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Effectively introduce and train new assembly operators to enhance learning capabilities and improve performance

Master's thesis in the master's degree program, Supply Chain Management

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CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020
www.chalmers.se
Report No. E2020:088

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Abstract

A constantly changing fast-paced environment in today's industry puts requirements on learning capabilities. To stay competitive organisations need to focus on learning to be flexible and enhance performance. The automotive industry has recognised benefits of implementing lean principles and the most important aspect to successfully perform a lean transformation is the organisational culture. The lean culture is focused on establishing standardised work tasks to work as a foundation for developing people through learning and continuous improvements. This study analyses how new operators are introduced to the work activities of assembly and the improvement work within the automotive industry. The result of the thesis is recommendations on how the case company can work to enhance performance by focusing on the learning process of new operators. The study also identifies the importance of shifting ownership of the process from top management to the operators including the introduction to improvement work for new operators.

Keywords: Learning theories, Lean management, Improvement work, Introduction process, Organisational culture/learning

1.Introduction

The first section of this thesis will aim to give the reader an understanding of the aim of this master's thesis. First it will include the problem background followed by the overall aim of the thesis together with the two main research questions of this thesis. Lastly the section will finish by presenting the scope and limitations of the study.

1.1.Background

In a global environment that is constantly changing with fast development in technology with new innovations, it becomes more crucial for organisations to focus on learning capabilities to stay competitive (Hess, 2014). Organisations are putting more focus on learning capabilities to develop the workforce in order to adapt to trends of globalization, technology development and sustainability issues (Marquardt, 2011). In turn this also makes it important to develop leadership skills and organisational culture (Liker and Convis, 2012).

A commonly widespread systematic method within organisations to gain competitive advantage is Lean Production (Liker and Convis, 2012; Liker and Hoseus, 2008). Lean Production is a concept with its roots from the Toyota Production System (TPS) and is described by Liker and Hoseus (2008) as a long term philosophy that focuses on adding value to customers and the society. Lean Production or the Toyota way is associated with eliminating waste, continuously working with improvements based on standardised work tasks, respect for people, teamwork, tools and methods and a pull initiated production system (Liker and Hoseus, 2008).

However, it is argued by Liker and Hoseus (2008) and Liker and Convis (2012) that Lean Production is not just about the lean tools but more importantly the organisational culture and the leadership. By considering the organisational culture and the leadership of the organisation, the overall result of the business as well as the people within the organisation can be developed. For an organisation to become lean there is more than using different lean tools to enhance operational efficiency. To become lean, an organisation needs to look at the transformation as a never ending journey. A lean transformation does not have a start or an end, to be successful it requires strongly committed leaders and a long-term culture that emphasizes the importance of continuously working with improvements. As described by Emiliani and Stec (2015), one of the main reasons why organisations fail in their lean transformation is because of the leadership's commitment. The fact that management looks at lean as a manufacturing tool, meaning the lean practices is limited to a portion of the organisation such as the operations. Disregarding the

organisational culture is the reason many organisations fail in their lean transformation journey as well.

It is described by Hess (2014) that organisations as well as individuals need to be continuously learning, adapting and improving or face the risk of becoming obsolete. It is stressed that the fundamental grounds of achieving operational excellence and innovation is learning. For an organisation to learn it is crucial that the individuals within the organisation learn (Hess, 2014). The research by Hess (2014) shows how individuals can become better at learning but also how organisations can create environments to enhance learning capabilities, it is described that a high performing learning organisation consists of the right people, the right environment and the right processes.

In order to create a good learning environment it is, according to Chaffin and Hancock (1966), important to consider five different factors that affect learning. These factors are: Previous knowledge, Motivation to learn, physical and psychological capabilities, a thorough and precise definition of the work tasks and the type and amount of training that the operators receive (Chaffin and Hancock, 1966). Furthermore, Chaffin and Hancock (1966) argue that the human capabilities determine how well a manual work task can be performed independent of the operator's previous experience or motivation. The human capabilities are divided into three categories: Sensory skills, psychomotor skills and motor skills. These capabilities are important to consider when creating a learning- and training program. A training program is important to help the operator to learn the tasks in a way fitted to the particular individuals skills. It is not unusual that the learning operator does not have the capabilities that is required to successfully accomplish the assembly task at the speed rate required, it is therefore of great importance to help the operator as much as possible in the learning phase (Chaffin and Hancock, 1966).

Manual work tasks and the training associated with learning manual labour is described by Chaffin and Hancock (1966). Introducing new operators to the manual tasks of an organisation can have a negative effect on the performance and therefore it is important to develop the introduction process. The introduction process of new employees is associated with learning the work tasks and the culture of the organisation. Liker and Meier (2007) presents the introduction process used by Toyota called the job instruction method. It includes the breakdown of work tasks and the analysis work tasks to be able to effectively teach new operators. However, the responsibility of the operators at Toyota is not only to be able to perform the work activities. A big part of the responsibility is also to improve the process and generate ideas of improvement (Liker and Hoseus, 2008).

The case company has identified issues with new operators affecting the takt and quality at the final assembly during the introduction process. This is creating stops and generating waste which is affecting the overall performance of the organisation. They need help to identify how the takt and quality is affected during the introduction process of new operators. The case company is facing challenges in leadership and wants to create an environment that will improve the introduction process. Improving the introduction process and increasing learning capabilities would help increase the quality of learning that new operators achieve. This would help to increase the overall performance and create a culture of continuous improvements and ownership of the process.

1.2.Aim

The aim of this master thesis is to identify how takt and quality is affected during the introduction process of new operators. This is done to provide the case company with recommendations on how to improve the introduction process and increase performance by reducing takt disturbances. This thesis also aims to identify how new operators are introduced to the improvement work of the organisation. Performance can be increased if the ownership of the process is shifted from top management to the operators (Liker and Hoseus, 2008).

First, in order to provide recommendations to handle disturbances in the takt the current state of the learning process for new operators has to be mapped. From this the first research question that the study aims to answer is:

> *RQ1 - How does the learning process for new operators look like today and what improvements can be done to avoid disturbances in the takt when new operators are introduced at the assembly line?*

Secondly, to identify positive enhancements of the improvement work the role of new operators in the improvement work and organisational culture will be investigated. Which generated the second research question that this study aims to answer.

> *RQ2 - How are new operators introduced to the improvement work of the organisation?*

1.3.Scope

The master thesis is limited to a period of 22 weeks. The study was performed at the final assembly of the case company and the manufacturing process of the organisation was not considered. This master thesis was conducted in a lean environment which is why lean principles were used in the analysis of the findings. Leadership on the first level will be in focus at the

production teams including the work of team leaders and supervisors. The research is time-limited and a big part of the research is to map the current learning process of the case company to provide the organisation with recommendations of improvements. Therefore, no further analysis on the recommendations are performed.

2.Theory Section

In this section relevant literature to the study will be presented. The case company has undergone a lean transformation and therefore the first part of this section will be connected to lean and the Toyota way. The focus will be put on the organisational culture, standardised work tasks and the kaizen mindset to achieve continuous improvements. After that learning organisations will be presented, the three cornerstones of learning organisations will be presented which are: People, environment and process. This will be followed by different types of learning theories, learning time, learning curve and other factors that can affect the learning process of new employees in a setting of manual labour. Lastly, theory connected to how Toyota works with training and introducing new employees to the assembly line will be presented.

2.1.The Toyota Way

In a time of less human-, material- and financial resources the japanese manufacturing companies needed to act. The country of Japan had suffered huge losses after the second world war and for japanese manufacturers to stay competitive they needed to do something different (Womack, Jones and Roos, 2007). It is further described by Womack et al. (2007) that from this the Toyota Production System (TPS) was developed by the first leaders of the Toyota Motor Company Eiji Toyoda, Taiichi Ohno and Shigeo Shingo. The main focus of the TPS was the elimination of waste.

The Toyota way has developed over the years and the model presented in the internal version of the Toyota way 2001 is described as a house with two pillars: Respect for people and continuous improvement (Liker and Hoseus, 2008). It is further described by Liker and Hoseus (2008) that the foundation of this house contains five elements: Challenge, kaizen, genchi genbutsu (go and see), respect and teamwork. Liker also developed a model based on the internal document which he presented in the Toyota Way called the 4P model. The 4P model is illustrated as a pyramid with problem solving (continuous improvement) at the top followed by People and partners (respect, challenge and growth), Process (eliminate waste) and Philosophy (long-term thinking). Both of these models represent the Toyota way in different ways but the purpose of them is the same and have a lot in common. Both models should represent a total system, they show that lean tools support people and continuous improvement, they are process oriented rather than results oriented and both models focus on people and their continuous improvement (Liker and Hoseus, 2008).

