. Next, we discuss the problems that the department in question experiences. In doing so, we label the problems, for further reference. All problems are summarized in the problem cluster in Appendix 5.

# 2.1 Supply chain department

The supply chain manager receives a request from sales. The request is always a minimal order quantity (MOQ) to fill up the stock levels at ATAG. ATAG is producing to stock instead of producing to order because they strive to have a delivery performance of 97.5 %. He fills in the request in SAP. SAP is the software tool that they use to control their inventory. That means he fills in the product number and date of release. From this, SAP calculates the quotation. The quotation is a number of products that need to be produced in a certain week. This is the input in the distribution resource planning (DRP). DRP is a function in the software tool SLIM4. DRP checks if there is enough inventory to make the product. If there is enough inventory and time to produce, then the product is available to promise(ATP). Preferably the supply chain manager places the request 8 weeks into the future. If there are components missing than the purchase department receives a message that they have to order components.

Every product has his own lead time. The lead time is also integrated into SAP. When an order is placed in SAP it calculates if there is time left in that week to produce the product.

The supply chain manager is never sure when they receive an order. To make an assumption he is using a tool in SLIM4 to create a forecast. SLIM4 contains different key performance indicators (KPI). He is able to see if a finished product or component is in stock and if the product was delivered in time with the KPI delivery performance.

The supply chain department experience multiple problems. The problems are found below. The labels for example 1A reference to problem cluster in Appendix 5. Problems:

- 1A: SAP does not contain proper cycle times. When ATAG started using the software they made an assumption without using measurements. This results into cycle times that are sometimes too high and sometimes too low. The manager uses excel to create a better order planning at the moment.
- 1B: Because the cycle time of the products is not known ATAG uses a guideline to produce 250 products a week. This amount is not based on research. It is a guideline. The target is not made often and that is one of the reasons the backlog occurs.
- 1C: *There are some problems with the suppliers*. Some are unreliable when it comes to the delivery time and the quality of the product. This was one of the reasons, that there were days that the production department was not able to produce any products. To make sure that production is always able to produce, the supply chain manager came up with a fixed

period of three weeks. All components have to be in stock three weeks beforehand. If one of the components is not there the manager throws the product batch out of the fixed period and checks if there is another batch to switch it with.

• 1D: *Backlog of 1200 finished products*. The supply chain manager promises indirect their costumers products but were not able to deliver due to production problems.

### 2.2 Purchasing component department

The purchasers are the direct connection between supplier and order planner. The order planner would like to have an amount of products at a certain time. The purchaser has to make sure there are enough components to produce that order.

The second task of the purchaser is handling problems considering the delivered order. It could be that an amount of components was not right or the quality department rejected the order for some reason. The purchaser has to make contact with the supplier to discuss the problem. There is one extra task that is not supposed to be part of the purchasing department. When new components arrive at the warehouse, the warehouse assistant sends an email to the purchaser that the order has arrived. The purchaser makes sure the right stickers are printed to stick them at the order and book the order into SAP. The sticker contains the information if the order needs to be checked by a quality engineer or may be stored in the warehouse right away.

The purchasing department experience multiple problems. The problems can be found below. The labels standing in front of the problem can be found back in Appendix 5. Problems:

- 1C: The purchasing department experiences problem 1C just like the supply chain department. The description can be found back at section 2.1.
- 2A: A second problem is the *stock difference*. The purchaser thought to have more than enough components in stock of the product called 10715. The truth is that ATAG is missing one and a half pallet. Stock differences happen with many components but never with such a quantity difference.
- 2B: The last complaint was that *the purchaser is not able to look very far in the future*. For example, the Christmas holidays are coming that means that we have to order earlier than eight weeks beforehand to make sure we have components in the beginning of January.

# 2.3 Warehouse department

The physical distribution manager is in charge of the warehouse. The warehouse departments are spread over two buildings. At Impact 83 is the warehouse P100, that receives finished goods. The goods are stored there until a truck comes.

At Impact 52 is the warehouse that contains at the first floor, see also Figure 2.1 below:

- storage for service parts;
- warehouse P001;
- the production department;
- fast pick for production (P002);
- and the blocked stock (P003).

Blocked stock means that no one is able to pick it up until purchasing department has decided what to do with it. Warehouse P001 contains parts stored for production and parts for research and development and some obsolete stock.

Only in warehouse P001 and P002, is not a real time pick up method used. There were plans to make it real time. A scanner is bought but it turned out that it did not function properly.



Figure 2-1 Lay-out warehouse department and production department (divided by the black line) 02-01-2017

The warehouse experiences the following problems, the labels in front of the problems can be found back in the Appendix 5.

Problems:

- 3A: *In warehouse P001 and P002 an old administration method is used*. The only requirements are a paper and a pen. On the paper you fill in the date, product number and the amount of components you would like to replace. At the end of the day you hand in the paper to the logistic assistant and she will process it in the computer. This method is very error-prone.
- 2B: Problem 3A is one of the reasons there is a *stock difference*. See section 2.2 purchasing components departments.
- 3B: The next problem is that the warehouse contains *multiple storage bins with half empty boxes with the same component.*
- 3C: The warehouse employee has no authorisation to access the computer system.
- 3D: Due to problem 3C the warehouse employee has no clue what is the bin location of a component. So he has to *search manually*.
- 3E: *There are too many obsolete products in POO1.* The physical distribution manager cannot tell if a product will never be used again but she does have an indication. She can see if the product moves or not.
- 3F: *There is a shortage of space in warehouse P001*. Pallets are standing in front of a location bin or between the storage racks with no location bin at all.
- 3G: The last problem the physical distribution manager could think of, is the 540 different components as fast pick at P002 warehouse. The fast pick is worth 30,000 euros. That is too much fast pick in the opinion of the physical distribution manager.
- 3H: *It is hard to control Inventory*. The P002 warehouse is a fast pick warehouse. There is fast pick that will not be used in weeks, but some of the components could be already in a

subassembly. Subassemblies are not registered. This result in a components that looks available but are not.

### 2.4 Production department

The production department produces hobs. Looking at the layout of the production department, shown in Figure 2.1 before, it is divided into five sections:

#### 1. Sealant section

Their job is to assemble the tops of the hobs. The assembly knows 2 or 3 phases depending on the hob type. Stainless steel, combination and induction hobs require an extra phase named phase 1 in this research. Phase two and three are for all hobs the same. Phase two is to add to glass/stainless steel plates. Phase 3 is adding trim. Each phase requires a drying time of 8 hours.

#### 2. Pre-assembly stations

Here are eight different compositions are made.

#### 3. Assembly line

There are eight workstations at the assembly line. In Figure 2.2 below, an enlarged view is shown of the production and packing line. In the Figure are the stations shown, where st1 stands for station 1. Their main tasks are placing gas pipes (st1 and st2) and add wiring to the under bins (st3), doing a leak test (st4), assembling the under bins with the tops (st5) and doing the final test (st6).

#### 4. Packing line

Choose the right polystyrene foam and box. And fill the box with instruction material, install packages and loose fragments. See st7

#### 5. Warehouse section (called P002)

Most of the components are stored around the production place. In this warehouse there is a 'take whatever you need' policy. All employees of every section may pick components straight away without having to administrate anything.



Figure 2-2 The loop of the production line. The arrows visualise the flow of producing an combination hob.

Furthermore, we received a form with production data from the production leader. The form can be found in Appendix 3: production output 2016. The form shows the production quantities with notes. It appeared that they had some technical problems and that components were not present or rejected. This result in problems 4A,4G,4H written below in the problem section. In a bad week they

were not able to produce any hobs at all and the production leader had to send the employees home. Sometimes are they working on Saturday because they are trying to get a grip on the backlog.

Problems the production department experience are written below. See also Appendix 5 to reference the labels:

- 4A: *Technical problems with test machines or computers.* The production line is very vulnerable. If there are technical problems than the production employees can go home because they are not able to work.
- 4B: Another thing is that the production leader is not happy about is the *setup frequency*. Sometimes it is more than ten times a week. He prefers to make larger batches instead of small ones.
- 4C: Components not delivered in time
- 4D: Rejected components
- 4E: The employees told me about *long setup time*. This is caused by problem 4F.
- 4F: *Production line employees have to collect the components themselves*. If you are a new employee, it is likely that you are unable to find the components in the fast pick warehouse, P002. Not everything is stocked at P002 and sometimes the employees have to call the production manager or another employee who is authorised to pick up components in P001.
- 4G: Sometimes an employee is ill or has a free day. There is *no one to replace* them.
- 4H: Another request came from the sealant section. They work with products that smell. *From the degreaser product they become tired and some employees complain about getting a headache.*
- 41: The air intake and suction does not seem to work well.
- 4K: The last thing is working with RVC plates is hard work especially when it is a large batch. *The plates are heavy and sharp.* At the end of the day you feel your fingers and back.

# 2.5 Quality department

The department of quality tests components and finished products. They test the first five deliveries of each new component. If there is nothing wrong with the components than the testing is stopped. The finished product is tested every sixty days. That is also planned in SAP. SAP tells the quality engineer there are components delivered and need to be tested. It also tells how it needs to be tested.

During the assembly, components are being tested as well. This results in the next overview when goods can be rejected:

- 1. Testing incoming goods the first five deliveries.
- 2. Final test of finished product at the end of the assembly line.
- 3. Testing a finished product type ever sixty days.
- 4. Leak test of gas pipes. There are two test moments at the assembly line.
- 5. Visual mismatch. The employees from production are able to see if the product is damaged.
- 6. Wrong fitting.

If there are a lot of rejected components during production the quality engineer gets the option in SAP to place the components back into the incoming goods test.

The senior quality engineer worked on a project to increase the capacity of the production line. He has done some observations at the production line. The quality engineer was most shocked about the amount of pre-assemblies randomly boxed up on the ground and the high buffers between stations. It is definitely not a just in time production method. Problems he saw are described below. The senior quality engineer tried by business analysis techniques (B.A.T.) to rearrange the workstations to create a better work flow and less buffers. B.A.T. is a theoretical approximation that tells us how long actions last.

At the production line the senior quality engineer discovered several problems, see also Appendix 5:

- 5A: Some components were not unpacked and were lying at the production line.
- 4F: see section 2.4 production department.
- 5B: *The B.A.T analysis shows that the final test station and the induction station are bottlenecks* depending on the on the product they produce. See Appendix 4: bottleneck. There is already research performed on this topic. Nothing is done with this research yet.

### 2.6 Research and development department

The research development manager not only oversees the product development but also the production line. In his team, a senior production engineer works on the layout, the work instructions for the production line and risk management. Those are the main topics. He has some great reports about how to improve the layout but they have never been executed due to the consideration between money and effort. Also the lack of space is part of the decision.

Other members in the R&D team are the product developers. The developers create a new design and the corresponding bill of materials (BOM). The BOM is a hierarchical list of components used in an assembly. For example, a certain product type contains parts with certain quantities.

The research development department saw several problems, see also the label reference to the problem cluster in Appendix 5.

- 4A: see section 2.4 production department.
- 6A: The production department does only have one leak test machine as a backup. Sticker machines, printers and the final test *machines have no backup* too. In the office, see the layout in Figure 2.1 before, test machines are present. These test machines are used by the quality engineers. The final test machine is very large and it will not be easily moved to the production station in case of a failure.
- 6B: The work instructions are shown on computer screens. *If the computer behind this brakes or fails by software issues than the production department cannot produce until it is fixed.*
- 6C: The last problem lies within the BOM. The BOM is used for backflushing. Backflushing is a process of determining the number of parts that must be subtracted from inventory records. Lately it was discovered that *some parts have wrong characteristics in the BOM*. Not enough parts were backflushed which caused a stock difference to occur.

# 2.7 Summary Chapter 2

This chapter gave an overview of problems experienced by the six departments within ATAG. The next chapter organizes these problems. We create a solving priority list with help of the company guidelines.

# Chapter 3: Research design

In this chapter we are organizing the problems found in Chapter 2. The problems turned out to be inter-related. This resulted into a problem cluster and is explained in section 3.1. The problem cluster shows 17 core problems. We created a solving priority list in section 3.2 with help of the company guidelines. We have not enough time to solve all problems, that is why we have made a selection in section 3.3. The selection results into a research design. In the design are the research questions are presented and we created steps to solve them, see section 3.4.

# 3.1 Combining the problems

All the problems the departments experience turned out to be connected as shown in the problem cluster in Appendix 5. Below, in Figure 3.1, an artist impression of the problem cluster is found. In yellow stands the main problems. One of them, the backlog of 1200, is the motivation of this research and is the company's priority. The starter problems (in yellow) are leading back to seventeen core problems shown in red and red-yellow. The difference between the red and red-yellow is that the red-yellow problems are already detected and that a research team is working on them at the moment. In orange are also core problems, but they are connected to another main problem who will not be investigated in this research, because the focus of this project is on the backlog. The pink and blue dots shows that the three main problems are connected with causes that also influence the priority main problem, the backlog of 1200. Solving those problems will help solving the full warehouse problem and getting more grip on controlling the inventory.



Figure 3-1 Problem cluster of ATAG containing problems of six departments

# 3.2 Core problems in order of priority

It is impossible that we solve all problems in 15 weeks. Therefore, we made the decision to create a priority list that tells us in which order the seventeen core problems are going to be solved, see section 3.2.2. Before the priority list is created, the company guidelines are taken into account in Section 3.2.1. The company guidelines determine the highest priority.

#### 3.2.1 Guidelines

In consultation with the different departments it was decided to set the following guidelines:

- At first it is necessary to create a strong base in the production department. This means
  making sure that there are enough components to start the production. To do this the
  following actions are needed:
  - Retain the fixed period
  - Solve the stock difference

- The second step is creating a realistic production planning. To realise this, the following thing is of importance:
  - Knowing what is the capacity of the production department?
- The third step is to make sure that technical problems not occur at the production line.
- The fourth step is creating a better work environment in the production department.

#### 3.2.2 Priority list

Knowing the guidelines of the company leads to an order allocation in the seventeen core problems. Below the problems are ranked as describe:

- 1 Strong base
  - 1.1 Order pickup method is not real time

The administration system is outdated. At the moment that a worker picks up an amount of components it is written down on a sheet. At the end of the day the sheet is picked up by a logistics employee, who writes it down into the computer. There are two issues with this system. At first it is possible to write down an unreadable number or location. For example, the letter H, depending on the writer, can look like an N. If the wrong article is changed in the computer than stock differences can occur.

The second issue is the time between picking up an article out of the warehouse and processing it into the computer. The time difference can be 3 days due do a part time logistics employee. It is possible that the company runs out of a component, during these three days. This means that it is not registered and therefore no new components are ordered. The result is a certain product type cannot be produced due to the lack of components. To solve this problem a scanner was bought. The scanner can be used to process transfers in real time. However, the scanner is not working properly due to the software issues and is boxed up in a closet.

1.2 Unreliable supplier

Missing parts for production is one of the worst things that can happen. There are two reasons for a lack of parts. One is that delivery times are not being honoured. Secondly there are components that are wrongly assembled by the supplier. This results in that the components fail the incoming quality check procedures. These two situations became almost a common thing.

The purchasing team is already looking for an alternative supplier for the wrongly assembled parts, so this problem is already being solved. But it seems that there is no penalty for suppliers that do not deliver in time.