There are several tools used in the TPS that have been adapted by many other companies to reach operational excellence through problem solving. These problem solving tools can be e.g.

5S, pull-systems (kanban) and andon. It is argued by Liker and Hoseus (2008) that it is not the tools that will help you reach operational excellence but rather the lean mindset that puts great focus on a broader culture that is developing the people of the organisation. Companies have tried to adapt and lean out their processes from the bottom up to get their employees engaged in the improving processes but failed since they did not consider the overall culture of continuous improvements that is present at Toyota (Liker and Hoseus, 2008).

It is explained by Liker and Hoseus (2008) that the word culture is important to define since different people have different perceptions of the world culture. It is often mentioned that culture is an important part in creating a successful company and some quotes presented by Liker and Hoseus (2008) emphasize this: “The tools are the easy part; The change of culture is the hard part.” “Lean works in Japanese culture where it was created but not in our culture.” “It’s all about culture”. Many people understand the importance of culture but it is important to define what culture actually is to be able to understand it and in turn change it.

There are several models that illustrate that culture exists on many levels and it is often shown as an iceberg, there is much more than what is seen above the surface. Most of the iceberg is under the surface where the deeper knowledge of the culture exists (Liker and Hoseus, 2008). A model of culture has been presented by Schein (1984) which shows three levels of a pyramid which can be seen in *figure 1*.

The top of the pyramid is artifacts and behaviour. This is what can be seen on the surface and is explained by Liker and Hoseus (2008) as an object, the physical layout of the workplace, how people behave and written documents. But there is much more to culture and to dig deeper understanding of people's norms and values is important.

Norms and values are the second part of the pyramid. Norms are accepted rules on how to behave at the workplace and do not have to be written down because everybody should know the norms of the organisation. Values are more the principles the organisation lives by, for example at Toyota the problem solving identification to continuously improve the processes is the main value of the organisation (Liker and Hoseus, 2008).

Underlying assumptions is the last part of the pyramid. This is what is assumed deep down to be the nature of the organisation. The underlying assumptions of an organisation is explained by Liker and Hoseus (2008) to run so deep that it is almost impossible to change.

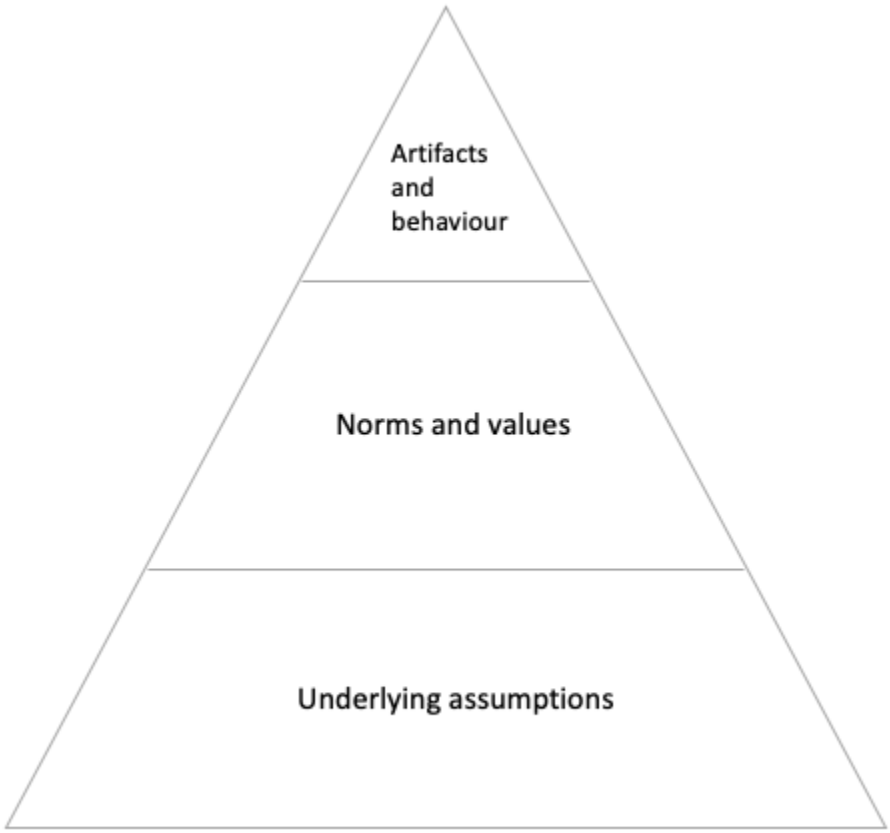

Figure 1: The pyramid model of culture presented by Schein (1984).

2.1.1. Standardised work task

According to Liker and Hoseus (2008) standardised work is defined as the best way to do the job today until there is an improved and established way that becomes the new standard. Standardised work is a baseline for improvement, the foundation for creating a repeatable process with quality results and enables training. A critical part of Toyota culture is based on continuous improvement which is possible by setting standards in order to define how to work and train people in their organisation.

In order to be able to achieve efficient standardised work the job and surrounding processes has to be stable and this is accomplished if three requirements are fulfilled. The first requirement is takt time which explains how many minutes a product cycle should take. For the takt time concept to be useful it is important to have stable demand. The second requirement is the standard work sequence which explains in what steps and order the work should be performed in.

Here it is important that the parts, tools and materials arrive at the same times in order for the standard work sequence to be accomplished. Third requirement is to have a standard work-in-process which indicates the accepted level of inventory between the different steps in the process. To assist this requirement it is critical to focus on quality and maintenance to achieve a stable process (Liker and Hoseus, 2008).

In most companies one person is assigned to train the new employees and teach them how to conduct the job. It is up to that individual to make decisions on what and how to teach the new employees. If there is no standardised way to complete the task the student learns how to perform the job based on the way the person teaching them is performing the task. The short amount of time often spent with the trainer results in the student filling in the gaps by themselves. This leads to everybody conducting the work as they see fit (Liker and Hoseus, 2008). This is preventing organisational learning and the continuous improvements of the organisation. Standardised work is explained by Liker and Hoseus (2008) as a way to create a repeatable process that reliably produces wanted results. It is further explained as the foundation for both training as well as the foundation for improving the process. If the work is not standardised the trainer does not know how to perform the job in the best way and how are they then able to teach the best way to a new employee? An unstable process that is done differently by everybody is impossible to improve since any improvement would just result in yet another way to do the same job (Liker and Hoseus, 2008). To be able to improve the process and train new operators the job needs to be clearly defined. A standardised way to perform the job which is the best known way to do it today is taught to new operators and works as a foundation to build upon. The idea is to improve the standard to be able to define a new best way to perform the job (Liker and Hoseus, 2008).

Training of people within the organisation is always done in a stable environment at Toyota with group leaders and team leaders that are comfortable. They know how to do the work and also how to teach the work. The work conducted by the team has already been broken down into the smallest detail including how to position the body, where parts should be, safety protocols and quality key points (Liker and Hoseus, 2008). With all this in place Toyota is using something called the job instruction method that will be explained later in this section. Most companies do not have the same environment or standardised work to the level of Toyota therefore Liker and Hoseus (2008) recommends to take it step by step. Meaning that the first step is to create a stable process based on standardised work tasks to be able to effectively train the process to new employees. Liker and Hoseus (2008) also explains that being selective and choosing a smaller area or process to develop can be beneficial. Starting with a pilot project to create the standard and training the standard before moving on to different areas across the plant.

2.1.2.Kaizen - continuous improvement

Kaizen is an integral part of leadership, how the company operates at a fundamental level and not only a number of projects. There are two types of kaizen; maintenance kaizen and improvement kaizen (Liker and Convis, 2011). Maintenance kaizen is about reacting to unpredictable events and scenarios that require immediate actions, where the aim is to bring the system back to standard. When the problem has been restored, work groups go through the root-cause to prevent the problem from happening again. Improvement kaizen is the process of doing extra, finding new standards and continuously improving to reach “perfection”. According to Liker and Convis (2011) there will always be room to improve in every process even after several improvements and it is the leader’s job to emphasize this thought to all the employees.

Since, the leader will only add energy to the system temporarily and not permanently. Therefore, the main role of a Toyota leader in kaizen is to add new energy to the system, by taking supporting roles, encouraging and coaching without commanding and allowing the group to truly own their processes. In that way the employees will be motivated to continuously improve by daily kaizen (Liker and Convis, 2011).

The different types of kaizen is rooted in the culture of Toyota that connects to problem solving. There are no quick fixes for organisations but if there is one key to Toyota's success it would be problem solving (Liker and Convis, 2011). It is described by Liker and Hoseus (2008) that the first thing a student learned from Taiichi Ohno, who is considered the father of Toyota Production System (TPS), was problem solving. This is also why it is so deeply rooted in the organisational culture of Toyota with problem solving as a means to continuously perform maintenance- and improvement kaizen.

The first step for every team member at Toyota is to learn the assigned new job. This is done through the Toyota job instruction method and includes repetition until performing the tasks becomes natural. The team members eventually become good enough to perform the activities of the job within the time requirements (Liker and Meier, 2007). It is explained by Liker and Hoseus (2008) that it is often enough that new employees are able to perform the job according to the standard with high quality but this should only be considered the starting point. Within the job tasks of an operator working within assembly at Toyota there are also requirements on developing the process and generating ideas for improving the job.

The process of continuous improvements relies upon the operators working within the process and the culture of engaging people in the improvement process (Liker and Hoseus, 2008). It is the engineers who first set up the process but unexpected things happen and it is impossible for the engineers who are not working within the process to detect all the disruptions. The operators working within the process can however observe all deviations from the standard first hand and act to stop the deviation moving forward to the next process (Liker and Hoseus, 2008). By

shifting responsibility to the operators working within the process it is easier and cheaper to find deviations and act upon them to improve the process. The way this works at Toyota can be seen in *figure 2* and is explained on the basis of five steps: First the engineers get input from the operators working within the process to set up the process in the best way by solving previous problems. Secondly the team members on the shop floor need to highlight deviations from the standard to bring problems to the surface. Third, there is a process for immediately containing any problems or deviations that occur to prevent defects to be passed on or that later process gets affected by deviations at a previous work station. The fourth step is to conduct root cause problem solving to make sure that the problems that have been experienced over a period of time do not happen again. The fifth and last step of the process of continuous improvements include a process for managers to identify larger system problems to ensure an improved level of overall performance.

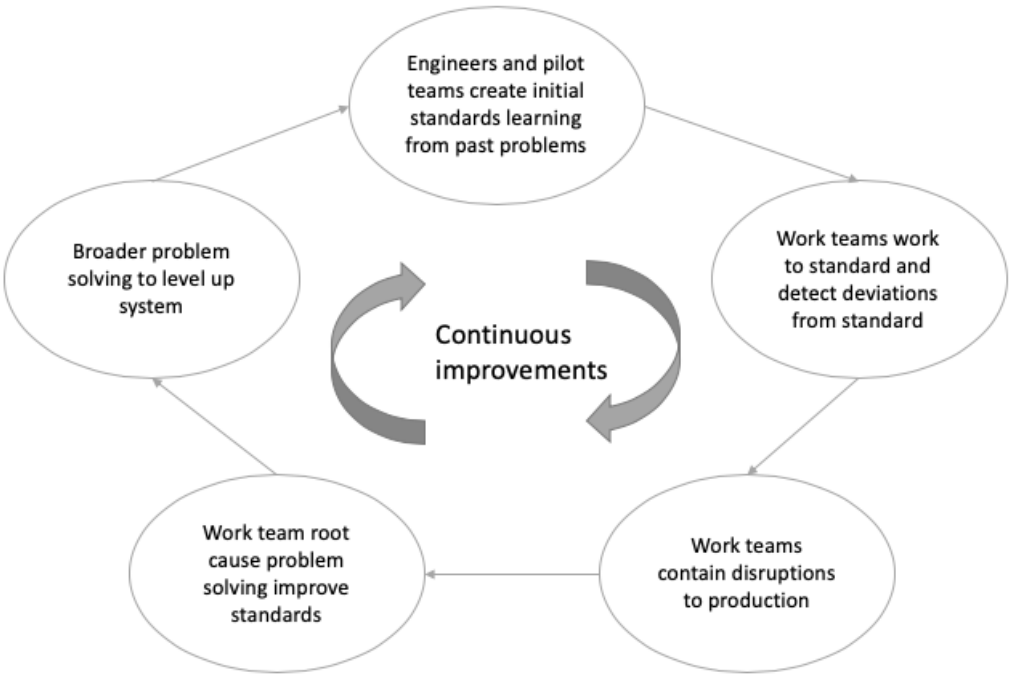

Figure 2: The process of continuous improvement according to Liker and Hoseus (2008).

2.1.2.1.Continuous Improvement of Job Training

The process of continuous improvement does not just apply to the process of teaching new operators the work conducted at the shop floor. It is described by Liker and Hoseus (2008) that many organisations do not prioritise the development of people in their daily work. Training is often viewed as the responsibility of a specific training department or an assigned person that teaches the student as they perform the activities of the job. At Toyota all senior staff is a teacher for the more junior employees and are supposed to act as mentors to help develop the people of the organisation. It is described by Liker and Hoseus (2008) that a Supervisor's job is to facilitate the growth of their subordinates to help them develop as people and in turn perform better for the organisation. In order to develop the people they need to be challenged, motivated and get a sense of achievement in the workplace (Liker and Hoseus, 2008). The Supervisors should train their subordinates and it is emphasized that each person has different values, personalities and abilities which result in the requirement of the training being customized to fit these.

However, the Supervisor of the organisation also needs training and mentoring. Most of the literature connected to learning and training is focusing on the shop floor including team members and group leaders but training on the manager and executive level is also required (Liker and Hoses, 2008). It is described by Liker and Hoseus (2008) that often higher up in the hierarchy you move up the less clear the definitions of the job become. However the Toyota job instruction method should be integrated at all levels of the organisation according to the toyota culture. This means that disregarding the hierarchy level of the organisation it is important to conduct training to increase knowledge and understanding throughout the organisation. Managers and executives undergo training at Toyota following the same procedure as the workers on the shop floor and the process of training is improved based on the standard as well. How the Toyota job instruction method is used in the Toyota culture will be explained later in the theory section.

2.1.3.Teamwork

As previously stated one of the pillars of the Toyota way is respect for people and in the foundation of the lean house this has been divided into respect and teamwork (Liker and Hoseus, 2008). Unlike western countries Toyota puts great focus on teamwork instead of individual performance and they believe that teamwork increases the opportunity to enhance both individual and team performance. Despite the fact that Toyota is famous for its teamwork they still identify that groups and many meetings can be inefficient and therefore reduce the efficiency of individual work. They act to prevent this in different ways such as leaders that are highly trained to keep the teams on track in the problem solving process (Liker and Hoseus, 2008). It is described by Liker and Hoseus (2008) that the team fills two roles, they support the individuals

in their work and also help to solve problems that in the end improves how the work is being done.

At Toyota there is usually a distinguishment between two types of groups: work groups and problem-solving groups. Work groups are the ones who get the daily work done and find opportunities to improve the way the work is done and the problem-solving groups are most often temporarily with a special focus to solve a specific problem. They often focus on problems that are applicable for several different departments across the company (Liker and Hoseus, 2008). Toyota identifies the optimal size teams to 5-7 people that report to a team leader then each team leader reports to a group leader who shall have responsibility for four teams. Furthermore, Liker and Hoseus (2008) argue that the right group size is important for the organisation of Toyota because they are looking to have a horizontally flat organisation.

2.1.4.Shu-Ha-Ri

One of the methods that Toyota is using to develop their employees is the layered learning cycle called Shu-Ha-Ri (Liker and Convis, 2012). It focuses on the relationship between all students of the organisation with the tutelage of a sensei. The sensei is most often the direct supervisor to the student or the supervisor of the students supervisor. The sensei has an important role of providing challenges, opportunities and coaching to the student so they can develop and learn. Both the student and the sensei have responsibility, the student has the responsibility to have the motivation to be willing to learn and the sensei has responsibility for the student's development (Liker and Convis, 2012).