#### 1.3 Assembly worker has to pick up components in P002 or P001

In this problem it does not matter in which production department the employee works. There is one employee selected to pick up components in the P001 warehouse. The assembly worker could call him for help but sometimes it is much easier to pick up the component themselves. When the assembly worker picks up the component by himself, he has to tell the employee that is authorised to register it.

The authorised person could easily write down the wrong amount, write down a different product or totally forgets to register. It is also possible that the assembly worker forgets to inform him. This leads to stock differences.

Some components have a fixed location in the P002 warehouse, but the problem is that this is not registered in the computer. Being a new employee makes it hard to find the right component in a warehouse of 540 different components. Workers collecting components themselves result in a long setup time. Most of the time they grab a random amount of a

certain component. That means that during production they run out of it and they have to collect again. Resulting in a disturbance in the production rhythm.

1.4 BOM error

The bill of materials (BOM) is not filled in properly. Lately, it was discovered that some parts have wrong characterises. The BOM is used for backflushing components. When the amount of parts does not match with the reality in the BOM, then not enough parts were backflushed. This causes a stock difference.

1.5 Rejected components at production are not blocked real time

Each week the red boxes with rejected goods, at production, are emptied by a quality engineer. By doing this not real time there is a small stock difference during the week.

#### 2 Production planning

2.1 Wrong cycle time in SAP

When SAP was introduced it needed a cycle time to make the production plan schedule work. ATAG never performed traditional measurements, clocking with a stopwatch. The assumption numbers in SAP are a wild guess.

Not knowing your production capacity makes it hard to create a production plan. That is why a production target is made. The production target of 250 is not often reached. It completely depends on the product types and occupancy rate if they will reach the target that week.

2.2 Setup frequency

Setups are equal to no production. The more setups, the more production time is wasted. In the current situation ATAG setup up multiple times a day. The setup in ATAG situation is that production employees collect new components to start a new batch. Only two stations required machine adjustments but this will only cost 30 seconds.

#### 3 Prevent technical problems

3.1 No backup test machines close by

The production department does not contain robots but it does contain several testing machines. In total there is one leak test machine for the main pipe, a leak test for all the pipes and, the final test machine.

The quality engineers have in their office, next to the production department, a leak test machine for all the pipes and the final test machine as well. So there are two backup machines but there are not standing on an ideal location in cause of a failure. The machines cannot easily be picked up and moved to the production line.

3.2 Software failure

The work instructions are shown on the computers standing in front of the assembly line stations. If the computer fails due to for instance a software issue, then the assembly line cannot work efficiently.

#### 4 Work conditions

4.1 Air intake and suction is not well

The ventilation is not good. The production line is standing in a warehouse and therefor the air conditions are not optimal. There is a lack of air suction and intake at the sealing department. The fumes of the degreaser and soaps, cause the assembly workers to become tired and get headaches.

4.2 Lifting heavy tops

The tops are less than 23 kilograms, which means it meets health and safety requirements. Still the sealant employees cope with back pain issues and pain in their fingers after a work day.

- 5 Other core problems
  - 5.1 In case of illness no replacement workers

Having someone ill does not have to be a problem. Unfortunately, at this production line it is. Eleven employees is the preferable amount to maintain the flow and there are twelve employees in total. Having the flew targeting the production team is a current problem. It happens that four employees are ill and therefore at home on the same day. There are no on-call employees if the utilization is running low. This results in a lower output.

5.2 Prepacked components at assembly line.

Components that are laying at the production line prepacked form extra work for the assembly line employee. This means there is less production time available.

5.3 Bottleneck induction station

It takes a lot of time to create a hob that contains an induction cell. Making a hob that contains gas and induction results in a buffer between the gas and the induction station. There was research performed on how to improve the production lay-out to create a higher output taking into account the induction station. It seems like nothing is done with the conclusions of the research yet.

5.4 No authorization to check in SAP the location bin of the component

The production employee who has the job to collect components in the warehouse does not have authorization to check the location of the components. He could go to the other side of the warehouse to ask or he could search.

5.5 Purchaser of components cannot see the forecast

The purchaser reacts when it is clear there is a lack of components. If the supplier is on a holiday, he is not capable of delivering the components. So if components are required, during or around a holiday, then the order has to be placed more up front than normal. To do this the forecast of hobs production has to be known. The purchaser could see this by using the software Slim4, but the software is not available to the purchaser.

#### 3.3 Choosing the core problem to perform research

Solving seventeen problems in fifteen weeks is ambitious. Having all problems completely solved in fifteen weeks is not a realistic target but most of them could be set into motion. In this research is chosen to perform research on the problems that influence the strong base and a realistic production planning, guidelines one and two. A reminder:

#### Strong base

- 1.1 Order pickup method is not real time
- 1.2 Unreliable supplier
- 1.3 Assembly worker has to pick up components in P002 or P001
- 1.4 BOM error
- 1.5 Rejected components at production are not blocked real time

#### **Production planning**

2.1 Wrong cycle time in SAP

2.2 Setup frequency

#### 3.4 Research questions and design

In the previous sections is decided which problems are going to be solved as much as possible in the upcoming weeks. To find a proper solutions, research needs to be done. In this section reasons for research can be found with the research questions.

#### Problem 1.1: Order pickup method is not real time

In section 2.3, warehouse department a solution for this problem is already introduced. The warehouse bought a scanner to make the order pick up method real time. Research questions belonging to this topic:

- 1) What is wrong with the current scanner?
  - a. In what manner can the current scanner be fixed?

To answer the research question 1: 'What is wrong with the current scanner?' an experiment is done. The following steps are done to solve the questions:

- Step 1: Together with the warehouse employee the scanner is going to be tested by doing experiments. A list of issues is made.
- Step 2: Looking into the issues found in step 1 and see if they are repairable.

The answers to the research question 1 can be found in Chapter 4.

#### Problem 1.2 Unreliable supplier

The purchasing department is already talking to other possible suppliers. The purchasing department will not need further assistance.

#### Problem 1.3 assembly worker has to pick up components in P002 or P001

This is a major problem it affects the production output, the warehouse and the purchasing department. To solve this problem a new pickup and delivery method need to be introduced for the production department. This will require research and therefore the following research questions:

- 2) How can the way of supplying be improved, so that the setup time is reduced and the output is increased?
  - a. What is the current setup time and how often does the assembly worker run out of components at the workstation?
  - b. Which methods are there to supply the production department and what are their pros and cons?
  - c. What is the current shipping method of ATAG?
  - d. When could a product be delivered?
  - e. Which improvement cycles could be used as a guideline to improve the supplying method?
  - f. How to introduce the new method?

To solve research question 2 the following steps have to be done:

- Step 1: Knowing what is the current situation by solving research question 2a.
  - Creating a measurement plan.
  - Measure the setup time between the different hop types and measuring the shortage of components during production. Step 2 can be done parallel to step one.
- Step 2: Questions 2b, 2d, 2e and 2f is going to be brainstormed about and looked into literature.

- Step 3: Questions 2c: Describe the current shipping situation. Including shipping method, transportation type, transporting routes.
- Step 4: Depending on how question 2c is answered, introduce the methods.
- Step 5: Creating supping method options suitable for ATAG

#### Problem 1.4 the BOM error

No research questions are needed to solve this problem. In consultation with the different departments is decided that the BOM sheets are not going to be verified on errors, because it is time consuming. There is another effective way to solve this problem.

- Step 1: Solve problems 1.1, 1.2, 1.3, 1.5.
- Step 2: Count the physical parts lying in warehouses P001 and P002 solving the stock difference.
- Step 3: When a stock difference is noticed because a certain component is missing, it is more easily to trace it back to the BOM of a certain hob type.

#### Motivation for above steps

By counting the physical parts in the warehouses, the stock difference is solved temporary. Temporary because the BOM error still exists. The reason that problems 1.1, 1.2, 1.3, 1.5 are going to be solved first is that the BOM error is the only problem that could cause the stock difference.

#### Problem 1.5 rejected components at production are not blocked real time

Currently, once a week the red boxes with rejected components are emptied. The quality engineers are going to be approached if they could check the rejected components once a day.

#### Problem 2.1 Wrong cycle time in SAP

The wrong cycle time in SAP makes it hard to make a production planning. To find out the real cycle time the following research questions are going to be answered:

- 3) What is the capacity of the production department?
  - a. How can the cycle time be measured?
  - b. Which products are going to be measured?
  - c. What if the capacity turned out to be to low?

The questions are going to be answered doing the following steps:

- Step:1 Solve the stock difference because, this results in knowing that there are always enough components. Stock difference can not cause disturbers at production department anymore. The production flow should be relative constant.
- Step 2: Perform research on research question 3a and 3b by looking into literature.
- Step 3: Measure cycle time.
- Step 4: register the cycle times into SAP.
- Step 5: Answer question 3.
- Step 4: Answer question 4.

#### Problem 2.2 Setup frequency

In the current situation ATAG knows 0 up to 5 setups a day. Reducing the setup time with problem 1.3 is the first step. The setup frequency is the next problem were to look into. Would it be still a problem that ATAG setup this often or is it acceptable? By answering the following research question, it provides insight into setup frequencies:

4) How much can the setup frequency be reduced or can ATAG become so flexible that it is no longer necessary to reduce the setup frequency?

#### What happens to the other core problems?

The third guideline is about the technical problems. A research team form R&D is working on a solution to solve the software failures and are looking into new test machines with back-up, known as problem 3.1 and 3.2.

The same research works parallel on a project team that checks if the production line could be more optimised. Taking into account problem 5.3 the bottleneck stations.

Guideline four is about the work conditions and is also taking into account by the R&D research team. A new project is started that looks into problem 4.1 (air intake and suction) and problem 4.2(lifting heavy tops).

Problem 5.1 absent workers due to illness at production department. The R&D manager spoke with the CEO. The decision is made to create a flex pool with current employees who works in different departments. The flex pool will be used as support. In consultation with the production leader the flex pool will perform easy tasks like brushing up the hobs, prepacking and testing hobs. If the employee is more familiar with technique and production, they could help with creating induction hobs.

Problem 5.2 is about the prepacked components at the assembly line. This problem will hopefully be solved with solving problem 1.3.

Problem 5.4 and 5.5 are both about authorization. The managers who are able to put in this request are approached.

#### 3.5 Summary Chapter 3

In this chapter we described how the problems experienced by ATAG in Chapter 2 are connected. The connections are shown in the problem cluster in Appendix 5. We found 17 core problems. The decision has been made about the order in which these core problems are going to be solved. The solving order has been made by using the company guidelines.

In this research are a few problems selected to perform research on. In section 3.4 are the research question given with the design on how the research questions are going to be solved.

In the upcoming chapters the research questions are going to be solved one by one.

# Chapter 4: Solving picking method not real time

In this chapter the first research question is going to be answered namely, *What is wrong with the current scanner* see, Chapter 3 section 3.4. Chapter 2 section 2.3 described that the current, not real time, picking method leads to a stock difference.

There is a scanner available that makes the picking method real time. Unfortunately, the scanner is stashed in a closet and is never used due to some unknown software problems.

Below are the research questions answered belonging to this topic resulting into a conclusion and recommendations.

# 4.1 What is wrong with the current scanner?

The best method to find out the scanners problem is by testing it. In preparation to the experiment, the batteries and one spare are fully charged so this will not give any problems. Together with the logistics employee the scanner is tested. There is no manual of the scanner available. The only way of knowing what the scanner is able to do, is by using it.

#### General information

In the warehouse there are multiple storage racks. The storage racks are divided into bins. See an example in Figure 4.1. Each bin contains a sticker with the bin barcode and bin number. After scanning the bin sticker, the scanner will give information about the component number and the amount.



Figure 4-1 Exempel storage rack

It is not necessary to scan the bin sticker. The bin or component number can also filled in by hand. Doing this by hand will be error-prone. The software of the scanner is created by the mother

company, the IT department in Gorenje. Therefore, the program of the scanner is in English, but this is not a problem.

The scanner contains different menus, were the components could be replaced and component locations can be found. While using the scanner different problems were found. Below the problems are divided into software and hardware problems. Next to each problem there is an explanation on what the scanner must be able to do.

Software problems:

- 1) When an empty bin is scanned, the scanner returned with an error. The location bin was not recognized.
  - The scanner must recognize the bin location and tells us that the bin is empty. Perhaps it would also be useful if the scanner could give us the option to add a component to the empty bin by scanning the bin sticker.
- 2) If the scanner gives an error, like the empty bin error, then it is always in Slovenian.
  - Preferably the scanner should not give any errors, but only warnings. For example
     Are you sure that you would like to place two product types in the same bin? Or: This product is also located at ... are you willing to continue?
- 3) Transfers within a warehouse work well, but transfers between warehouses is complicated. When a product is moved from one warehouse to another the bin location cannot be put in immediately, but a second action has to be performed in which bin number is put in.
  - The ideal transfer method is that while moving a product from P002 to P001 the product label can be scanned and that the scanner gives an optional bin location in P001, or that the bin location could be scanned by a logistics employee.
- 4) The scanner contains a scanner and a camera. The camera is not efficient, because when you want to scan a product you have to go through a menu were the employee can select the

infrared scanner or photo camera. It is unnecessary to have this menu and it would therefore be good to remove this.

- 5) Not all the product stickers are recognized by scanning the product barcode. This is because the supplier did not use the stickers required by ATAG.
- 6) The current software is not supported in 2017 and therefore it is not updated.

Hardware problems:

7) The scanner is not able to reach the top shelve of the storage rack. The range of the infrared is not large enough.

#### 4.2 In what manner can the current scanner be fixed or is it unfixable?

The scanner is unable to reach the top shelves and the software will no longer be supported in 2017. Therefore, the current scanner is not perfect and vulnerable. We recommend purchasing a new scanner that is able to reach the top shelves and that a functionality list is made. In the meantime, the current scanner can be improved with software adjustment by the IT department in Gorenje. The list of problems is send to Gorenje to make the readjustments to the current scanner in the upcoming weeks. Than the current scanner can be used.
# Chapter 5: How can the way of supplying be improved, so that the setup time is reduced and the output is increased?

In this chapter the sub research questions are answered of research question 2 according to the research design described in section 3.4. Research question 2 is *How can the way of supplying be improved, so that the setup time is reduced and the output is increased?* 

For this research it is important to have an indication of the current setup times and disturbs. This is important to know to determine how much time will be saved by creating a new supplying method. The current setup times were not measured before. In the first section (5.1) of this chapter the current setup time is determined and also how often a station runs out of components, during a production order. The second part (5.2) starts with a literature research on the different shipping methods and transportation types. Within the shipping method the production layout is taken into account by introducing the 5S method. Knowing the different supplying methods will help to describe the type of supplying method currently used at ATAG, which is also described in section 5.3. Section 5.4 is about when the deliveries can take place. In part 5.5 we used Hicks and Matthews theory of improvement cycles. We selected theories that are helpful in this research. Section 5.6 is about change management. The sub question, 'How to introduce a new method?' is answered in this section. Section 5.7 gives a summary of Chapter 5.

## 5.1 What is the current setup time and how often does the assembly worker run out of components during a production order at their workstation?