The japanese word shu ha ri refers to the three different stages of learning that the student goes through as well as the three levels of involvement from the sensei. Shu means to protect and in this phase the student is under a lot of scrutiny by the sensei. The student learns the tasks of the work by continuously repeating these tasks in accordance to the standards and instructions provided by the sensei (Liker and Convis, 2012). This learning cycle starts from the beginning of the first day for new employees. At Toyota new employees need to learn how to assemble parts onto a vehicle in a standardised way. This is done by following an instruction method that breaks down short cycle jobs into short elements of only a few seconds that the student needs to know to be able to complete the job (Liker and Convis, 2012). In this stage the student first gets to see the sensei perform the work tasks, then the sensei performs the work tasks at the same time as the sensei describes each step and why it is performed. The student is then asked to repeat why every step is important to understand why the work tasks are performed in the first place. As the student completes different work tasks they can be combined so that the student can perform the entire job (Liker and Convis, 2012).

Ha means to break away and in this stage the student has a little bit more freedom to complete the tasks without supervision of the sensei but the sensei still has responsibility for the quality of the work that the student performs (Liker and Convis, 2012). In this stage the new employee or student is expected to perform the work exactly as it is described in the instructions and it is not until the student reaches the ri stage that they can have more freedom.

Ri means freedom to create and in this final stage the student does no longer have to think about the different tasks because they are so rooted that the student can perform them without thinking. In this stage the tasks that the student needs to do to complete the job comes naturally. In this stage the student can start focusing on the purpose of the job and possible improvements of the job tasks as well as teaching others (Liker and Convis, 2012).

It is important to remember that Toyota sees the shu ha ri as a learning cycle that will continue throughout the individuals lives and it is not just assembly-line jobs that follow this pattern. Toyota finds it important that every job within the organisation is teached in a detailed way to make every worker the master of their own workstation to be able to work continuously with improvements (Liker and Convis, 2012). It is further explained by Liker and Convis (2012) that an enabler for this learning cycle is the standardised work which enables self-development and improvement of the work stations.

2.1.5.The Toyota 3M model

There are several different types of waste and as mentioned previously the Toyota Way focuses on elimination of all waste. The waste people mostly think about is muda which refers to the waste that can be seen (Smith, 2014). There are also mura which is inconsistent and muri which is overburden and in the Toyota Way it is important to focus on eliminating all three different kinds of waste (Smith, 2014).

Muda is what most companies focus on when reducing waste in the organisation and it is closely linked to the seven wastes: Defects, Extra processing, Waiting, Transportation, Inventory, Motion and Overproduction (Smith, 2014). Mura is according to Smith (2014) defined as unevenness or inconsistency and it is important to avoid mura since it often leads to muda. It is described that a way to avoid mura is to work with level loading which is called heijunka. By leveling the load the demand can be levelled out and the processes become more predictable (Smith, 2014).
Muri is the type of waste that is connected to overburden. It relates to the fact that the people of the organisation or the processes are overburdened. Muri is also related to the eight waste of muda which is a non utilized workforce potential (Smith, 2014).

2.1.6.Real time management

Borovits and Segev (1977) states that real time management is about maintaining the functions of the organisation. Even though the real time management is usually seen as an operational control in day to day orientation, the managerial activity within real time management can be divided into three areas: strategic planning, management control and operational control (Borovits and Segev, 1977). The real time manager has the task to strategice, manage and maintain the organisation's operations by operating in the present. The majority of their job involves dealing with disturbances directed towards maintaining the functioning of the organisation (Borovits and Segev, 1977). Real time management allows opportunities for organisations to maximise their business effectiveness by collecting data and reaching close to zero downtime in the production (Rydén and Sawy., 2019). It is also stated by Rydén and Sawy (2019) that when disruptive technologies and changing business practices occur it is important to critically understand what managers working with real time management can do to capture value from the real time management capabilities. One tool that is often mentioned and used to aid real time management is visual management that is an open channel of communication visualising real time information.

2.1.7.Visual management

It is stressed by Liker and Hoseus (2008) that the leaders of Toyota work to make sure that there are open channels for communication that creates trust and respect between the different employees of the organisation. The purpose of communication is also to share the management point of view as well as trying to encourage team members to participate in improvement work and come with new ideas. It is also emphasized by Liker and Hoseus that face-to-face communication should be done where the work is performed. This means that the leaders lead from where the value is created and not from their office. An important part of the communication is visual management which helps provide real time information that indicates how things are going and to know where to improve. The aim of using visual management is to communicate a problem for all employees to see (Liker and Hoseus, 2008). However all information may not be of value and it is important to make sure that the information communicated is clear and of value. Often companies have taken steps to communicate better and involve the employees in the process but they have missed the aspect of communicating effectively (Liker and Hoseus, 2008).

Different tools that Toyota is using in their visual management to support the manufacturing with real time information are e.g. Kanban, andon, graphs, numbers and A-3 reporting. The A-3 reporting is a tool that shows information regarding a problem on an A-3 sheet with the purpose of communicating the problem in order to solve it (Liker and Hoseus, 2008). Visual management

should be used daily to get updates regarding how the work is progressing which in the case of Toyota or the case company means that the team leader or supervisor shows the visual management board to the employees every morning highlighting yesterday's work in accordance to for example safety and quality.

2.2.Learning organisations

According to Hess (2014) there are three cornerstones that are important to consider to be able to become a learning organisation. These three cornerstones are: The right people, right environment and right processes. These different cornerstones and why they are important to consider for organisations will be presented below.

2.2.1.Right People

The right people is the first cornerstone of learning organisations according to Hess (2014). The right people refers to the fact that a learning organisation needs to have employees that are willing to learn and teachers that facilitate learning capabilities.

According to Hess (2014) people often rely on their previous experience of learning to approach or avoid new situations. The teachers of the organisation need to work with feedback in a way that fosters learning, makes people engage in new situations and take on new challenges instead of avoiding them based on previous bad experience. The theory of self efficacy is important to learning organisations since employees and teachers that have high self efficacy have a great belief in that they can accomplish something, which in turn will help organisations accomplish learning throughout the company (Hess, 2014).

According to Hess (2014) motivation can be divided into three categories: Autonomy, relatedness and competence. Autonomy is the sense of having control over the workplace and knowing that one can affect their own work. Relatedness is connected to the fact that people need to feel a sense of belonging and for example working in groups to achieve goals. Competence relates to the fact that in order to increase competence people need to have opportunities to face challenges. Motivation to learn is different for people and instrictic and extrinsic motivation is also discussed by Hess (2014). Instrictic learning is when you are motivated to learn because you want new knowledge and appreciate the fact that knowledge will help with self-development. Extrinsic motivation means that one is motivated by the fact that it will give something such as rewards. For organisations to constantly improve it is important that the employees are motivated to learn and increase knowledge. The people of the organisation should be motivated by self-development rather than improving to achieve a bonus (Hess, 2014). Leaders also have to manage this and make sure that the employees are motivated and help to

increase their learning capabilities. Theory Y leaders are appreciated since the Theory X leaders have a belief that employees are lazy and will take advantage of the leader if they appear nice whereas Theory Y leaders are the opposite (Hess, 2014).

2.2.2.Right Environment

Hess (2014) explains that in order to have a good organisational learning environment that has high employee engagement, there must be good leaders that teach inline with the organisation's culture and beliefs. It is also important that there is a systematic way of learning at all levels in order to achieve high employee engagement and increase the overall performance. Hess (2014) also states that a learning environment is when the leaders are role models and that the employees have a chance to be creative and challenged in a positive way. In order to create a good environment for each employee it is important to dedicate time and truly understand what drives each of the employees. This lies on the leaderships role of the organisation to facilitate learning and create personal relationships (Hess, 2014; Fowler, 2014)

In lean management it is core to create the best environment for their workers, where the employees can speak freely without the fear of punishment. Mistakes should not be seen as failure instead should be a learning experience (Liker and Convis, 2012)

2.2.3.Right Processes

According to Hess (2014) there are two kinds of processes in the high-performance learning organisation formula, which is the right kind of communication processes and critical thinking processes.