When production employees are asked if they know how long it takes to setup their station, they answer with a guess, around 5 minutes. Additionally they say that, during the production order, they often run out of components and have to collect them themselves. How often this happens is going to be measured and is shown in the results section. Which setup times to measure and secondly how the setup times are going to be measured is described below.

## 5.1.1 Which setup time to measure?

Setups are required to make small machine adjustments and to collect new components for a batch. The machine adjustments takes no more than 30 seconds. All production department stations needs to clear and clean their workstation and have to gather new components to produce a new hob type. There are 8 stations at the assembly line that create the direct output, from which 6 stations have to gather components and 3 stations require a machinery adjustment. Next to the assembly line there is the sealing and the pre-assembly department. Both departments deliver half assemblies and they deliver those on time. Not all setup times are useful to know. The sealant and pre-assembly departments have enough output to supply the assembly line is the bottleneck, because their output it too low. The bottleneck in the total setup time is not the machinery adjustments but the gathering components and clearing the station. Therefore we choose to measure only the 'gather and clearing' setup time at the assembly line stations.

To get an approximation of the setup times at the assembly line, it is preferable to collect as many measurements as possible. Setup times could vary because the setup time between two family hobs should be smaller than between two nonfamily hobs. Family hobs are products where similar components are used and they have similar processing times.

A good approximation for the setup times will contain:

• Measurements between all the 55 different hob types;

• Having the above measurements not only done once but multiple times for the same production order. This will result in an average setup time between hob type A and hob type B.

It is impossible to measure according to the above guidelines within the time frame of this research. This is due to four reasons:

- Not all product types will be made in the available research time.
- There are 55! (≈1,3\*10<sup>73</sup>) options in which order the different hob types can be produced. For example the setup time between hob type A and B is shorter than hob type A and C. This because less components needs to be collected to produce hob type B.
- Nor is the researcher able to stay at the production line 24/7 and measure all setups times due to other parallel activities that are part of this research.
- Having multiple measurements of the same setup, so the setup between hob type A and B, is not possible. This is because it is not included into the production planning in the upcoming weeks.

This results into the question: What is doable to measure in the available time? Every measurement is useful. That means within the research period the researcher will try to collect as much setup times as possible.

In the time line are three weeks left to measure setups times. After that there will be the first changes in the supplying method. In theory there will be 30 production orders produced in the upcoming three weeks so, 29 setup moments.

Due to the uncertainty about when the setup time takes place it is hard to plan an appointment for measuring it. There are meetings and duties planned that contain higher priority. For this reason is chosen to set a target. The target is to measure 50% of the upcoming 29 setup moments. The approximately 15 setup time would give a good indication of the current situation.

## 5.1.2 How to measure setup times?

There are 8 stations at the assembly line, see Figure 2.2. Station 4 and 6 are test stations and have no setup times. The setup is carried out by the employee who works on the station. Station 1 and 2 is staffed by the same person, therefore it is one setup moment. Each station has their own setup time. Therefore, the stations will be measured individually.

The number of hobs made per station is found on the computer screen in front of the station. The trigger for station one to setup is that the last hob is made. Station 1+2 is the first in line. The production employee will go after the last hob is made to the office to get the packing list. The packing list contain hob type, the amount that is going to be made and the components list. The component list only says which components are required and not the amount of components that is to make the complete production order.

The moment that the employee of station one and two is going to the office, is the moment the time measurement starts. The end of the setup time is the moment when the underboard is placed on the assembly line to start the new order.

The packing list of the employee of station 1 is collected and placed on the first made hob of the new production order. Station 3 receives the new hob and picks up the packing list. Picking up the packing list is the start of the setup time. The end of the setup time is the moment the employee starts adding the new components to the new hob. Again after station three assembled the first new hob the packing list is placed on top of it.

Station four is the leak test station. Station 5 does already contain most of the components. All components required at station 5 are located around the station and when the employee is out of a component he asks for a replacement box with components. The employee at station 5 has to collect the tops. The tops are subassemblies containing glass panels or stainless steel panels that the sealant

department made. The moment that the employee receives the packing list and leaves the station to collect the tops the measurement starts. When the tops are in place, the measurement stops. Station 6 is the final test station and will not require setup.

The employee of station 7 does require new components. The moment when the employee receives the packing list the measurement starts and when the employee returns from the offices the measurement stops.

The measurements can be done with a regular digital clock, a stopwatch or a regular watch. The advantage of the stopwatch is that the time measurement is close to the real setup time. It is in minutes and seconds.

The disadvantage is that there is always an error in this type of measurement. The stopwatch could be set to late or too early.

The advantage of using a regular clock is that the time is written down. For example station one started at 10:31h with the setup and ended on 10:40. Doing it like this for every station, not only the setup time per station is known but also the time between the setups and the full time that is required to setup the assembly line. Knowing the setup time between stations could give an indication on which moment the new components need to be delivered. For example station one is starting the setup. This is a signal for the future supplier that he has 20 minutes left to deliver the new components to station 7.

The disadvantage of using a regular digital clock is that the measurement could be one minute off. Starting the setup at 10:31:58h the digital clock in position of the researcher shows only 10:31h so, no seconds. 10:31:58h is almost 10:32h. If 10:31h is written down than after two seconds of setup time, the measured setup time is already one minute.

The third option is using a watch. The advantage of the watch is that it could contain a second hand (Dutch= secondewijzer). Only the watch of the researcher is not containing a second hand.

## Conclusion

For this research a digital clock is used, because at the end it give more information. The reason is that only an indication is required, not having the time in seconds accurately is not considered as a problem. Knowing that there is awareness of this deviation is enough.

The production leader will inform me a quarter before each new setup by sending a text message. If the researcher is available than the setup time could be measured.

## 5.1.3 How to measure running out of components?

The researcher cannot stand at the production line 24/7 and see if the assembly line worker is running out of components. We decided to give every station a post it, see Figure 5.1. On top of the post-it is written the station number. Underneath there are the dates and 'the lines' that stands for the amount of times the employee had to leave their station to ask or grab components. The station employee add lines only when they produce so, not during the setup time. Each line is standing for one component. The researcher walks every day through the production is able to check if a new post-it is required. Changing the post-it will also include changing the colour of the post so it stays visible and is not becoming part of the production decorations.



Figure 5-1 Post-it measurement

At the end of the research the data will be averaged. By doing this research, it is proved that there are disturbances and that production time is wasted. An assumption can be made on how much time is wasted. Running to the office and asking for a component will cost 1 minute. A lot of components

are floor pick and can be searched and found by the employee. Let us assume that finding costs 1 minute and filling the boxes costs 1 minute.

That the production employee is going to the warehouse to pick up the components himself is quite rare and they are not allowed to it, so we assume that this is not happening.

The average of the assumed times is 1.5 minute. Therefore, each line on the post-it will stand for 1.5 minute.

## 5.1.4 Results

All measurements can be found in the Appendix 6 and 7. In Table 5.1 below are the average setup times shown per station. Station 1 and 2 is staffed by the same person (see Figure 2.2), therefore it is one setup moment. The pre-assembly stations also kept track of their materials. We decided to add them to the result list. The pre-assembly station is called VM in the Appendix 7.

station	Average setup time per station	Running out of components (average per day)	Time waste getting or asking for components per day
1+2	00:08:30	13	00:19:30
3	00:07:30	4	00:06:00
5	00:03:00	2	00:03:00
7	00:04:00	7	00:10:30
8	-	3	00:04:30
Pre assemble stations	-	4	00:06:00

Table 5-1 Result setup time + running out of components 18-1-2017

## 5.1.5 Conclusion

Looking into the average setup time result presented in Table 5.1 above we can conclude that station 1+2 is the bottleneck. From the sum of the average setup time with the time waste of station 1+2 can be concluded that for 28 minutes nothing is produced. If there are multiple setup times during the day than the duration of not producing will be longer than 28 minutes. As shown in Appendix 4, the employee at station 1+2 could makes a hob every six minutes. This means that within 28 minutes the employee could made four hobs at least. 4 Hobs a day multiplied by 5 days a week multiplied by 48 weeks a year results in 960. 960 Hobs that are wasted by setup and running out of components.

From Table 4 in the Appendix 6 can be concluded that setup times of stations 1+2 and 3 are fluctuating the most. The setup times of station 1+2 fluctuate between 4 and 12 minutes. The fluctuation is because not all hob types are of the same family. The more similar components between the hops, the lower the setup time. Therefore, the setup time between hop HG9511MBA and HG1472MDA, two non-family hops, is the longest, see table 4 (in green) in the Appendix. The setup time between family hobs will never be zero, because not all (pre-assembled) components are the same. Another outstanding result is the fluctuation of the setup time of station 3. It took 15 minutes to setup this station. The employee collected the components as usual, but after collecting he needed to label the wiring. This hob is produced for the Australian market and therefore the regulations require the wiring to be labelled. 9 Of the 15 minutes were used to label the wires by two employees and this is therefore the main reason why labelling should be done at the pre-assembly. Station 7 has a setup between 3 and 6 minutes. The reason for an above average setup time at station 7, is that the employee was unable to find the pre-assembled installation materials and manuals. The setup time of station 8 is not measured because this hob type was not produced during the measurement period.

## 5.1.6 Discussion

The running out of components measurements are in my opinion unreliable. In the first week I found out that setup times were marked as shortage of components. Resulting in a high shortage and unusual date.

Still I think that the number of shortage must be higher. Reason to assume this are:

- There were production days, in which it seemed like there was no shortage of components at all. After verifying this result with the staff they answered with, I forgot to keep track.
- Multiple times employees were uncertain if the measurement was still running and therefore they did not write down when there was a shortage. They were reminded that the measurement continued until the researcher requested to stop.
- I am certain that not all shortages are written down. I did several observations in this research. During one of the observations, I saw an employee forgot to write down the shortage but did collect materials. When I asked how many marks he had placed today he immediately wrote down four lines. Instead of the one he just collected. Add the end of the day there were still four lines but all the fast pick components were filled up.

The running out of components measurement is still running. With the new logistic and delivery changes I can see if the running out of components decreases.

## 5.2 Literature: Which supplying methods do exists to supply the production department and what are their pros and cons?

Before the question is answered what the current situation is at ATAG, we first look at the different supplying methods. Knowing the different supplying methods will provide us key factors were to look at in the current situation.

In order to find out the supplying methods is made use of literature. The supplying method is divided in three sections:

- shipping methods, see section 5.2.1
- transportation types useful for internal suppling, see section 5.2.2
- the influence of supplying on the production department layout. We will introduce the 5S's, see section 5.2.3

## 5.2.1 Shipping methods

The warehouses P001 and P002 are the internal suppliers for the production department. Internal supplying methods works similar to external supplying methods. Chopra and Meidle devoted an entire chapter to transportation in the book supply chain management.

Translating the transportation networks of Chopra and Meidle into options for ATAG, you will get the following six internal supplying methods:

- 1. Direct shipping
  - Explained: In direct shipping there is a single supplier that delivers directly to multiple stations, as shown in Figure 5.2. Or multiple suppliers deliver directly to a single station, as shown in Figure 5.3. The warehouses in the case of ATAG will be P001 and P002.
  - Pros: Simple coordination.
  - Cons: Takes more time to supply the stations, because each component picked up in the warehouse is directly delivered at a station.



Figure 5-2 Direct shipping single supplier

Figure 5-3 Direct transport multiple suppliers

- 2. Milk run from warehouse to a single location
  - Explained: A milk run means that all the goods are collected before shipping. That means that workstation 1 will receive all the ordered components at the same time, see Figure 5.4.
  - Pros: This method makes sure that workers are less disturbed.
  - Cons: Preparing a delivery for one station could be less time efficient. Because if a certain component is going to multiple stations, than you have to go back to the warehouse and collect the same component again.



Figure 5-4 Milk run form P001 with direct delivery to multiple stations

- 3. Milk run from warehouse to multiple stations, by using milk run deliveries.
  - Explained: At first all the requested components for the stations are picked up at the warehouse. Then there it will be checked if one shipment can be made. For example, all the components for station 1 and 2 are picked and then delivered, see Figure 5.5.
  - Pro: With this method the transportation time is less compared to direct transport and only warehouse milk runs.
  - Cons: Working on multiple orders at the same time is more complex and therefore could be more error-prone. There is for instance a change that a component of station 2 is delivered at station 1.



Figure 5-5 Milk run from warehouse P001 to multiple workstations

4. Direct shipping through distribution centre with cross-docking.

- Explained: All suppliers deliver to the distribution centre (DC). The DC sorts the incoming goods for the multiple workstations and prepares different shipments, this is called cross-docking. The prepared shipment are stored in the DC until the shipment need to be delivered, see Figure 5.6 below.
- Pros: The requested components can temporarily be stocked.
- o Cons: It will take extra space to create a distribution centre.



Figure 5-6 Direct shipping through distributions centre

- 5. Shipping through a DC with milk run deliveries from DC.
  - Explained: An example is a shipment from the warehouse to DC, which can be delivered to from DC to all the work stations, see Figure 5.7. The milk run does not have to contain all the work stations.
  - Pro: This method reduces transport time.
  - Con: Planning is complex: preparing one shipment for two locations is the complex part. It requires knowledge about volume.



Figure 5-7 Shipping through DC with milk runs

- 6. Combinations of the above options.
  - Explained: Not every product can be shipped in a group in internal transport. Some fast moving products need to be transport more often than other ones. One delivery moment during setup is not enough. In Figure 5.8 below is an example of how a combination could look like. It is a combination of direct shipping from supplier to workstation, with a distribution and milk run deliveries. The supplier could transport through the distribution centre, or do a direct delivery to a workstation. The distributions centre checks if they are able to do milk runs and store temporally components that cannot be delivered yet. The green lines in the Figure below are the retour components that need to be stored at DC or be returned to the warehouse.
  - o Pros: Best match for individual products and stations
  - Cons: The planning and control method more complex than the other supplying methods.





## 5.2.2 Transportation types

ATAG requires an indoor transportation type for a short distance. The indoor transport is from warehouse P001 to the production department and back, within a 80 meters. It will not require a truck. Transportation types that will be useful for internal transport, taken into account that components needs different transportation types depending on their size and weight are:

- Non automatic transport types:
  - Package carrier by foot. In this option is not referred to package carriers as in a transportation companies like Post NL. The package carrier is a single man using their feet as transportation. It transports only small packages he is able to carry by hand.
  - Package carrier using a forklift. Forklifts are for the bigger components with pallet sizes. Depending on the packing material, two plates can placed on top of each other. If not than the forklift is part of the direct shipping method.
  - Package carrier making use of trolleys or mail carts. Trolleys come in different sizes and shapes. A few example are shown below in Figure 5.9. Depending on the components to transport can a trolley be custom-made. Trolley 5-9a consist of 15 shelves and 97 bins. The cost, according to Fami is 718,20 euros. The other two trolleys are form Kruizinga. The trolley shown in 5-9b costs 373,29 euros and 5-9c costs 511,23 euros. All cost includes tax.



Figure 5-9 Trolley types. 5-9a source: (Fami storage systems, 2013). 5-9b and 5-9c source: (kruizinga, 2017)

- Automatic transport system:
  - An automatic system could be full automatic with no human interferons. The system could contain guided vehicles (robots), baggage handling systems, trail transport or pneumatic tube systems.

Pneumatic tube systems will require some explanation. Tube systems are used in health care and banks. This internal transport system is ideal for small objects that need to be processed promptly. Depending on the dimensions of the goods to be transported and the layout of the building, a pneumatic tube system can be used or not.

The other automatic system will explain themselves in the videos below. https://www.youtube.com/watch?v=jCcFFbqFddQ https://www.youtube.com/watch?v=E2NKHR1FnpI https://www.youtube.com/watch?v=mEzCMS50mtE

## Conclusion

An automatic transportation network needs to be build up from the ground. In about 3 years when ATAG is going to build a new warehouse an automatic system can be considered in the new layout. In the remaining time the non-automatic transportation types are optional.

How a product is going to be delivered depends on the product. The variables that need to be taken into account are the size of the components, the amount and product type.

For a milk run trolleys could be used. Larger components will require a forklift. Small packages can be delivered by the carrier by feet.

## 5.2.3 5S

A supplying method and production department layout could be in conflict with each other. A shipping method could not work due to a lack of transportation space. If a transportation route is to narrow a trolley or forklift cannot be used. Another reason that a shipping method could not work is that delivery locations are not fixed.

Changing the supplying method could require adaptions in the production department layout. Meaning that ATAG has a choice: *is ATAG willing to consider a new production department layout to find the optimum shipping solution?* 

If so that the 5s theory can be taken into account.

5s is a system to organize to workplace created by Toyota. By organizing the workplace it creates operation stability. The stability will create a visual work place that reduces errors and helps safety. It is often implement in lean manufacturing and it is often called the foundation of lean. The 5S's are:

- Sort: Eliminate items form the workplace that are not need for regular operations. These items that could be eliminated could be equipment, tools, materials, supplies or information.
- Straighten: Only have the materials that are needed for regular operations on the work floor. Organize them, give them a fixed location and make them more visible.
- Shine: is about creating a clean work floor on daily base. It will maintain structure.
- Standardize: Set up standards for a sorted, straightened, and clean workspace.
- Sustain: It is all about discipline and creating schedules to maintain the 5s

## Conclusion

The 5S will be a good system to organize the production department on ATAG. Creating a new logistic process will sort the materials. This research will be the first step to operation stability.

## 5.3 What is the current shipping method at ATAG?

To find out the current situation at ATAG observations are made and sometimes asking questions to the employees. In section 5.2 we introduced supplying methods. This section gives the guidelines to look at the following points:

- Who is collecting the components?
- Where are the components stored?

- How are the components collected?
- What are the transportation routes?

## 5.3.1 Who is collecting the components?

On paper there are three authorised employees to pick and book components from warehouse P001 to P002.

The components that are lying at P002, the floor pick, can be picked by every production employee.

## 5.3.2 Where are the components stored?

P002 contains racks and shelves with lots of components. These components do have a fixed location but these are not registered in the warehouse management system(wms) within SAP. At P002 there are roughly 520 different components. There is a system in which the components are spread over P002. All components for the sealing department can be found in their department on and underneath tables.

Screws, labels, nozzles, and some other non-bulky components can be found in the bookcases, see Figure 5.10.

Furthermore, there is a storage rack than contains multiple layers of kanban shelves over the entire length, see Figure 5.11. The kanban shelves are divided into four sections. Two section are used as kanban shelves that are useful for the pre-assembly stations. One section is for assembly line station one and the last section is for station three. There is one more 'bookcase' containing manuals and warranty papers.



Figure 5-10 Fast pick shelves P002



Figure 5-11 Fast pick kanban shelves P002

P001 is a real warehouse. The layout is based on the component types. Gas pipes can be found in rack one, glass panels in two and so on. Not every components is stored in a rack. Due to the leak of space in the racks or the size of the components cases, they are stored between the racks.

## 5.3.3 How are the components collected?

The production employees pick components in P002. They pick them one by one, so by direct shipping, because they can only carry one box at the time. There are some exceptions:

• Station 7 is the packing line: At the packing line are standing pallets with boxes, pan supporters, and fill pieces of Styrofoam (Dutch: piepschuim). These pallets were originally stored at P001. That means that they are picked by the authorized employees who are allowed to collect these items in P001.

Station 5 is also supplied by kanban. Well that is the idea. In in a true kanban method there are 2 full boxes on shelves in front of the station. If one boxes is empty than it is rolled back at the return line, located underneath the station. See Figure 5.12. Then someone has to see the empty boxes and fill it up.

The kanban system is not working, because these empty boxes are from paper and go straight to the trash bin. A second reason why it is not working is due to the return line. It is placed on the wrong height, therefore the boxes cannot be returned, see Figure 5.13.



Figure 5-12 Kanban method (lateral view)



Figure 5-13 Kanban method conflicted, box does not fit between the retour shelve and the production line

- The production employees use milk runs in P002 if they are able to carry 2 boxes. It depends on the size and weight of the boxes.
- Direct shipping from P001 to the production department. If possible direct shipping with small milk runs from P001 to production department.

Other findings during observation:

- When employees are in a hurry they go to warehouse P001 themselves and tell the production leader afterwards, that for example he needs to book the amount of 20 cables to P002.
- Each component is not delivered or picked by a specified amount. The specified amount would be the amount of components required to make a production order, but that is not taken into account.
- During the setup time the employees have to collect the components but also bring back the boxes with the current components they will no longer use. However, the components will be stored in P002 with exception of the glass and stainless steel panels.

## **Conclusion about collecting at ATAG**

The current shipping method is a combination of direct delivery, kanban, and small milk runs. In Figure 5.14 below a simplified representation of the current shipping method is shown. Every station receives components of warehouse P001 (blew lines) and P002 (purple lines). All stations bring components back to P002 (green lines). Some stations bring components back to P001 (yellow lines).



Figure 5-14 Simplified overview of the current supplying method

## 5.3.4 What are the transportation routes?

The current transportation routes are similar to the walking patterns of the production employees. The production employees are collecting most of the components themselves. Not only during setup times employees are walking across the production and warehouse departments but also during a production order. Reasons for walking are:

- running out of components;
- warning the production leader that they are almost finished with the production order;
- bath room breaks;
- asking other production employees for help;
- or in case of station one, collecting underboards on the other side of the production line. See pictures in Figure 5-15 below from the underboards.

In a new supplying method the walking patterns has to be taken into account to make sure they cannot conflict with the transportation routes.



Figure 5-15a Underboard on transportation trolley and 5-15b underboards on production line

#### In a new supplying method the walking patterns has to be taken into account to. In Figure 5.16 below the walking patterns of 8 of the 12 employees are shown in different collars:



Figure 5-16 Walking patterns: production employees collecting components

## 5.4 Literature: When could a component be delivered?

In section 5.2 we found out that transportation type depends on the component amount, size and weight. For a milk run shipping and delivery method we could use trolleys. Forklifts are used for direct shipping. When the components are going to be delivered is not taken into account yet. Before this question is answered the components needs to be dived into product categories, see section 5.4.1. The deviation can be made in different ways. We give options on how the deviations could take place.

After the deviation options we provide the 'when to be delivered' options described in section 5.4.2.

## 5.4.1 Dividing the components over the product categories

ATAG is using no exact guidelines that divides components into section. Recalling the current situation, 540 components are stored at P002 and therefore are fast pick for the production employees. Recalling the same section ATAG is willing to use a kanban system.

Using the 5S theory will help to divided the components. The first step in 5S is to sort items. Only the components for regular operations may stay.

Components used for regular operation will be in this case fast pick and kanban components. Every other component will require an order delivery.

To make the difference noticeable between the three product categories the definitions are given: - **Fast pick** 

The fast pick components are simple to explain by explaining what a fast-pick area is. De fast pick components lay within this area. The fast-pick area is defined as follow:

"The fast-pick area of a warehouse functions as a 'warehouse within the warehouse': Many of the most popular stock keeping units (skus) are stored there in relatively small amounts, so that most picking can be accomplished within a relatively small area. This means that pickers do less unproductive travel and may be more easily supervised." (BARTHOLDI & HACKMAN, 2016)

Figure 5.17 shows how the fast pick area works. All components are coming in and are stocked in the reserves are also known as the main warehouse. For example the green component will be stocked on two places. The green component is a fast moving item and will be restocked to the fast pick area to reduce travel time.



Figure 5-17 Example fast pick area (based on Chapter 7 Bartholdi & Hackman)

#### - Kanban

Kanban is a Japanese verb that translated in to English stands for a visual signal. Kanban is often used in production environment as a planning and control system. Meaning that a

signal is used as the trigger to come into action. The signal in kanban is an empty spot or an empty box as is explained in section 5.3. The empty box triggers a logistics employee to fill the box again. Recalling the Figure 5.18 below. There will be preferable two or more bins standing behind each containing the same component at the production department. When one of the boxes is empty than the bin is taken of the shelve and slide onto the retour tray. The empty box on the retour tray is the signal for an employee to fill the box up and slide the full box back onto the shelve. By using the kanban system at the production line, you will never runout of components because of the two bin system but that is only if the second bin is filled and delivered just in time.



Figure 5-18 Kanban system

## - Order delivery

Order delivery is when it is specially asked to deliver the components. In kanban you will not ask for components because the logistics employee will notice themselves if an empty bin needs to be refilled.

Below are 2 options given in how the components can be divided over the three product categories. After the 2 options are given they are discussed.

## Option 1

Components that are qualified for kanban and fast pick are determined based on the Pareto principle. If a component fits in 80 % of the hob types then it is kanban or fast pick. Some components are sunken in the production line, see Figure 5.19. Therefore it cannot be part of the kanban system. Meaning that in the current situation if the components sticks or are sunken into the production line it will be fast pick. Otherwise it is kanban.

All the components that are not in 80 % of the hobs are automatically delivered by order.



Figure 5-19 Components sunken in the production line

## Option 2

The first selection is made by the question is it a screw, a label or a sticker? If so, then it will be fast pick. After the first selection the Pareto principle is applied. Is it sunken in the production line then it will become fast pick if not it will become kanban.

Cons: Even if the screw is only part of six hob types it become fast pick. The production department is not very large meaning it is preferable to have as less fast picks as possible. Not only because of the lack of space, but also to reduce the searching time of the employee.

## Discussion:

The Pareto Principle is used as a guideline. After the 80% selection is made, the selection has to be finetuned. Is the amount of components in the 80% to high? Is there enough space at production line to kanban this amount of items? Or are there more places for kanban available, such that a 70% selection can be made?

The options are both based on components that are sunken in to the production line that in becomes fast pick. Can the components be relocated so that it could become kanban?

There will be a difficulty after dividing the components over the three product categories. The problem lies within components that are coming in boxes consisting of 2000 pieces. In a kanban box there is only room for 100 components. If the box containing 2000 pieces is located in the warehouse P001 and a 100 items need to be transferred to P002, then the warehouse employee has to count a 100 pieces. It will take a lot of time. Solutions for this problems are:

- Preferably the boxes are filled to the brim without counting the pieces. This method is possible if the location of the box containing 2000 pieces is on P002.
- Another solution is weighing the full box after filling, then the amount of components can be determined. This number is then extracted from P001. The disadvantage of this methods is that it will take an extra act.

## 5.4.2 When could a components be delivered?

Now that we divided the components over the product categories we focus in this section on the delivery moment. We can deliver components, depending on the product category, in three different manners:

- a schedule = Just in time method
- an empty spot as the trigger to pick and deliver = kanban method
- as soon as possible, like an emergency/express delivery

Below is discussed what the delivery options are per product category (fast pick, kanban and order delivery).

## Fast pick supplying method

The fast pick can be delivered at the assembly line but can also be picked by the production employees themselves. Below are the two options explained.

## Option 1

Shelves containing fast pick are located at the production department The shelves are refilled by logistics employees according to the kanban method. The production employees pick the components from the shelves.

## Option 2

A trolley contains the fast pick components. The trolley has a fixed location in the warehouse. Once a day the logic manager he walks with the trolley to the production department to fill up the boxes.

## Kanban supplying method

The empty kanban boxes are preferably picked and filled once a day at a fixed moment because that will reduce the travel distance and it is easy to control.

If the filling frequency is higher than once a day, then:

- First: Place components in bigger boxes so they can contain more products
- Second: instead of a two bin system a three/multiple bin system. This could also be an option if the weight of a bigger box is too high.
- Last: raise the picking and filling empty boxes frequency. Apply these solutions only if the first two solutions not work.

## Order delivery supplying method

The order delivery is more complicated than the kanban method. Timing becomes important. Knowing the production order makes is more easy but at the same time the order is only fixed if they start producing in the case of ATAG. It happens that last minute changes in the production schedule are made due to an undelivered or lost product. To make it even more complex is that the exact time of a new setup is hard to predict. This because of the unknown throughput time of the products. The order delivery moments also depend on the different production departments. The sealant department needs depending on the hob type 2 or 3 days components in advance. This because each sealant phase has an 8 hours drying time.

The sealant department also require some flexibility because of the sealant molds. They could make two orders next to each other but if it requires the same mold then the second order cannot be made. What can be made depends on the available other molds.

It is a similar story for the pre-assembly station. The due date is fixed but it does not matter in which order the different subassemblies are going to be made as long as everything on the paper is done by next week.

How to handle the complex situation of the sealant department and the pre-assembly stations is explained in Chapter 6.

The production line is more simple than the pre-assembly stations. If there comes an overview with required components at the assembly line per station it can easily be delivered. Option 1: It could be a just in time delivery. The required components could be placed on a trolley and handed over to the station. The assembly line employee can decide where he likes the components to be standing.

Option 2: The warehouse employees put the order behind the current order on a fixed position. The setup time will reduce to almost zero.

Now that we explored the relevant order delivery options, let us have a quick look in the literature about improvement cycle.

## 5.5 Literature: Which improvement cycles could be used as a guideline to improve the supplying method?

To create the right strategy to solve research question 2, we looked at the improvement cycle studies Hicks and Metthews performed in 2010. The right approach depends on the tool that you like to improve. Hicks and Matthews have created manufacturing improvement paradigms and their corresponding tools and methods in one overview. For more detailed information we would like to refer to the article (The barriers to realising sustainable process improvement: A root cause analysis of paradigms for manufacturing systems improvement, 2010)

The first step in de improvement cycle is to understand the relationship between efficiency, flexibility, quality and capability. This is <u>the base</u> of a manufacturing production system and is found in the centre of Figure 5.20.

Around the base are 8 different cases in the company. The 8 different cases are:

- 1. Process control
- 2. Operator led initiatives
- 3. Quality control
- 4. Tooling design and change over
- 5. Equipment redesign, modification and replacement.
- 6. Maintenance
- 7. Product modification and new product introduction (Product led NPI)
- 8. Other manufacturing philosophies like lean and Business Process Reengineering.



Figure 5-20 Improvement cycle source (Hicks & Matthews, 2010)

In this research we work with 3 of the cases. The approach is described below, according to the definitions of Hicks and Matthews:

- Process control: "Automation of changeover and machine setup, in process monitoring control."
- Tooling design and changeover: "Tooling design: Improve production performance, and in particular flexibility, whiteout compromising efficiency, though improved design of tooling." "Changeover: improve changeover performance through automation and /or techniques such as SMED or DFC)
- Other manufacturing philosophies like lean and Business Process Reengineering.