The right kind of communication process is about reaching learning conversations. Hess (2014) states that there are two types of conversations, system one conversations and system two conversations. system one conversations are conversations that confirm what we think and know. These conversations are safe and protected from harm, looking bad or being wrong. However, system one conversations do not contribute to learning. The other type of conversation is system two conversation which is a nonjudgmental, honest and open minded exchange. system two conversation highlights the process and brings people together to learn from each other and to reach the best objective result. In order for this to occur trust and mutual respect is important. It is also important to understand the process by entering system two conversation with an open mindset so that new information may change previous opinions and beliefs (Hess, 2014).

Learning, innovative thinking and critical thinking is best achieved when promoted by trusted mentors, managers, leaders and teammates in the right working environment. Learning is a team

effort and the quality of learning conversations will be higher if the people feel trusted and valued at their workplace. Two important factors for the process to work is that the involved people have to be able to speak freely and there should be no punishments if something goes wrong, it should rather be encouraged to admit that something went wrong to learn from it. This will according to Hess (2014) create a positive work environment with high employee engagement which enables system two conversations.

Critical thinking processes are tools designed to identify weaknesses and improve our mental models. These kinds of tools are according to Hess (2014) almost compulsory in business environments since change is hard especially for big organisations. The purpose of the tools is to slow down our habitual way of thinking and work to think more deeply, increase the probability to be more open to disconfirm data, increase the disconfirming of data, help resolve and double check the pre-assumptions and beliefs and last help continuously learn from results of taken decisions. Hess (2014) explains Klein's three process tools; Recognition-Primed Decision Model (RPD), The PreMortem and The Insight Process. A conclusion of the tools is the RPD-model requires you to approach the decision-making research to differ from what is usually done. Makes you stop and visualize an outcome then move forward only if you think it will work, if not then visualize another outcome. The PreMortem process is thinking about what could go wrong along the way and how the causes of failure would affect the proposed plan. The last process is about getting an insight of the actual process which gives new information and ideas to improve the process. The number one reason for the tool's effectiveness is that it slows down our thinking since we must think critically in each process (Hess, 2014).

2.3.Learning Theories

It is generally hard to define learning and depending on the source it is described in different ways. According to Nationalencyklopedin (2019) learning is a process of an interaction with the outside world, the process is actively experienced by humans and animals where the experiences affect the behaviour and modifies it. Chaffin and Hancock (1966) defines manual work specifically and states that learning is to reduce uncertainty to complete the task faster. Ellström (1992) defines learning as lasting changes in a person's behaviour based on their interactions with the outside environment. Mellander (1991) and Franklin (1964) however talk about learning as a means to acquire knowledge and Franklin (1964) further discuss that the knowledge required to perform a task gives the trainee the control to affect quality and quantity during a given period of time.

In this report learning is defined more in line with Mellander (1991) and Franklin (1964) as the process of acquiring required knowledge to be able to perform work tasks as well as how the operator experiences this knowledge.

2.3.1.Different types of learning

Just as for the definition of learning there are several ways of acquiring knowledge and in turn the learning process can look different. In this subsection different ways of learning is presented to act as a base for this report, it is important to consider that there are several ways of learning and to combine these to create an environment that will enhance the learning capabilities and make the learning process as efficient as possible for new operators in an organisation.

2.3.1.1.system one and system two thinking

How the mind works is discussed by Hess (2014) and this is closely connected to learning for individuals but also organisations. The author argues that it is important to understand how people learn as well as what environmental factors enhance learning to be able to create a learning organisation. This can of course look different because people are different but it is important to create an environment where people can learn and develop. This is something that is really important within lean management since a great focus is put on self-development within the organisation.

According to Hess (2014) there are two ways of thinking and the way of thinking that we need to use is dependent on the patterns, complexity and routines of the tasks. The author describes that 20% of our energy is consumed by our brain, and that our way of thinking is either in “system one” or “system two” (Hess, 2014). “system one” is fast and unconsciously automatic thinking, with little to no energy used from the brain. While “system two” is effortful reasoning where focus and concentration is needed, which is where the majority of the 20% energy is used. This can relate to the practice of Shu Ha RI, where from the beginning “system two” must be used in almost every task. It then depends on previous experiences how fast an individual can start doing the tasks automatically “without thinking”, with other words using the “system one” way of thinking. This is usually when you have reached the Ha stage. Ri stage is when you almost do not use any brain energy doing your tasks. When mastering a task it leaves room to use the “system two” way of thinking on finding continuous improvements.

2.3.1.2.Cognitive and Motor Learning

Dar-El, Ayas and Gilad (1995) defines the individual learning process in industrial tasks in two phases: cognitive learning and motor learning. At the beginning the operator uses the cognitive system to remember the new instructions, develop the correct working method, perform the tasks correctly etc. When the operator gains more experience by repeating the same sequence, the need

of the operator's cognitive system reduces and starts performing the tasks by motor learning. When the task feels simple or is very simple then only motor learning is taking place. Dar-El et al. (1995) has researched these learning methods and came up with a conclusion that in many industrial tasks the cognitive system dominates the learning process during the early learning process and when the number of repetitions has increased then the motor learning system dominates.

The key factor here is if the task is very simple then the cognitive system plays a minor role and that the experience is a key determinator for how long an operator needs to operate using the cognitive learning system. Motor learning can be compared to what Hess (2014) talks about as "system one" way of thinking and cognitive learning as more "system two" way of thinking. And it is important to consider both as a part of the learning process

2.3.1.3.Learning curve

There are different definitions on how learning is done just as there are different definitions on what learning is. A way that learning is usually described is through a learning curve and an ordinary learning curve that is often mentioned is the one seen in figure 3. Most often learning is starting slowly followed by several learning plateaus (Sigrell, 1995). This is further explained by Rubenowitz (1992) who states that the first phase, a in figure 3, the individuals learn just a little per time unit. This mostly has to do with the fact that when learning something new the individual has to familiarize with a new system and the task to be learned is new to them. In the next phase, b in figure 3, the learning is rather fast but it is explained by Rubenowitz (1992) that in this phase there is a risk that the individual overestimates their own ability. This in combination with the fact that the individual can get bored due to the fact that they have learned how to perform the task but not why is the reason that problems may occur and the first learning plateau c is reached. When these problems are solved the learning process can continue shown by the phase d in figure 3 until the maximal knowledge is reached.

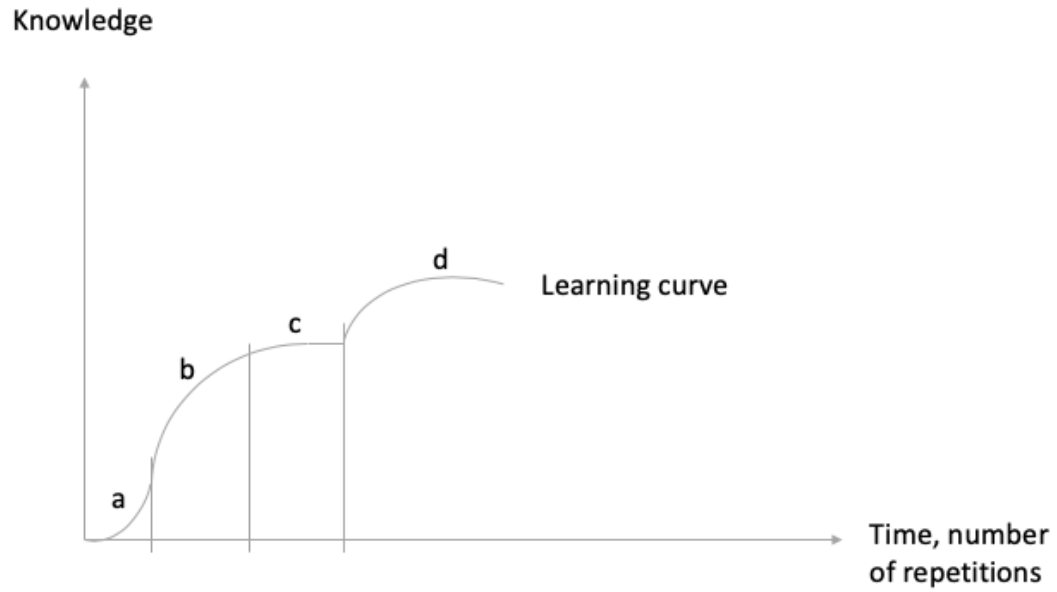

Figure 3: The learning curve according to Sigrell (1995).