A separate approach is required for every case. Several methods are found around the cases in Figure 5.20. Below they are described in more detail.

## 5.5.1. Process control

The description of the process control approach is based on changeover of machines and monitoring their performance. We are not looking at the machinery in this research. We are looking for a method on controlling the transport flows between the warehouse and production department. The transport flows are a different process, but the approach can be the same. In both cases six sigma can be used.

## 5.5.1.2 Six-sigma approach

Six sigma is a set of tools for process improvement. The main goal is to identify and remove the causes of defects. Six-sigma knows different cycles and tools. The most popular cycle, according to (Slack, Brandon-Jones, Alistair, & Robert), is the DMAIC.

DMAIC stands for:

- **D**efine the problem
- Measurement stage
- Analyse measurements
- Improve the process
- **C**ontrol, reflect on the effects of the improved process.

Tools used by six-sigma are statistical process control (SPC) and control charts. SPC has to do with quality variability. This method focuses on the causes of variability and tries to minimize it. The variability is shown within the control chart(s).

## 5.5.2 Tooling design and change over

Improving changeover performance can be done by automation and /or techniques such as singleminute exchange of die (SMED), (Shingo, 1985) or Design for changeover (DFC).

Both methodologies are a step by step process that identify improvement opportunities.

- 1. <u>Identify pilot area</u>. What is the current duration of a variation in the setup times? When are there opportunities to setup? Is there familiarity between products and are there any constraints?
- 2. <u>Identify elements</u>. What work is performed to change over and how long does it take?
- 3. <u>Separate external elements</u>. For example, cleaning and inspection of goods is an external element.
- 4. <u>Convert internal elements to external</u>. This chapter is exactly doing this step. In the current situation, the production employees collect their own components. This part is going to be moved to external by creating a different supplying method.
- 5. <u>Streamline remaining elements</u>. Can we simplify other elements so that less time will spend on changeovers?

The SMED method can be part of research question 5. See Chapter 3.3.

## 5.5.3 Other manufacturing philosophies

Hicks and Matthews explained lean thinking and Business Process Reengineering (BPR) as other manufacturing philosophies. Another method chosen by the researcher is the theory of constraints (TOC).

## 5.5.3.1 Lean

Lean is also known under the name of lean synchronization. The Lean theory is based on the fact that for the lowest possible cost, the product and or service flow starts at the right time with the right amount and is delivered at the correct location (Slack, Brandon-Jones, Alistair, & Robert). Lean is created to tackle waste. Lean is focused on a strategy known as just-in-time.

Lean synchronization is primarily used in production processes in which large numbers and high quality products are manufactured.

According to the theory, there are seven types of waste:

- 1. Overproduction
- 2. Wait
- 3. Transport
- 4. A process
- 5. Stock
- 6. Work that adds no value
- 7. Defects

Lean uses the following indicators:

- Costs
- Throughput time: elapsed time from input to output.
- Added value = overall equipment effectiveness

In Chapter 3 all problems are indicated and described. Knowing the problems, they can be divided over the different types of waste. For the interested reader and the company, we indicate which waste types are tackled by creating a new shipping method:

Process

Picking is not real time booked. Because of handwriting it happens that the wrong product is booked, causing stock difference. This process is a waste. Finding out all mistakes takes more time than the process itself.

Wait

- Setup time.
- Running out of components waiting on a replacement.
- Searching for components.

Transport

- Picking one by one is not very effective.

Stock

- There could be less stock at the product department. If components will be delivered by logistic.
- Stock can be found in multiple bin places and multiple warehouses.

## 5.5.3.2 Business process reengineering (BPR)

This improvement cycle was created for radical changes to a process, keeping in mind that the new process creates value for the customer. Business process reengineering contains the following guidelines:

- Create a business process which is organized around a natural flow of information, materials and consumers.
- Redesign a process.

- Check if internal customer can be their own supplier instead of depending on others.
- Do not separate work form those who perform the work and those who plan and control the work.

## 5.5.3.3 Theory of Constraints

In the literature it is described that the Theory of Constraints is a cycle that is created to constantly search the biggest bottleneck and to find and implement suitable improvements. The theory is designed for creating higher output within factories. The system that fails could be a physical shortage, but it could also be a process.

The theory contains the following steps:

- 1. Identify the bottleneck that has the biggest negative impact on parameters.
- 2. Take a decision about how the bottleneck could be optimised.
- 3. Centre the bottleneck and create a process around it. The bottle neck can be supported by a Buffer-Drum-Rope system. The drum symbolises the bottleneck. The buffer stands for stock between two operations. The buffer makes sure that the bottleneck has always enough supplies to produce. The rope is the communications system.
- 4. Reflect on the new approach. If the approach was not able to improve the bottleneck, it should be deleted.
- 5. Go back to step 1.

The parameters used within this process are the:

- Throughput time: the output per time period
- Inventory: all the inventory located at several places. Inventory need to flow.
- Operating expense: the cost to start a process and to keep it up and running.

## 5.5.4 Conclusion section 5.5

All methods contain parts that will help finding and solving problems at ATAG. All methods give guidelines on how to find a problem and how to improve.

In the opinion of the writer there is not one perfect method that fits ATAG's needs. SMED can be used as an approach to solve research question 4, *How much can the setup frequency be reduced or can ATAG become so flexible that it is no longer necessary to reduce the setup frequency?* To answer research question 2, multiple methods can be used to find alternative supplying methods. In Chapter 6, options are given based on Lean, TOC and BPR. Meaning that there will be one option were the bottleneck in the current situation is going to be tackled and a second option that creates a completely new supplying method with a different planning and control approach.

We have explored improvement cycles that will help with creating a new supplying method. A new supplying method, suitable for ATAG needs a proper introduction. In the next chapter we provide an answer on *How to introduce a new method*?

## 5.6 Literature: How to introduce the new method?

Changing a process can be hard. Resistance of employees is one of the problems that can occur. Not only the employees need to be convinced that changing the current process is good, but also the business team of ATAG. In order to stay ahead of possible resistance, I added this chapter to the thesis.

P.R. Lawrence posted an article in Harvard business review in 1969. His paper is titled: 'how to deal with resistance to change'. His paper explains how to create social change. The conclusion of this research was as following:

Involve employees in the process by creating new methods. This improves the social change. Knowing that changes are going to be made and being involved in it, creates more good will to make a new process work (Lawrence, 1969).

The manner in how to involve the employee could be as follow:

- Discuss the problems with the employees. Also talk with their supervisors, but start at the people that are effected the most by the problem. Ask everyone if they already tried to improve things and whether it worked. What would the employees see as a solution to a certain problem?
- 2) The engineer or project team that works out the solutions should use the following steps:
  - First, briefly explain the problem (again)
  - Then introduce a possible solution
  - o Make clear that the first solution is also an experiment
  - Ask if the employee would give it a try to see how it works out.
  - o Evaluate

## 5.7 Summary Chapter 5

In the first section of Chapter 5, setup times are measured at the production line. The setup times fluctuate a lot depending on the station. The bottleneck is station 1+2 that require an average setup time of 8:30 minutes. The time wasted on running out of components was expected to be higher but the time wasted remained lower than the setup time, with the exception of station 1+2 and station 7.

Referring to the bottleneck, station 1+2 will stand still for 28 minutes a day if there is one setup time a day. In that period, there could have been made at least 4 hobs. 4 hobs a day multiplied by 5 days a week, multiplied by 48 weeks a year, results in 960 hobs a year. We would like to recall that the backlog was 1324.

In section 5.2 literature is used to discuss supplying methods. In the literature are found that supplying method consists out of shipping methods and transportation types. A suitable supplying method depends on the production department layout. Some layout changes could be required for a new supplying method. Therefore, the 5S's theory is introduced. It will form the base if adaptions at the production line need to be made. The different shipping and transport method options are used to create supplying methods in Chapter 6. Within these options the 5S's theory is taken into account.

The current situation at ATAG, described in section 5.3, is that the components are stored in warehouse P001 and 520 components are (also) stored in P002.

On paper there are three authorised employees to pick and book components from warehouse P001 to P002. The components that are stored at P002, the floor pick, can be picked by every production employee. The production employees pick what they are able to carry. The supplying method is direct shipping and or small milk run picking and delivery.

The supplying methods are similar for picking and delivery from P001 to P002, with the exception that sometimes a forklift is used for the large and heavy components. No trolleys are used. Multiple components are picked if the employees are able to carry them. There are kanban racking's, but these are not used as the kanban method describes. Within the current situation, there has also been looked at the walking patterns. The walking patterns represent the transportation trails.

## Section 5.4

Choosing the moment of delivery is not as easy as it looks. There are different product categories that have the same goal: the delivery must be on time. The only problem is that ATAG uses product categories, but have not registered which component belongs to which category. To solve that problem, we gave ATAG options on how to divide the components over the three product categories.

The next step was to find out when, how and by who the products were going to be delivered. The answer depends on the product category. For each product category the options on when, how and who are given in section 5.4.2. These options are also used in the multiple supplying methods given in Chapter 6.

In section 5.5 we introduced the improvement cycle (Hicks & Matthews, 2010). There are different methodologies described such as, six-sigma, SMED, lean, BPR and TOC. Six- sigma is a cycle that is more general in how to find the problem, fix it, and finetune it. We chose BPR and TOC a guideline to provide suitable options / solutions. The options can be found in the next chapter. Section 5.6 will helps the research team on how to approach and introduce a new method.

A lot of information is gathered in Chapter 5. The research done in Chapter 5 is used to develop supplying options in Chapter 6. We provide ATAG multiple options were they can choose from. The company is able to see the pros and cons of each option. ATAG may decide how much they would like to change their process and supplying method(s) and decide which option the most suitable is.

## Chapter 6: Choices for delivery methods suitable for ATAG

This chapter gives multiple options for solving research question 2, *How can the way of supplying be improved, so that the setup time is reduced and the output is increased?* Research, revealed in Chapter 5, became the base to create delivery methods described in this chapter.

The production department is divided into three sections, sealant, pre-assembly and the assembly line. Each section has his own planning and control system because they have other needs and needs at other frequencies. In spite of the differences within the production department, the sections have the kanban system in common. In the first part of this chapter (6.1) the kanban process is described. In section 6.2, 6.3, 6.4, we focus on the individual department sections. We reveal multiple supplying options in this chapter for each production department.

After introducing all supplying options, we provide some tips and tricks to help ATAG choose, see section 6.5. The last section gives a summary of chapter 6. The summary includes an overview of all options and methods by showing decision tables with the pros and cons.

## 6.1 The kanban process

The kanban process is a process that all sections within the production department use so, sealant, pre-assembly and the assembly line. In Chapter 5 section 5.3, we revealed that ATAG does have the tools to use a kanban supplying system. Unfortunately, it was not used. In section 5.4 we described two options that divide components over three product categories. To recall, the product categories are fast pick, kanban and order delivery. Which components become part of the kanban process is answered below. The next part is about when and by who the supplying of kanban components takes place. Now that is known what the kanban components are and who is going to pick and deliver them we look at the bins and briefly the layout of the warehouse.

## What are kanban components?

In consultation with the production leader, production engineer, R&D manager and the process holder of logistics, we came to an agreement to use option 2 (described in section 5.4). That means that screws, labels and stickers are automatically part of fast pick.

We also agreed that if a component fits in 70% of the hob types, than the component becomes kanban and gets a fixed position at the production department. Originally we used 80% according to the Pareto principle so, this became 70%. There will be one exception in the 70% selection kanban. A component cannot become kanban if the component is sunken into the assembly line, recall Figure 5.19. The sunken components will become pick. To visualise the decision making above, see Figure 6.1 below. In Appendix 8 we included the list of fast pick and kanban items according to the above rules.



Figure 6-1 Decision scheme, fast pick, kanban and delivery order

## Supplying

As is described in section 5.4 an empty bin is a trigger to refill the bin. The intention is to collect the empty kanban bins once a day at a fixed time. Therefore it needs to be calculated how many bins are required for a certain component. Also experience can be used to find out if the amount of bins per component is correct. For the interested reader, in appendix 8 is the amount of required bins and bin sizes added. We choose the bin size depending on the amount of components that fits in a box and the using frequency.

Who fills up the kanban boxes depends on the component. Not all the components are 'raw' materials. Some of the components are subassemblies made by the pre-assembly department. Some subassemblies will become part of kanban too. This means that subassembly kanban bins needs to be made and filled by the pre-assembly department. The 'raw' component kanban bins are going to be filled by the logistics employees.

The empty kanban bins will be picked up and scanned. With the new scanner, described in Chapter 3, we can add a menu in which the logistics employee can create a new kanban picking list. After scanning all empty component bins, the scanner calculates the warehouse locations of the components and find the shortest walking trail.

## The bins

In the previous section was revealed that we have two departments collecting the kanban bins, the logistics and the pre-assembly department. Therefore it is better to visualise with bin colours who is responsible for which bin type. There are in total three bin colours:

- The colour of kanban bins that needs to be filled by the logistics employee is orange.
- The bins that the pre-assembly department has to refill are coloured <u>blue</u>.
- The other bins used for regular order delivery are grey.

We are not going to purchase new bins in the right colour, because the coloured bins were not deliverable in the required sizes. We found out that a lot of grey bins are not used. These bins can be either dyed or stickered in a different colour. Ordering new stickers is easier than dying the bins in opinion of the company and the writers. Figure 6.2 shows an example of what the grey bin will look like after an orange sticker is added. All sides will receive a plain sticker in the middle so, without the lettering.



Figure 6-2 Example orange coloured bin

The kanban boxes will require a label. The label will consist of:

- The product number + barcode
- The amount of a component that needs to be put into the box for it to be filled completely
- The fixed location at the production department
  - For example, station 1 shelve B place 1 will result in the code: St1-B1
- Optional: If possible the location were to find the product in the warehouse. If the kanban components lay at a fixed location in the warehouse this would be an option.

## Warehouse and kanban

Using kanban also influences the lay-out of the warehouse. The kanban components are often picked and therefore require a floor location. It would be effective if the kanban components lay within the same aisle. Meaning that these components get a fixed location range.

Now that we know the common kanban process at the production department, we look at the individual sections, starting with the assembly line.

## 6.2 Assembly line picking, shipping and delivery method.

In the previous section is the kanban method introduced and will therefore not be included in this section. In this section we will look at the picking, shipping and delivery method of components that require an order delivery approach. In section 6.2.1 we provide five options for picking and shipping bins and in section 6.2.2 we give 3 options how the bins can be delivered. The last section 6.2.3 gives specific options in handling pallets in picking, shipping and delivery.

## 6.2.1 Assembly line picking and shipping options

We give five options on how ATAG could pick and ship components that require an order delivery procedure. In this section we focus on order delivery products that are going to be transported in bins so, without any pallets. The pallet picking, shipping and delivery method options are described in section 6.2.3.

The five <u>picking and shipping</u> options are based on the improvements cycles, recall section 5.5. Below the options are described with the improvement theories involved.

- Option 1: Current situation
- Option 2: The current situation with some adjustments so that the bottleneck becomes less disturbed. The TOC theory is applied.
- Option 3: Milk run with sort-while-pick method. The BPR theory is applied.
- Option 4: A variant of option 3
- Option 5: Milk run with pick-and-sort method. The BPR theory is applied.