2.3.1.4.Learning time

Learning time is defined by Chaffin and Hancock (1966) as the number of repetitive cycles required for a person to attain the standard or normal cycle time of that job. According to Chaffin and Hancock (1966) the learning process starts from the point where the new operator acknowledges that the job exists and the learning time is counted from that time until the cycle time can be achieved. This also helps with improving the effectiveness of the training since it is possible to reduce the time required to reach the standard cycle time with the correct quality obtained.

There are several factors that can affect the learning time and according to Sjölander (1985) the factors that has to be considered are: Prototypes, Assembly instructions, Pictures of the object, The appearance of the object, The number of activities, Hidden activities, Asymmetry, Exposure of the material, The sequence and precise movement.

Prototypes of the finished product are important to have at hand to show the operators the hardest parts of assembly. Sometimes it can be hard to have prototypes at hand if for example there are really short cycles or very expensive products which would tie up a lot of capital. According to Sjölander (1985) this could be solved with buffers in between the stations to provide prototypes of the finished product of the previous workstation.

Assembly instructions should be provided at each workstation to facilitate learning and should include the cycle time for each activity preferably using a computer screen at the station. Pictures

of the object and the instructions should also be included at the station to help with the learning process.

The appearance of the object and the number of activities are also factors that affect the learning time according to Sjölander (1985). It is described that it is much easier to learn to assemble bigger parts than smaller detailed parts as well as the fact if one workstation includes more activities it will be harder to remember all steps.

It is also discussed by Sjölander (1985) that hidden activities should be avoided as much as possible to try and make the learning process more simple, hidden activities will most often prolong the learning time. Asymmetry is also positive to avoid confusion in assembly.

The exposure of all material required to perform the activities of a station is important to shorten the learning time and decrease learning costs. The sequence that the assembly is performed in is also important in regards to the learning time. To enhance the learning the sequence should be done in a logical order and follow natural steps. The last factor mentioned by Sjölander (1985) is precise movement and it is mentioned that too many precise movements that require a high level of accuracy will affect the learning time in a negative way.

2.3.2.Factors that affect learning

There are several different factors that affect the learning of new tasks that are both associated with the person that is learning as well as the task that is being teached. According to Chaffin and Hancock (1966), who defines learning specifically for manual labour, there are specific factors which influence the learning process, these factors are:

1. The amount of previous knowledge that is transferable and applicable to the job being learned.
2. The extent of trainee motivation to attain the standard performance level of the new job.
3. The trainee's physical and mental ability to make correct responses to requirements.
4. A good description of what is involved in the job being learned such as the complexity of the job, the relationship between motions and the redundancy of the motions.
5. The type and amount of training that the trainee is exposed to. This means the amount of training that is designed specifically to orient a trainee to achieve the performance standard of that job.

These factors that are mentioned by Chaffin and Hancock (1966) can be summarized into three different factors that should be considered in a learning environment: The job classification factor, motivation to learn and the ability to learn.

Except the factors mentioned by Chaffin and Hancock (1966) there are other factors described by Regström and Andersson (2006) that are deemed relevant to this project. These different factors are presented below.

2.3.2.1.Forgetfulness

Something that is always occuring while learning new tasks is forgetfulness and according to Schafer (2001) work that is being done in cycles with breaks in between cycles and not in one continuous steady flow will create forgetfulness. The learning process will be longer if one is learning several new tasks in parallel to each other because it will make it harder to remember the tasks being learnt (Lundh, Montgomery and Waern, 1992). Forgetfulness does not always connect to fault in the learning process, it can also be that the attention span of the person being trained is low which can be a reason for forgetfulness.

According to Regström and Andersson (2006) if consideration is made to the fact that if learning is not continuous the learning curve will be longer. Often one work task consists of many different activities which will make it impossible to learn in one continuous flow which in turn will make forgetfulness inevitable. According to Moxnes (1984) distributed learning results in a better performance of learning. Distributed learning is when tasks are divided into smaller activities and distributed over a longer period of time rather than learning the entire task in one continuous way (Moxnes, 1984). This is true for simple as well as more complex work tasks.

A factor mentioned by Rubenowitz (1999) that also affects the forgetfulness is proactive and retroactive transfer. Proactive transfer is previous experience that may affect the learning process and recollection of a new work task. Retroactive transfer is activities after the learning that affects the recollection. According to Rubenowitz (1999) it was previously stated that forgetfulness was something that started as soon as the training was completed but now it is considered an active process that can be affected by impulses, impressions and knowledge gained between the training and recollection of a new work task.

2.3.2.2.Motivation to learn

There is a strong connection between learning and motivation, how effective the learning process is depends on the level of motivation to learn (Moxnes, 1984). This is also something that is mentioned by Hess (2014) where the willingness to learn is one of the key aspects in learning organisations. It is not possible to force someone to learn but a mentor/teacher can coach and create an understanding on why learning is of value. The problem however according to Moxnes (1984) is that it is hard to stimulate people so that they actually want to learn. People are also motivated by different things, according to Stone (2008) motivation can be divided into two main categories: internal- and external motivation. Internal motivation is connected to the inner

curiosity and excitement of learning that is often gained at birth whereas external motivation is connected to incentives such as rewards or bonuses achieved for learning. In the case of learning new tasks it is preferable to have employees with internal motivation because they have a greater willingness to learn (Stone, 2008).

The self -determination theory describes how the internal motivation is affected at the workplace. According to Regström and Andersson (2006) the self-determination theory consists of competence, autonomy and affiliation. All these three factors are important to create internal motivation and will therefore affect the learning process. Fowler (2014) also mentions what motivates people based on three psychological needs: Autonomy, relatedness and competence. This view is similar to the self-determination where autonomy is described as the need for self-governance and a choice and can influence the workplace. Competence refers to the need to develop and face challenges and get new opportunities to grow (Fowler, 2014). And relatedness or affiliation is the need to feel that one is connected to another and not only contributing by oneself but also in a bigger picture. It is the need to belong and to work together towards common goals (Fowler, 2014).

2.3.2.3.Exhaustion

Exhaustion stems from mental or physical work and means tiredness. If an employee has done a lot of mental or physical work or even slept badly it can lead to exhaustion. Too much information presented at once also referred to as information overload is also something that can result in exhaustion that in turn can affect the learning process or completing work tasks (Colman, 2015). It is very individual and different people are affected in different ways but reasons behind exhaustion can be stress, information overload or working with monotone work tasks for too long.

2.3.2.4.Previous experience

With previous experience from similar working tasks will affect how fast an individual collects new information within the area. This is mainly because previous activities affect the brain's ability to directly gather the information in a more accurate manner. However, previous experience can also have a negative effect, since that experience can be performing a task in a completely different way than what the new “arbetsgivare” demands. If the previous experience is considered positive then the learning process will take less time (Rubenwitz, 1999, från deras arbete kanske ta de som reff)

2.3.2.5.Age

One important factor that affects learning is age and the general perception is that young people often have an easier time learning new tasks. Age can create problems in learning and when it

comes to repetitive work age means that it will take longer before the person knows how to perform the task for the first time and after repetition it will be harder to complete the tasks in time (Moxnes, 1984). However it is also mentioned by Moxnes (1984) that this is not always true and in fact sometimes age means that it is easier to learn. This was especially true for new tasks that were of importance to their work.

2.3.2.6.Repetivity

According to (Chaffin and Hancock, 1966) the manual tasks in the automotive industry often consist of an operator doing identical movements a number of times under one working cycle. This is defined as internal repetitive working moments that are not repetitive within one cycle should be learned separately, but the repetitive moments are learned most effectively in the working cycle since it is repeated (Chaffin and Hancock, 1966).

2.3.2.7.Complexity

The complexity in a working task is determined by the amount of information it contains and not how long the working cycle is (Chaffin and Hancock, 1966). Thus, the complexity is defined as the amount of clues and movements that has to be taught in order to accomplish the task flawlessly. According to Chaffin and Hancock (1966) research the learning time is directly affected by the complexity of the working taks. Thus, reducing the complexity by dividing the working tasks into different smaller working tasks will reduce the learning time. It is also stated by Regström and Andersson (2006) that a high degree of complexity can lead to an impaired performance, uncertainty and stress.