## **Option 1: Current situation**

Keeping the current method. The current method is described in section 5.3. In the current method the employees setup their own station. If the production employee is short in components, than he calls the production leader. The production leader will make sure that the components are brought in.

## Advantage:

- No changing policy is required.
- High flexibility: During setup can be decided which batch to produce next.

Disadvantages:

- Disturbers at the production line. The production employees will walk away to find the production leader.

- High setup time: Production time will be wasted by gathering components by the production employees.

## Option 2: Current situation + bottleneck adjustment

Keeping the current method with the exception that no interference of the production leader is required if there is a shortage of components. Each production line member does have a scanning system at their station. With some software adjustments the assembly line employees will be able to scan the barcode of a component. The employee puts in a certain amount of a components type. The logistics employee will receive a picking order on the warehouse scanner and is going to get it.

## Advantage:

- The production employees will not have to leave their stations asking for the components.

## Disadvantages:

- This is a form of direct delivery, which means that it is not the most efficient way. In theory it is possible that the logistics employee receives multiple orders of one station. All the orders will be separately being delivered.
- There is only one scanner available so there is a possibility that the production employee has to wait for the components, with the risk that the assembly stands still.
- The logistics employee has to stay put all day waiting for an order to come. Or drop immediately other work activities.

## Option 3: Milk run with sort-while-pick method

In this option we will use milk runs per production order, meaning one batch of a certain hob type. The milk runs are explained in section 5.2.1. The logistics employee collects all required components for one batch onto a trolley. Possible trolleys are described in section 5.2.2. Each section on the trolley represents a single station at the production line.

## Advantage:

- The components are immediately sorted.
- Less disturbers at production. The production department receives the right amount of components. A shortage of components will less occur.

## Disadvantage:

- There are multiple orders a day. Collecting each order separately results into a longer travelling distance for the logistics employee. With the increased travelling distance, the complete picking time will also be longer.
- Less flexible than option 1 and 2. The production line can only choose to produce a certain batch that is already picked by the logistics.

## Option 4: A variant of option 3

In this option we use basically option 3, but with slight adjustments. We use milk runs for each order but some order are family. Not just family but almost identical twins. The production leader produces these identical twins already after another. In the production department these twins have their own production number but in the warehouse we can pick these twins in one picking list. We will use one picking order so, one milk run and one delivery milk run. Advantage:

- This will be the quickest method of all options.
- Less disturbers at production. The production department receives the right amount of components. A shortage of components will less occur.

## Disadvantage:

- We will require still multiple milk runs due to de different production orders a day.
- Less flexible: similar to option 3.

## Option 5: Milk run with pick-and-sort method

This methods makes use of collecting multiple orders in one milk run. After all the components are picked, the components needs to be sorted over the different order trolleys. The sorting and temporary storage can be done on an cross docking place described in section 5.2.1. The amount of orders in the milk run could be the total number of orders produced on one day.

Advantages:

- The travel distance and the picking time will be reduced compared to option 3.
- At the cross docking the sorting takes place. Components have to be recounted and loaded on to the right trolley. If there is a picking error it will come through at the cross docking.
- Less disturbers at production. The production department receives the right amount of components. A shortage of components will less occur.

Disadvantage:

- At the end is a period of sorting. Meaning an extra time window. The total time spending on the picking and sorting could be as much as the extra travelling time in option 3.
- Less flexible: similar to option 3.

The options just described are all suitable for ATAG at the moment. We also have explored if it was possible to use multiple trolleys attached to each other, creating a train. Each trolley represents one production order. Due to the layout of the warehouse you are not able to use a train. A train will be too large to make a turn and therefore this options is not suitable for ATAG.

All the collected components require a delivery. This will be introduced in the next section.

## 6.2.2 Assembly line delivery method

In this section we look at how the delivery takes place of the ordered bins and who delivers them. We have provided 2 options on the how method. In this two options the logistics employee make the delivery. In the 3th option the delivery is made by the production employee. All option have their own advantages and disadvantages.

## Option 1: Handing the components over to the production line employee

The logistics employee will deliver the products just in time. Representing the components to the station employee. The station employee will place the components into position. Advantage:

The production employee is able to place the component onto a shelve that works best for him. The setup time reduces compared to the current situation.

Disadvantage:

- Planning is more complex. The logistics employee has to be there in time but what is the right time?
- -The setup time is not reduced to almost zero.

## Option 2: Deliver components on the station shelves

The warehouse employee places the component boxes right into the shelves behind the current order see Figure 6.3. In the Figure are the green bins the current order and the blew bins the new. If the production employee is done with the green order the boxes are rolled back at the retour shelve. The components have fixed locations on the stations.

## Advantage:

- Planning less complex than option 1.
- The production employees does not have to place the boxes onto the shelves, this will reduce the setup time to almost zero.

## Disadvantage:

Attention of the logistics employee is required if there is enough space to fill up the shelves. If the logistics employee is picking in the Figure 6-3 Option 2 warehouse there is no view on the production line.

## Option 3: Let the production leader deliver

The production leader delivers the products at the assembly line. It could be delivered in to the shelve or just in time handed over to the station employee.

## Advantage:

The production leader has to keep an eye on the production line. The production leader sees sooner that new components can be placed on the shelves.

Disadvantage:

The production leader is not always there. The production leader is attending meetings and has to make the production planning.

## 6.2.3 Picking, shipping and deliver a pallet

A pallet require a different picking shipping and delivery approach than a bin. Bins can be picked using milk runs but pallets requires a direct delivery. Station 1, 7(packing) and 8(induction) receives complete pallets. The pallets that are part of an order delivery are in the picking list of the logistics



employees. What to do with those pallets because a pallet will not fit on a trolley? Below we give two options.

## Option 1: Direct delivery from warehouse to station

The pallet is picked and directly delivered on a just in time base, picking the pallets 15 minutes before they are required at the assembly line. Meaning that it must be an option in the warehouse-scanner-picking-list that it is possible to come back later to collect the component. Or if possible use direct shipping to the production line station and place the pallet next to the current pallet.

## Advantage

- No temporary storage space is required in the warehouse. It can immediately be picked and delivered. This is also lean, recall section 5.5. The logistics employee is not shipping the components twice.

## Disadvantage

- Planning is complex: When is 15 minutes before the required time? Not knowing the cycle time is one reason why it is complex.
- There is a possibility that the logistics employee is busy with other tasks. Does the employee has to drop all his work to deliver the pallets?

## Option 2: Temporally storage at cross docking

The pallet is picked and temporally stocked at the crossdocking. Depending on the production order, the cross docking needs at least one pallet storage place per order. In the worst case four pallet places are required; one pallet for station 1, two pallets for station 8, and one for station 7.

#### Advantage

- If the pallets stands on the cross docking area than the production leader is able to pick them end deliver them when required. The logistics employee is able to work structured and is not disturbed constantly.

## Disadvantage

- A cross docking area needs to be created.
- We are exactly shipping twice that is part of time waste in the lean theory.

This were all options for picking, shipping and delivery at the assembly line. The next department is the sealant section. The option for this section will differ from the assembly line due to the unique delivery moment of components.

## 6.3 Sealant picking, shipping and delivery options

The sealant section of the production has some complications. Recalling to section 2.4, the sealant section assembles the tops of the hobs so, they create a subassembly.

To create the subassembly 2 or 3 phases are required depending on the hob type. Each phase requires a drying time of 8 hours. The drying time makes planning of picking and delivery more complex, because it means that the sealant department has to start making the assemblies 2 or 3 days before the tops are required at the assembly line.

Below we give four option. We have taken into account the improvement cycle described in section 5.5 and the 5S theory described in section 5.2.3.

- Option 1: Current situation
- Option 2: Current situation + bottleneck adjustments (TOC)

- Option 3: Deliver X days in advance depending on the amount of phases (BPR)
- Option 4: An example of a new planning and control system (BPR & 5S)

## Option 1: Current situation

In the current situation, all the sealant components can be found in their department with exception of the glass and stainless steel panels. If require new components are required, like the panels the sealant employee will ask the production leader. The production leader asks the logistics employees to bring them or he brings the component himself. Glass panels will be brought with a forklift. Depending on the amount of decorative profiles a trolley can be used.

## Advantage:

- No changing policy is required.
- Flexible most of the components are at the sealant department.

## Disadvantages:

- Disturbers: the sealant employees will walk away to find the production leader. A lot of production time will be wasted.
- The logistics employee has to interrupt other activities if the production leader asks them to collect the required components.

## Option 2: Current situation + bottleneck adjustments

The sealant department contains an unused scanner. The scanner could be reprogrammed so that the sealant employee is able to scan barcodes of the required products. If components are scanned 10 minutes in advance, then the logistics employee is able to deliver them on time. Also, the retour spot can be scanned so that that the logistics employee knows that it is required to pick something up.

Advantages:

- The production employees will not leave their stations asking for the components.
- There will be less storage space required at the sealant department than in option 1.

Disadvantages:

- In theory it is possible that the logistics employee receives multiple orders in the scanner. There is only one scanner available so there is possibility that the sealant department has to wait for the components. Especially if multiple pallets are required there will be a long waiting time because it is part of direct delivery.
- The logistics employee has to stay put all day waiting for an order to come.

## Option 3: Deliver X days in advance depending on the amount of phases

As is explained in the introduction of this section the sealing process consist of maximum three phases. Each phase has to dry eight hours meaning three days of production could be required to finish the subassembly. If the production date at the assembly line is known than all the required components could be delivered three days in advance.

## Advantages:

- Easy to plan and control
- One moment of picking and delivery for this department instead of frequently retuning.

## Disadvantages:

- The production planning needs to be spot on. The production line may not worker harder than planned because otherwise the subassemblies will not be done. This results in that the production department becomes less flexible.

- A larger storage place is required. In conflict with the 5s theory, recall section 5.2.3.

## Option 4: An example of a new planning and control system

Within this option, we show a new manner of planning and control. We redesign the supplying system and also the layout of the sealant department. The researchers are inspired by the *planning board system* used by ATAG's mother company in Gorenje. The planning board system will work as the planning and control system for the sealant department and the logistics employee who is responsible to supply the sealant department.

In the literature, different kinds of planning boards systems are described. Nevertheless, we are not interested in the literature but only in the sealant department working order. The phases described in the introduction and in section 2.4 represent the working order. The working order will be the guideline to develop a suitable planning board for ATAG. Below we introduce an example of the planning board.

After the planning board is introduced we describe in more detail the planning board cards. The cards give information about the components that are required to assemble a top type. We describe how this card could look.

We also taken into account the 5S theory. In the current situation, see option 1 before, most of the components were stored at the sealant department. In this new method, we clean up. Only the required components may stay. The required components will be delivered by logistics on a fixed delivery location.

After introducing this new method we give a brief summary of option 4 and focus on the pros and cons of the system.

## Planning board system

To recall the introduction, the sealant department has a working order containing different phases. In the Table 6.1 below, is a brief description of the phases. Phase 2 is always the last phase of every hob type. Phase 1a and 1b are exchangeable meaning, that it is okay to do phase 1b before 1a. It makes the sealant department flexible. The sealant employee can choose to do phase 1b first because that mold or workstation is available.

In the third column of table 6.1 are the required components, that are necessary for each phase. Pay special attention to the interchanging phases because if phase 1a is assembled it forms the base of phase 1b. Meaning that no new panels are required. Pay also special attention to the <u>boxes</u> and <u>pallets</u>. Phase 1a and 1b will require a pallet delivery. This is important to know later on for the fixed delivery location.

Phases	Description	Required components
1a	Only required for stainless steel(SST) tops	A <u>pallet</u> with panels (glass, SST) <b>OR</b>
	and combination or induction hob tops.	subassembly 1b
	The task is adding reinforcement.	
		If SST than a <u>pallet</u> with reinforcement.
		If combination/ induction hob boxes with
		reinforcement
1b	Required for all hob tops except induction	A <u>pallet</u> with panels (glass, SST) <b>OR</b>
	tops.	subassembly 1a
	The task is adding burner plates to the	And <u>boxes</u> with burner plates
	panels.	

2	Required for all hob tops	Boxes with decoration profiles
	Task adding decoration profiles.	

Table 6-1 Sealant phases

Our goal is to visualise the flexibility of the work phases into the planning board. We came up with the following suggestion see Figure 6.4 below.



Figure 6-4 Planning board sealant section

The planning board is divided into two sections. A planning part and a received part. The planning part needs to be prepared by the production or sealant leader once a day on a fixed time. Preparing means placing hob type cards on the board in order of assembling it. The card provides information on the hob type and the required components to make the subassembly. Later on, we give an example of how the card could look like.

The received part of the planning board, is filled in by the logistics employee. The logistics employee looks into the planning and sees what the sealant department is willing to produce. According to Figure 6.24, a certain hob type in phase 1b does have the highest priority. The logistics employee picks the card from the board and starts collecting the required items that are on the card. After collecting, the logistics employee brings all the items to the sealant fixed delivery location. The card is placed in the table received in the same phase column as shown in Figure 6.4.

A hard working sealant employee just finished a subassembly and walks to the planning board to see which new assembly he is able to make. He looks at the table received and sees a hob type that he is able to make. If this subassembly is ready, then it needs to dry for 8 hours. Meaning that tomorrow phase 2 can be added to phase 1b. The sealant employee places the card on the planning board in column phase 2 at the end of the day. In the morning, the logistics employee will see the required components for phase 2 and will pick them.

## **Delivery places**

The attentive reader has probably noticed that phase 1a and 1b columns are separated from phase 2 in Figure 6.4. This has to do with the available delivery places at the sealant department. Phase 2 only requires box deliveries according to table 6.1 above. The sealant station that requires these components does have enough storage space to store all the required components of one production day. Meaning that the logistics employee can do a milk run in the morning to collect all the cards in planning table of phase 2 column and pick all components at once.

Phase 1a and 1b requires a different supplying approach because they need pallets with panels or reinforce plates. There is a change that there are not enough pallet places available for an entire production day. It depends on the batch size. The smaller the batch sizes the more production orders, resulting into more pallet places. There are 3 delivery pallet places and one retour spot available, see Figure 6.5 below. The empty pallet place on the delivery spot is the trigger for the logistics employee to fill it up. The empty place will be filled with the production order of the highest priority. The highest priority is in the case of Figure 6.4 is the cards standing in row 1 phase 1b.



*Figure 6-5 Delivery location for phase 1a and 1b* 

## **Information card**

We designed an information card for the planning board. There are 55 hob types. For each hob type a card should be made if ATAG chooses to use this method. The information card provides the components that are required to make the subassembly. An example of a card is shown below in Figure 6.6.