2.3.2.8.Stress

According to Mark A. Staal (2004) stress can be defined as "...an agent, circumstance, situation, or variable that disturbs the 'normal' functioning of the individual...stress [is also] seen as an effect—that is the disturbed state itself...this bifurcation of meaning is arguably the most fundamental source of the confusion surrounding the stress concept."

In the industrialized countries job stress has a major occupational health problem, where researchers have large documentation of that stress at work impairs memory, attention and action (Purwandini et. al., 2012). Purwandini et al. (2012) mentions that extreme forms of job stress can create burnout, anxiety and depression which can lead to reduced effectiveness, lost productivity and high healthcare expenses in industries, costing thousands of dollars in damage to workers health and damage to equipment.

Stress can occur from both physical and psychological sources; research demonstrates that individuals with low job control over their job experience have higher stress levels than those with high job control (Purwandini et al., 2012). Other factors that have shown being sources to crease stress are high job demands, noise, improper lightning, lack of social support and lack of autonomy (Purwandini et al, 2012). Purwandini et al. (2012) adds that specially for manufacturing workers where they generally work hourly shifts and sometimes have ordered overtime, this leads to a disruption of their work rhythms, which has a high impact on the quality of work, sleep and social life and results in increased stress.

There are four main approaches to reduce and manage stress: physiological, behavioral, psychological and environmental where the first three are individual focused. The individual focused strategies aim to increase an operator's resources to handle stressful situations that can occur in a workplace. The individual focused approaches are more popular due to the fact that they can be established and evaluated in a short time at an inexpensive cost. Breathing exercises are proven by research to be an individual resource that are able to help stressed people think clearly and decrease their stress levels after performing them (Purwandini et al, 2012).

2.4.The learning process at Toyota

It is described by Liker and Meier (2007) that Toyota is using the Job instruction program as a method to break down and analyze jobs and to teach them to new employees. They do so by using a four-step method which is a critical factor in Toyota’s ability to develop people. In this section the way Toyota breaks down the jobs into elements will be presented followed by the job instruction program and how people working with training of new employees learn how to use the four-step model based on the job instruction course. It is important that the job instruction training is done by someone that is capable of following the standards as well as having the right capabilities to train and teach others. According to Liker and Meier (2007) the overall intent with the job instruction method is to enhance productivity by reducing the “break in” period and to improve safety and quality by making sure that the workers understand critical elements of the work.

2.4.1.Breaking down the job into elements

It is explained by Liker and Meier (2007) that the breakdown of jobs into elements include three main parts: The major steps of the job, The key points of the job and the reason why the key points are important. The identification and presentation of key points is described as the most important aspect when it comes to the training process and the key points are what ensures the safety of the worker, quality of the product, the productivity rate and the control of the costs

(Liker and Meier, 2007). Shortly describing the major steps defines what is being done and the key points describe more in detail how the major steps are performed.

Breaking down jobs into elements is a big part of the standardised work mentioned previously and it is also necessary to break down the job in order to effectively teach others (Liker and Meier, 2007). standardised work is a process that is used by Toyota to develop their work methods and it is described as a process that intends to produce specific outcomes connected to the work. Toyota just as every other organisation strives to generate high results and they believe in the key to success being the development of talent as well as generating excellent work methods (Liker and Meier, 2007). It is emphasized by Liker and Meier (2007) that there is a difference between breaking down tasks to accomplish standardised work and breaking down tasks for training and teaching. However, standardised work goes hand in hand with job instruction training which is the main method that is used to develop people at Toyota.

It is further described that in order to reach the best results from the training process it is necessary to break down the jobs into small pieces that can easily be trained and teached. Often the entire job is divided into tasks, which then is divided into steps and finally these steps are divided even further into elements. If the work is not divided into small elements and the work is not detailed enough many of the most critical elements can be lost in training (Liker and Meier, 2007). It is mentioned by Liker and Meier (2007) that when an organisation thinks that they have divided the work inte small elements most certainly Toyota would have defined the details five times as much.

One of the most common mistakes when trying to teach a new operator a job is that too much information is put into one job, for example an entire job is being teached in one session or the breakdown of the job is not done in detail resulting in lumping together many different elements into one single task. One of the most important parts of the job instruction method used by Toyota is the fact that a student should not be presented with more than they can process at one time. Since learning is very individual it is a challenge for the trainer to understand the specific situation for every student but they have to be able to evaluate the situation during the training and adjust accordingly (Liker and Meier, 2007).

It is often assumed that the best way to teach a new employee an entire job is to do so based on the sequence that the elements are performed. It is described by Liker and Meier (2007) that in reality the best way to teach an entire job is to do one element at a time in a specific sequence but this does not mean that this sequence has to be in the same order as they are performed.

2.4.2.The job instruction program

How knowledge is transferred effectively within Toyota has a lot to do with the job instruction program that is used. The job instruction program at Toyota can be divided into four steps: Prepare the student, Present the operation, Try out performance and Follow up.

The first step is to prepare the student, which means that the trainer should identify what knowledge the student has and create interest in the work being performed. It is also important that the trainer helps the student relax and make sure that they are not stressed going into the next step of the job instruction program (Liker and Meier, 2007).

The second step is to present the operation. In this step the major steps and the key points are introduced to the student. These are based on the breakdown of the job done previously and are used to provide the student with a standardised way to perform the work tasks (Liker and Meier, 2007). As mentioned previously the major steps are the general steps included in the job while key points are more detailed in the way the major steps are performed. When training a new employee the major steps are shown first and the student is just observing. The second time the major steps should be presented again but this time the key points should also be included. The third time reasons behind the key points should also be introduced to the student (Liker and Meier, 2007).

The third step is Try out performance and in this step the student is introduced to the work task and gets to try out to perform it. It is important that the trainer interrupts and corrects the mistakes in this step and it also works as a good way for the trainer to evaluate the skill of the student and make a decision if step 2 needs to be repeated. When the student is performing the steps they should also do it three times where they first only explain the major steps then the key points and lastly the reasons behind the key points.

The fourth and final step is Follow up. In this step the student is tested on their skills and they are encouraged to ask questions to be able to perform the tasks correctly. The trainer should only observe and give feedback when they deem it necessary. In this last step the student should be able to perform the work independently. This four step model could be used for all different work tasks to help train new employees in an effective way.

2.4.3.The job instruction course

The job instruction program is teached to all trainers in a job instruction course. The job instruction course takes place in a classroom setting over 5 days of 2 hour sessions each. This course does not mean that the employees are ready to teach using the job instruction method and can be trainers. They do not get the practical experience necessary just by taking this course and

therefore it is important that the more experienced trainers and the team leader work and coach the new trainers until they can perform the job independently (Liker and Meier, 2007).

The content of the job instruction course can be seen in figure 4 and will be explained further in this section. The first class includes a discussion on the importance of effective training and the important role of the leaders. The new trainers also get to familiarize with the job instruction method. All sessions are designed and built on the previous session and the students are asked to present and demonstrate a training for each session. This means that the second day includes the first training demonstrations, the first demonstrations is often not that good since they have not yet been taught how to work with the job breakdown process but this is intentional to show the new trainers what happens if the student is not prepared and only have seen the job being performed one time (Liker and Meier, 2007). Most of the time is used to let the new trainers demonstrate their take on the job instruction method to help them learn from each other (Liker and Meier, 2007).

It is emphasized by Liker and Meier (2007) that the new trainers are far from ready to teach new employees just based on the job introduction course. At Toyota each new trainer that returns from the job instruction course to the workplace is mentored by other skilled trainers and the team leader who also should be trained in the job instruction method. This is done because each of these leaders have a lot of practical experience working with the job instruction method and are skilled in the process.

Day 1:

- Introductions (put students to ease).
- Get students interested in learning.
- Help students see the need for effective training.
- Review five requirements of leaders.
- Demonstrate ineffective training techniques.
- Demonstrate correct instruction technique (job instruction).
- Review the four-step model

Day 2:

- Brief review of day 1.
- Training demonstrations from students (2).
- Instruction on breaking down the job (job breakdown).
- Review preparation necessary for training.
- Summary.

Day 3:

- Brief review of day 2.
- Review four-step method (recite pocket card).
- Review job breakdown sheets
- Develop a multifunction worker training plan.
- Training demonstrations from students (3).
- Summary.