Hob type: HG9571 Quantity: 40					
SAP	Beschrijving	Quantity	Pick		
Phase 1b					
24741	GLASSPANEL HG9571MB	1	×		
414444	BURNER FIXING PLATE MAGNA NO G-BLANK	2	x	- <sub>00000</sub> Q Q	
414446	BURNER FIXING PLATE MAGNA SU G-BLANK	1	x		
414454	BURNER FIXING PLATE MAGNA ST G-BLANK	1	×		
428654	BURNER FIXING PLATE WOK BLANK	1	×		
Phase 2					
10725	DECOR. PROPFLE AIR-INLET 898,4	1			
335311	DECORATIVE ALU PROFILE L522 INOX EMMI	2	Kanban		
335325	RIM FRT/BCK 898,4 BK EMMI	1			

Figure 6-6 Information card

The card is divided into the different sealant phases. The sealant department could ask for the components required for one phase by placing a mark in the pick column. If the production day contains ten production hours, then it is possible that the sealant department asks for the components of two phases, but this will be rare due to the eight hours drying time. Written above in

the heading is the quantity of subassemblies the sealant department likes to make. The logistics employee will pick the cart from the production board and starts picking 40 pieces of every component except for the component 414444. This component requires 2\* 40= 80 pieces in this case. In Figure 6.6 is shown that in phase, component 335311 cannot be picked. It is part of kanban and it is therefore already located in the sealant department. In summary:

- Components required for phase 1a and 1b will be picked during the day. The trigger is an empty pallets place on the delivery location. The delivery places are checked frequently to see if they are empty.
- All the components for phase 2 will be picked once a day if there is enough storage space to store it.
- Some components are part of the kanban and are delivered once a day.
- The production board will be part of the planning and control system. All received components can be made into a subassembly the same day.
- A finished phase leads to new required components (picking order). Or the product is finished and is removed from the board.

## Advantages:

- The amount of stock at the sealant department will be reduced significantly.
- It will be more clear for the production leader where the sealants are working on.
- Even when the planning board is prepared, changes can still b made during the day as long as the information card is not picked yet.

## Disadvantages:

- This method requires a new production layout and a new planning method.
- The head sealer will receive an extra task (the same job can also be done by the production leader). Resulting into less production time.

## 6.4 Pre-assembly department

The last department we need to look at is the pre-assembly department. The planning and control process of the pre-assembly station looks a lot like the sealant department. Both departments make subassemblies, meaning that the same options for the sealant department could also be used for this department.

## Option 1: the current situation

The current situation is similar to the current sealant situation. All components are stored around the pre-assembly stations. If the employee requires components, they search for the production leader to ask for components.

## Advantage:

- They always have components to make an subassembly.

## Disadvantage:

- A lot of floor pick will be required and therefore storage space.
- Searching for components will still be a problem (production disturber)
- There is still a possibility that they run out of components and have to find the production leader for the new materials.
## **Option 2: Planning board**

A similar planning board is used as in option 4 of the sealant department. This method could work well for the pre-assembly station that puts together the installation and instructional materials. This work is done in a fixed order.

If this method also works for the other pre-assembly station is unsure. It requires further research, like an experiment to see if this could work. Unfortunately, by leak of time it cannot be part of this research anymore.

The advantage and disadvantage are similar to option 4 of the sealant department see page 50. With the addition of one disadvantage:

- It is uncertain if it will work for both the pre-assembly stations.

#### Option 3: Deliver the required components a week in advance.

The components needs to be delivered a week in advantage, because one of the pre-assembly employees works only 3 days a week. Within this three days the employee is able to create most of the subassemblies for the upcoming week.

The pre-assembly station staffed by another employee works 5 days a week.

Advantages:

- Easy to plan and control
- One moment of picking and delivery for this department instead of frequently retuning.

Disadvantages:

- The production planning needs to be spot on. The assembly line may not worker harder than planned because otherwise the subassemblies will not be done. This makes the production department less flexible.
- A large storage place is required because the pre-assembly stations requires lots of different components.

All options are given for each of the production department sections. Now it is time that ATAG makes a decision on how to proceed. Are they willing to choose one of the options and implement them? Or are they willing to put more research in one of the options? The next section provides some tips that could help making the decision.

## 6.5 Tips for decision making

In this section we give some tips to help decision making. Which trade-off can be made is explained in the first part(6.5.1). The second part is about experimenting. Most of the given options are not based on numbers. An experiment will provide some number and those are easier to compare. For this research is one experiment done, see section 6.5.2.

## 6.6.1 Trade-offs between options

Making a choice on which method matches the needs and wants of the company best, is based on trade-offs. The trade-offs that needs be taking into account are:

- Flexibility vs. inflexible
- Duration for shipping vs. reduction setup time
- Disturbens
  - o Delivery is delayed
  - o The amount of replacement orders

# 6.6.2 Make use of experiments

At the moment, we make the decisions on our needs by using assumptions. For example, we expect that 'an option 2' will take more time than option 3. We could make this trade-off with more exact numbers by doing an experiment. We could measure the influence of the method:

- How much is the setup time reduced by using method X?
- Are there less disturbers during the production order?

For this research, we were able to do one experiment. Below we reveal the preparations, results and discussion for this experiment. We choose to go with a picking, shipping and delivery method suitable for the production line, because their output is too low. We picked the options from what we thought had the longest picking and delivery duration. The options we experiment with are:

- Option 3 of the picking and shipping method: milk run with sort-while-picking method for one production order.
- Delivery option 1: Handing the components over to the production line employee
- Pallet picking, shipping, and delivery option 2: temporary storage of pallets at cross docking

#### Preparations

The required components that need to be delivered (not kanban or floor pick items) are found by reading the work instructions of the IGT hob.

Knowing the components, we asked the warehouse employee what the bin locations are. The complete picking list is in the Appendix 9. The warehouse employee needed 20 minutes to find out the locations.

A trolley is lent from the service warehouse department and is filled with empty boxes of different sizes. Different sizes because it is unknown which type of boxes are required by the component amount and size. The components that need to be delivered at station 8 need to be delivered in ESD protected box, meaning conducting boxes.

Box rules: each component need to be placed into the smallest box they fit in. This will spare space on the shelve at the production line. This result into more boxes being placed on the shelves in front of the production line instead of on the ground or behind the back of the employee.

All the products that are going to be delivered need to be picked from P001. In the future, all the order delivery products need to be stored in the warehouse.

The logistics employee has found out that some items were only located at P002. That results in that we have to search those components due to a non-fixed location.

In this experiment we intentionally make mistakes. We deliver one component shorted and one component too many. This simulates picking/ counting mistakes.

Making these mistakes will require a solution after or during the setup moment.

#### Results

Picking all components required for the IGT costed 2 hours and 22 minutes.

The delivery took place, the setup time per station:

Station 1+2: Helping the station employee clear the shelves and handing over the new components (1 minute), switching tools (30 seconds), picking up the subassemblies at the pre-assembly department (1 minute), the employee checks if all the right component are delivered (30seconds). Total of 3 minutes.

Station 3: in total 2 minutes.

Station 5: no deliveries.

Station 8: 5 minutes. Clearing the current order first and switching to the new one.

Station7: no deliveries. All required pallets were already in to place.

Comparing the setup time results with table 5-1 we see that the setup time of station 1, 2 and 3 is reduced with more than 70%. The average setup time of station 8 is not known.

The intentional mistakes were discovered during the production. An emergency delivery took place for the component that was shorted. The component was picked and not booked from P001 to the production department. Not booked, because the right amount is booked to P002 except the right amount was not picked. The component that has a surplus, was brought back to the warehouse without booking.

#### Discussion

The picking went quite slow. The forklift is often used, meaning that most of the components were not standing on the ground but two, three or even four shelves high. The wiring was easily picked. They were standing on reachable shelves. The only problem was counting them. They were tied up to each other.

One delivery mistake is made. One component type needed to go to the pre-assembly station instead of the assembly line. The component needed an addition before it became useful for the production line station. This subassembly turned out not to be made by the pre-assembly stations, because they did not receive a production order. A lucky mistake was that we picked the component in our experiment, so the pre-assembly station rapidly produced the subassembly.

The delivery of station 8 was quite confusing. All the required pallets were already standing there. Only the man was short in wiring. Our order contained the exact number of components. Chosen was to setup the station because there was no setup time known of station 8. The ordinary thing is that there were four pallets standing with components before the setup. After our experiment, the delivered station only required two 2 pallet places. Meaning there were 2 pallets standing there that could be delivered by box instead of per pallet.

#### Replacement order of a rejected component

There was one rejected component. The production leader called logistics for a replacement order. The new component was picked, booked and brought to the station within 5 minutes by the logistics employee.

# 6.6 Summary with decision tables

In the first section of this chapter we informed you about the kanban method. To find out which components are part of the kanban method, we have create a scheme shown in Figure 6.1. The scheme divides all components into the product categories: kanban, fast pick and delivery order. We design an kanban box with label. The logistics employee fills the orange boxes and the pre-assembly department fills the blue boxes once a day on a fixed time. The software of the warehouse scanner needs alterations so that empty kanban boxes can be scanned and is add to the scanners picking list. Furthermore, we advise to redesign the warehouse layout. This because, kanban items are picked every day so it is effective if kanban items are stored on floor level.

The next section looks into logistics around the assembly line. First we described the picking and shipping methods and afterwards the delivery method, see section 6.2.1 and 6.2.2. Tables 6-2 and 6-3 below are decision tables. These tables summaries the options and their pros and cons. We look at the following 5 factors:

• Flexibility: The ability to change the production order at the last moment. Instead of producing a batch of hob type X we interchange it with hob type B at the last moment. Wherein ++ is flexible and - - is inflexible.

- Reduce setup time: As a reminder in the current situation is the picking and shipping done by the production employees themselves. If a not-production employee picks the components than the setup time reduces. Wherein ++ is maximum setup time reduction and - in reduction in setup time.
- Picking & shipping time: The quicker the products are gathered the better. Wherein ++ is short gather time and - long gather time.
- Planning complexity: an easy system that keeps track on were all the components are and what needs to be collected at a certain moment. Wherein ++ complex and - not complex.
- Chance on disturbers: This is the chance on disturbers at the production department. Disturbers are running out of components and having no spare parts that covers a defect component at assembly line during production. Wherein ++ high risk on disturbers and - - is low risk on disturbers.
- Interrupts the logistics process: The change that the logistic employee has to drop all activities so that a delivery can be made on request. Wherein ++ is change on interruptions and - is low change on interruptions.

Notice that that the flexibility of option 3 till 4 is less flexible than the current situation. That the assembly line is less flexible is not a problem. The planning of the assembly line depends on what the pre-assembly and the sealant department has made. This results in that we know today what the logistics have to pick so we could produce hobs in the morning at the assembly line.

Assembly line picking and shipping method options	Flexibility	Reduce setup time	Picking & shipping time	Planning complexity	Chance of disturbers at production
Option 1:	++		++	-	++
Current situation					
Option 2:	++		+	-	+
Current situation +					
bottleneck adjustment					
Option 3:	-/+	++	-/+	+	-
Milk run with sort-while-					
pick method					
Option 4:	-/+	++	+	+	-
A variant of option 3					
Option 5:	-/+	++	-/+	++	-
Milk run with pick-and-					
sort method					

Table 6-2 Decision table, assembly line picking and shipping methods

Assembly line	Reduce setup time	Planning complexity	Interrupts the logistics
Delivery method			process
Option 1:	+	+	+
Handing over			
components by logistic			
Option 2:	++	-/+	-
Deliver on the shelves			
Option 3:	+	-/+	
Production leader			
delivers			

Table 6-3 Decision table, assembly line delivery methods

The next decision table is about direct delivery, see table 6-4. A pallet represents one component that is required at production. The pallets cannot be part of a milk run because the forklift can only

move one pallet at the time. Therefore pallets require a direct delivery method. There are two options given in section 6.2.3. The methods look at:

- Planning complexity;
- Interrupts the logistics process;
- Lean: Lean means no (time, transportation) waste. Wherein ++ is no waste and - waste.

Pallet picking- Delivery method	Planning complexity	Lean	Interrupts the logistics process
Option 1:	+	++	+
Direct delivery from			
warehouse to station			
Option 2:	-	-	-/+
Temporally storage at			
cross docking			

Table 6-4 Decision table, pallet delivery

In section 6.3 and 6.4 are the multiple methods for picking, shipping and delivery described for the sealant and the pre-assembly department. Below are the corresponding decision Tables 6-5 and 6-6. The table compares the following factors:

- Flexibility;
- 5S: all components and tools are sorted in the production area. All the components and tool that are not used are removed from the production department. Wherein ++ is 5S is applied and - is not applied.
- Picking and delivery time;
- Planning complexity;
- Chance of disturbers at production;
- Searching for components.

Sealant department Picking- shipping-	Flexibility	5s	Picking & delivery	Planning complexity	Chance of disturbers at
delivery method options			time		production
Option 1:	+		-/+	-	++
Current situation					
Option 2:	+		-/+	-	+
Current situation +					
bottleneck adjustment					
Option 3:	-/+	-	-/+	-/+	
Deliver X days in advance					
depending on the					
amount of phases					
Option 4:	++	++	+	++	
An example of a new					
planning and control					
system					

Table 6-5 Decision table, sealant department picking, shipping and delivery methods

Pre-assembly department Picking- shipping- delivery method options	Flexibility	5s	Picking & delivery time	Planning complexity	Chance of disturbers at production
Option 1:	++		-/+	-	++
Current situation					

Option 2:	++	++	+	++	
Planning board					
Option 3:	-/+	-	-/+	-/+	+
Deliver a week in					
advance					

Table 6-6 Decision table, pre-assembly department picking, shipping and delivery methods

Section 6.5 gives information about trade-offs and experiments. ATAG could choose factors that are the most important to them using the decision tables above. Furthermore we have done one experiment. We picked components for the assembly line according to the picking and shipping method option 3, milk run with sort-while-pick method. Option 2, temporally storage at cross docking for the pallets. To deliver all items is option we used option one. The logistics delivers the components and hands them over to the production employee. The production employee places the bins on the preferred shelve.

We spend 2 hours and 22 minutes to pick and ship all components for the IGT hob. The time required to deliver them was very brief. The logistics helped to setup the production line stations. The maximum setup time is 5 minutes and is at induction station. The other stations have a setup of 2 or 3 minutes. Comparing the results with Table 5-1 we see that the setup time of station 1, 2 and 3 is reduced with more than 70%. The average setup time of station 8 is not known.

Now we explored all supplying options and how we can choose out all of these options, let us have a look at the unknown cycle time of all 55 hob types. We have to discover the throughput times so that we could make a better production planning. With the new production planning the logistics employee have a better indication when new components are required at the production department.

# Chapter 7: What is the capacity of the production department?

This chapter provides answers on research question 3 namely, *What is the capacity of the production department?* Recalling the problem it is uncertain what the current capacity is. What is known is that the throughput times in SAP are a bad assumption. In the first section of this chapter we look at which products are going to be measured to discover the throughput, see section 7.1. The second part, section 7.2, is about how the throughput time can be measured. Section 7.3 gives a solution if the capacity is too low.

# 7.1 Which products are going to be measured to find out the throughput times?

To recall to a sub question 'Which setup times to measure?' in section 5.1.1 was mentioned that hob types can be family. ATAG makes 55 hob types. We divide the hob types over different hob groups. Listed below are three tables organized by hob group type. In Table 7-1 are gas hob groups listed. Table 7-2 is the combination group type so, hobs that contain gas and induction. The last table, Table 7-3, are induction hob groups listed. These table are provided by ATAG.

The colours within the table correspond to the families. In total there are 11 families. Even when the group code is different.

The group code gives the following details.

- Each code starts with 0. It contains no information.
- The first letter in the code is either an S or an A. It codes for the name of the brand. ATAG Duiven produces hobs under the name of ATAG (A) or ASCO (S)
- After the first letter comes a number. The number tells something about the amount of B's, I's and W's that are positioned behind the number. The letters represents: burner plates(B) or induction plates(I) or the amount of woks(W). The woks are the fusion volcanos.

Gas hob	Amount of hob types in the	Total Orders	
Groups	group	History	Forecast
0A1W	2	149	158
OS1W	2	216	383
0A2B	2	87	82
OS2B	2	169	300
OS4B	2	88	24
OS4B	2	88	24
0A1W3B	6	895	1092
OS1W3B	4	276	541
0A1W4B	5	4375	4807
OS1W4B	3	280	612
0A1W4BT	2	644	1137
0S2W2BT	2	456	420
0A2W2BT	2	144	142

- The letter T is stands for containing a timer.

Table 7-1 Gas hob groups 2016

Combination	Amount of hob types in the	Total Orders	Forecast
hob groups	group	History	
0A1IW	3	36	16
0A1W4I	6	1095	1375
0A1W4IT	2	196	382

Table 7-2 Combination hob groups 2016

Induction hob	Amount of hob types in the	Total Orders	Forecast
groups	group	History	
0A2I	3	326	575
0A5I	3	445	720

Table 7-3 Induction hob groups 2016

#### **Hypothesis**

The groups in the table are not only sorted on families but are also sorted on the hypothetic throughput times. The smallest hobs will have a lower throughput time than the bigger hobs. The smallest hobs are standing on tops in the tables.

#### Which hop types are needed to be measured?

All hob types are going to be measured by the diary method described below. The results of each hob type will be compared to see if there are outliers. Than the result will be compared to the other hob types in the family group. If it turned out that the families are well defined that the average of the family throughput times is taken and is used as input into SAP.

# 7.2 How can the throughput time be measured?

The throughput time from raw material to finished product depends on the raw material. The raw material can start at the sealant, pre-assembly or assembly line department. ATAG is most interested in the throughput time of the assembly line because this time is required to fill into SAP.

To determine what throughput time is of the assembly line, a diary is created. The diary is first updated by the production leader. The problem was that the production leader is not always at the production line. The diary is changed so that the first and the last station employees fills in the start and the end time

Although ATAG is primarily interested in the throughput of the assembly line, we decided that the sealant department and the pre-assembly stations also keep a diary. This because the throughput time for each subassembly is unknown. Knowing how much time is required to make the subassemblies provides insight into their capacity.

For the sealant department is the throughput and the cycle time required. Within the throughput time is also the drying time. The cycle time tells only something about the time that is required to complete a process. In this case the cycle time is the time required to complete phase 1a, 1b and 2. The phases are described in section 2.4. The diaries can be found in the Appendix 10.

#### Difficulty

There is one difficulty. ATAG is able to produce two hob types at the same time at the production line. For example, station 8 is producing induction hobs while the other stations are making gas hobs. Station 8 is in this case a side line that comes together with the main line at station 5, see figure 2.2. During observation is seen that the decision making is not always right at the assembly line. As soon as a hob appears on the side line, it is immediately squeezed onto the main line. This result in that the main line gets stuck. The employees standing on station 2 and 3 can no longer proceed until station 5,6 and 7 are done with the multiple induction hobs on the line. This is why the throughput of

the gas hobs is higher than thought, due to disturbers caused by the side line. If we fix the decision making first the disturbers will become less and therefore the throughput time is lower. The throughput time in this new situation needs to be measured.

## Recommendation on handling the difficulty

The side line only consist of one station and therefore the side line does not have priority over the main line. The main line needs to flow, meaning that extra hob coming from the side line cannot squeezed on to the main line if someone wants to. Of course can two hob types be made at the same time. It only need rules:

- Only 1 induction hob can enter the main line. If the induction hob is off the main line a new induction hob may squeezed onto it.
- 5 employees on the main line.
- The production line needs to extent a bit. Only 30 centimetre is enough to let one extra hob onto the main lain. There is still a form of disturbers. The packing line needs to work a little bit harder or need some assistance from the employee that does the leak test at station 4 and cleans the tops. The work pressure will not be that high the employee at the packing line starts sweating.

## Hypothesis

The groups in the table are not only sorted on families but are also sorted on the hypothetic throughput times. The smallest hobs will have a lower throughput time than the bigger hobs. The smallest hobs are standing on tops in the tables.

#### Addition on the measurement method

All hob types are going to be measured by the diary method described above. The results of each hob type will be compared to see if there are outliers. Than the result will be compared to the other hob types in the family group. If it turned out that the families are well defined that the average of the family throughput times is taken and is used as input into SAP.

# 7.3 What if the capacity turned out to be to low?

The capacity is not seen as problem in this research. This because the capacity is not known while writing this thesis. What is known is that the output is to low and there many causes for it. There are a few bottleneck depending on the hob types that are produced that day.

Looking again in Figure 1.2 in Chapter 1 we saw that the output is fluctuating and there is a backlog rising.

Recalling the findings:

"The forecast is promising for the upcoming year. ATAG expects a total of 12933 orders. The overview is shown in Appendix 1: products made in Duiven. The production target is 250 hobs per week. The production department normally work 8 hours a day, 5 days a week and 48 weeks a year. That means that the capacity should be 12000 hobs a year. It means that the forecast of next year is more than their capacity."

With the forecast + the backlog in week 48 makes a total 14257 pieces that needs to be produced in 2017. Below are two options given on how to reach the 14257 pieces.

# 7.3.1Transfer hob types

If the capacity is too low than it is possible to create an extra production line. Unfortunately, ATAG has no ambition to grow the number of production lines because it is cheaper to produce in Gorenje. We asked the CEO if ATAG would like to produce all the 55 hob types. In other words, is it possible to transfer a few hob types to the mother company in Gorenje? The answer is that all the hob types containing the fusion volcano needs to stay. Meaning that induction and gas hobs without the fusion

volcano can be transferred. See Appendix 1 + 2 to see the 12 hob types that are that can be transferred. If all 12 hob types could be transferred than the forecast will be lowered with 1115 product. Meaning that total forecast of 12933 minus transfer 1115 result into 11232. That would be under the target capacity of 12000. Staying below the target will provide some space to produce the backlog of 1200 pieces. If the backlog is gone it gives some room to grow and introduce the fusion volcano to other markets.

# 7.3.2 Backlog reducing method

Transferring products to Gorenje is not arranged by the morning. Meaning that if ATAG is not taken action the backlog will rise even more. That is not optional so we came up with an 11 hour production day to get rid of the backlog. This way of working starts on the 9<sup>th</sup> of January. The team is going to work in two shifts. They shifts do overlay each other. The production team is divided into two teams taken into account there employability. Some people have experience with all stations at the assembly line and some not. In Figure 7.1 below is an overview shown of the shifts. Working in two shifts will require one extra employee. Meaning that ATAG is going to search for a an extra employee.





So between 8:30 and 15:30 ATAG has 2 employees more than is necessary at the production line to produce normal gas hobs. It is possible to produce induction hobs at the induction station next to the normal production of gas hobs. That means that one of the extra employees could create induction hobs. There is one person left that has no task yet. This employee could do serval short tasks:

- Repairing hobs that did not make it through the leak test or final test.
- Cleaning the hobs tops. Cleaning glass panels and RVS panels after the sealing drying period.
- Helping the pre-assembly team. Due to extending the production time it is possible that the pre-assembly team is not able to create enough pre-assembled products.

Most imported is that the extra employees can cover illness during the production time of six hours. Nowadays when the team is a man short due to illness there is no one to fill up the empty production line stations. Resulting in no flow and production employees that are running around to cover the empty station.

The purple team contains out of two pre-assembly employees. It does not matter when they start working as long as they work 8 hours a day.

Chosen is to give the production team two options. One option is about their break time schedules and the other contains the rotating of the shift teams.

The employees may decide themselves about the working time between the breaks. Below are the options shown in Figure 7.2 and 7.3. The first is that they could have a break each two hours. The second options is that the lunch breaks are more moved to the afternoon because 10:45, options one, is quite early. The team chose to go with a break each two hours.



During the breaks of team green there are 4 employees at production line each break, with the exception of Tuesday then there are 5 at production line.

During the breaks of team blew there are only 3 employees working at the production line each day.



Figure 7-2 Break schedule option 1

#### Figure 7-3 Break schedule option 2

The second option the team is given is the rotation of the teams. Most of the production team members would like to work in shift green. Being home early has the preference. This is the reason why the option is given to rotate the teams. The option the team has given is:

- Rotate every 2 weeks
- Rotate every month

The team has chosen to rotate every two weeks.

The reason that they teams were not able to choose the option each week has to do with the working and sleep rhythm.

# 7.4 How much can the setup frequency be reduced or can ATAG become so flexible that it is no longer necessary to reduce the setup frequency?

This research question cannot be answered yet. It depends on the result of a new supplying method and the minimal order quantity of the company choice.

# Chapter 8: Conclusion & recommendation

Twenty weeks passed by and brought us to the results we have today. We started this research with a central question:

#### 'How to improve the performance of ATAG's production line by streamlining internal logistics?'

We found a lot of bottlenecks in and around the production department causing a lower output of finished products. In total 17 core problems are found. Originally, we were willing to perform research on four topics. The fourth and last topic is about the reduction of the setup frequencies. Unfortunately, no conclusion could be made on this topic, due to a lack of data on the setup times. This results in 3 problems we performed research on:

- The real time booking of components from warehouse to production department;
- The production employees who collect the components themselves in the warehouse;
- The unknown capacity of the production line.

All these problems affect the internal logistics. The goal is to streamline the internal logistics, such that the performance of ATAG increases. The performance is defined as the output of final products at the production department.

The biggest concern is that components are not real time booked from the warehouse to the production department. This causes stock differences and in the worst case, a stationary production department. We found a warehouse scanner suitable for real time transferring and booking of components. The scanner is operational, but the software has some bugs and could use some additional menu's. Chapter 4 provides information about the bugs. Furthermore, the software of the scanner is no longer supported in 2017 and additionally there is a hardware problem. We recommend to purchase a new warehouse scanner that is able to reache the top shelves in the warehouse. We asked the IT-department in Gorenje (the mother company) to add extra functions/menu's to the software of the current scanner to improve the functionality of the scanner.

The internal logistics is the second core problem that has influence on the output, see Appendix 5. The production employees transport components from the warehouse to the production stations themselves. A lot of time is wasted by grabbing and searching for the components, resulting into a high setup time. Therefore, the total production time is lower. We looked at the average setup time per station and the disturbers per station. We conclude that station 1+2 is the bottleneck in this research. If we setup once a day, we waste 28 minutes. According to the B.A.T analysis, the employee is able to make four hobs within 28 minutes. We conclude that on a yearly base 960 hobs are not produced due to the setup time and disturbers, if we setup once a day.

In the search for a new supplying method we first look into the literature. Hicks and Matthews provide picking and shipping methods, including direct transportation and milk-runs. The milk-runs reduce the transport distance and picking an delivery time in comparison with the current direct delivery method. The next thing we look at are the transportation types. There are different types of automatic transport systems, but we conclude that none of them will work at ATAG's warehouse. Perhaps that the automatic devices can be implement in the new warehouse that is going to be built in 2020. In ATAG's current situation, forklifts and trolleys are a good option. Furthermore, we apply the 5S theory, meaning that within the supplying method only the required components are delivered, while the components which are not required are removed from the production department.

We observed ATAG's current supplying method. The current shipping method is a combination of direct delivery, kanban, and small milk runs of maximum two different components. The kanban

method does not work, because the retour shelves are not used. The result is that there is no trigger to fill up bins.

With the conclusions above, we look at improvements cycles and theories that could help to form new supplying methods. TOC, Lean and BPR are applied in the multiple supplying options described in Chapter 6. Before the supplying method is created, we conclude that we have to divide all components into three types: fast pick, kanban and delivery by placing an order. Fast pick components require a fast pick area. The products that needs to be delivered and picked require a supplying method.

We conclude that the sealant and pre-assembly sections within the production department need a different approach than the assembly line. This is why each section has multiple supplying method options. The options include the transportation type, the picking, the shipping and the delivery method. ATAG can choose the options that fit their company needs the best, taken into account factors like: reducing setup time, flexibility and the planning complexity. We recommend ATAG to look at section 6.6. The summary provides decision tables with all the options and the trade-off factors.

The last problem we look at is the unknown cycle time. The cycle time to create one hob is always multiple days, due to the drying time at the sealant department. That is the reason why we measure the throughput time at the pre-assembly stations and the sealant station. At the assembly line we measure the cycle time because at the assembly line there are buffers. Getting to know the throughput and cycle time of the different hob types, will make it easier to make a production planning. A good production planning is required for the internal logistics. The logistics employee needs to know when components need to be delivered. Measurements of the cycle time are still running so no results are presented yet.

At the moment the backlog is rising and the sales forecast of the upcoming year is high, therefore we conclude that it is wise to create an 11 hour production day with two groups working in shifts. After the a new supplying method is implemented we recommend to perform research at the bottlenecks at the production line. The bottleneck is also one of the 17 core-problems. Solving this problem could increase the production capacity so, that ATAG's is able to grow.

If ATAG applies above recommendations and chooses the supplying methods based on the trade-offs and experiments, then the performance of ATAG rises and the internal logistics is more streamlined.

# Chapter 9: Discussion and reflection

In the opinion of the writer this research went smoothly. The 17 core problems found in the beginning of this research were not that shocking, because all the problem can be solved. The only shocking part was, the number of problems. It took a few weeks to explain all departments what the core problems are and in which order they need to be solved.

Furthermore, we give ATAG a countless number of possible solutions. As long as ATAG does not choose to stick with the current situation, the setup time will reduce resulting in more effective production times. However, the picking time will rise and it will cost an extra logistics employee. In my opinion it is absolutely worth it to choose a method that lowers the setup time by letting the logistics supply the production department. More hobs will be made by production and even more important we have a better view on the component streams. The component streams are the flow from the warehouse to a finished product. In the current situation, we miss a precise overview were components are and how many are present. This results in stock difference and therefore, component orders which are too late . We can all guess what happens if we have no components to produce. We are sure that ATAG choose a new method wisely and is able to make the right trade-off.

#### Expected changes in the future

I expect two things that are going to happen as a result of the new indoor transportation method. First the production layout will change, secondly the allocation of the components divided over fast pick, kanban and delivered by order will look different.

The current production lay-out does not have the best way of supplying. In the current situation, there are stations that cannot use the kanban method, because the shelves are blocked at the back. To deliver the components fast and at the right moment it is best to relocate the pre-assembly stations.

Secondly the allocation of the components to fast pick, kanban and delivered by order will change in the future. Not only because some hob types are being transferred to ATAG'S mother company, such that the 70% kanban deviation will look different. But also, because some kanban components are inexpensive and could be treated as a fast pick components.

## Hypothesis setup frequency

There was not enough data available to say something about the setup frequency. The wish of the company is to produce larger batches. I think that in the near future it is not necessary to reduce the setup frequency. If ATAG decides to reduce the setup time to almost zero, then why would you increase the stock of finishes products by producing bigger batches? ATAG produces to keep the stock full. They do not produce on request of a customer.

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