Day 4:

- Brief review of day 3.
- Review four-step method (recite pocket card).
- Review multifunction worker training plans.
- Training demonstrations from students (3).
- Handling difficult teaching situations.
- Summary.

Day 5:

- Brief review of day 4
- Review four-step method (recite pocket card).
- Training demonstrations from students (3).
- Summary and final encouragement.

Figure 4: The content of the job instruction course (Liker and Meier, 2007).

3.Methodology

In this section of the paper how the thesis was designed and executed will be presented. First, the research strategy as well as how the work was executed will be presented. This will be followed by the data collection including how the data was collected and why. After that the use of the data to analyse and answer the research questions will be presented. Lastly, a part on the quality of the research will be presented including validity and reliability of the research.

3.1.Research strategy and Research execution

This thesis was conducted based on an empirical study made at a case company consisting of observations of new operators being introduced to the assembly work and interviews with people that were deemed of interest at the organisation. It is described by Patel and Davidson (2019) that there are three ways of conducting a research and that is either inductive, deductive or abductive. An inductive research is when the researcher starts with the empirical research and bases a theory on that. Deductive theory on the other hand starts with established theory and conducts the empirical findings to essentially confirm the theory. Lastly, abductive research is a combination of the two previously mentioned ways to conduct the research (Patel and Davidson, 2019). The work conducted in this thesis was mainly deductive where established theory was used in combination with the empirical findings to find possible solutions to the perceived problem of affectance on the takt and quality when introducing new operators at the assembly line.

It is also mentioned by Patel and Davidson (2019) that it is important to consider the research strategy when conducting this kind of research. This thesis was conducted based on a qualitative research strategy as well as previously mentioned a case company strategy. The most distinctive difference between qualitative and quantitative research methods is that qualitative research methods are more based on words than numbers (Bryman, 2018). Since this thesis was an empirical study conducted based on interviews and observations a qualitative research can be favourable since it generates a more in-depth knowledge. According to Denscombe (2014) the purpose of a case company approach is to understand the complex relationship between factors as they operate within a specific social setting.

3.1.1.Literature study

The research conducted in this thesis was divided into four main parts. These research executions and in what order they were conducted can be seen in figure 5. The first part was a literature study, the main focus of the literature study was theories of learning, learning organisations, learning within production teams, lean culture and lean production. The literature study was

conducted primarily using the databases provided by Chalmers Library as well as Google scholar to ensure the validity of the scientific references used. The literature study worked as a foundation for the continued research and was used as input when conducting the data collection and the analysis of the data collected.

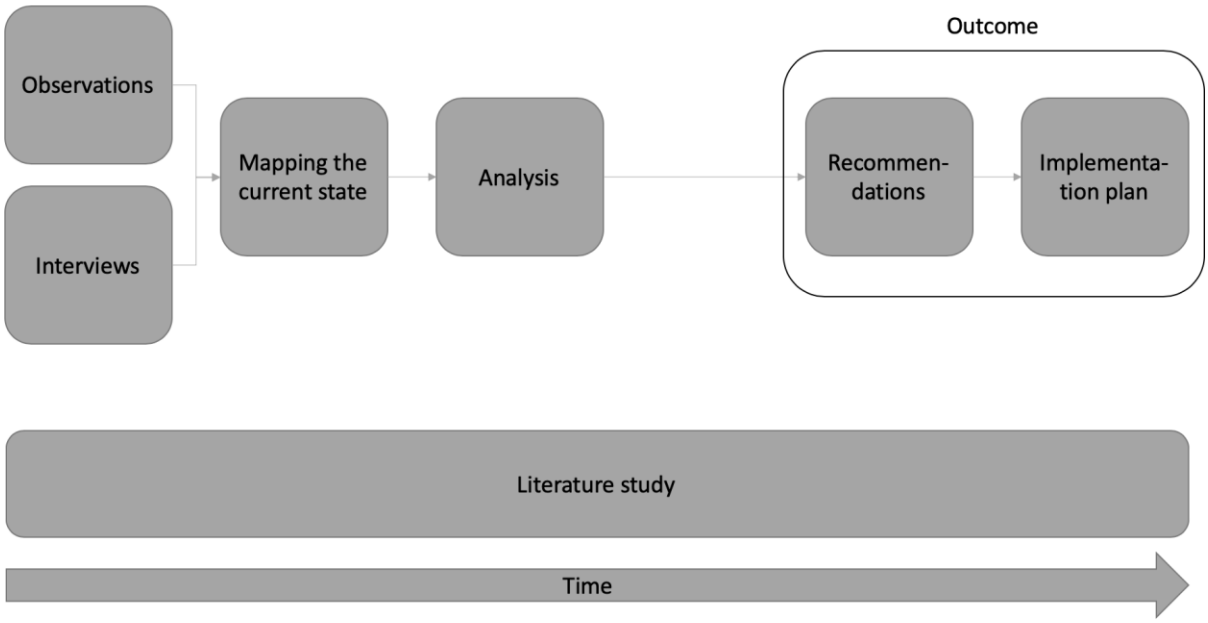

Figure 5: An illustration of how the research was conducted including the 4 main parts and the outcome of the research.

3.2.Data Collection

The data collection performed by the researchers is mostly generated through qualitative methods but also quantitative methods have been used to gather data. The data gathered can either be primary or secondary sources. Primary sources of data means that the data is gathered directly by the researchers and the secondary source of data is described by Dencombe (2014) as the data is gathered by somebody else. For this research mainly primary sources of data collection have been used.

3.2.1.Observations

Observations is a qualitative research method that is used to collect valuable information at the actual production site (Patel and Davidson, 2019). Observations were not conducted at random but instead the observations were carefully chosen to make sure that the information gathered by the researchers was relevant to the project and also documented. Observations were made on the

daily work of Supervisors (SVs), Team leaders (TLs), tutors, instructors at the introduction to assembly work and new operators. The focus of the observations was the new operators and the process of learning but since all the other roles mentioned are a part of the learning process their work connected to learning was important as well. One of the values of observations is that the researches can observe behaviours and events at the time they occur in a natural setting (Patel and Davidson, 2019). Observations of the learning process at the case company demands that the researchers are at the actual production site to create understanding of the learning process that is investigated. This was done over the entire period that the thesis was performed and the researchers were at the production site on several occasions every week.

Observations are defined by Bryman (2018) as the process when researchers engage in the environment of study during a longer period of time, observations are conducted connected to the actions of the participants in this environment, observations are conducted regularly and the researchers engage in conversation to interview participants to gain information that can not be observed directly. It is also mentioned by Patel and Davidson (2019) that there are different types of observations and for this thesis unstructured observations were decided to be used to gain understanding of the everyday work and behaviours. The unstructured observations were performed over the course of the entire project. First, unstructured observations were performed at the introduction to assembly looking at the daily work of the instructors and what the new operators learned at this step of the learning process. These observations were done for several days across different weeks looking at the learning process for different operators going to work at different modules of the organisation. Unstructured observations were also conducted at the final assembly, this was harder to perform since the objective was to observe new operators starting at the assembly line. It required planning to make sure that the researchers were present when the new operator was deemed ready to start at the final assembly. Unstructured observations were made with three different operators starting at three different modules to observe how the learning process looks like when the new operators are introduced to the assembly work at the line. The researchers also participated in the tutor course of the organisation which consisted of observations through the entire 2-day tutor course to gain understanding of what the tutors of the organisation is taught and how that is later used.

3.2.2.Interviews

In this thesis qualitative interviews were conducted. It is described by Patel and Davidson (2019) that semi structured interviews are more common to use in qualitative research because it is often not as standardised as structured interviews may be (Patel and Davidson, 2019). The idea is to make use of semi- and unstructured interviews because they are more flexible and it gives the researchers possibilities to follow up questions of interesting topics (Bryman, 2018). A problem with semistructured and unstructured interviews is that the result of these can be hard to compare

because of the vast difference that can occur between the different interviews. This is why semi structured interviews could be preferable to use over unstructured interviews for the researchers to be able to make more of a comparison between the different interviews (Bryman, 2018).

Unstructured and semi-structured interviews were held to create understanding for the learning process of new operators. Two different interview templates were created because different topics were of interest. The templates were used to be able to answer both the research question regarding the learning process of the new operators as well as the introduction to improvement work. The first template can be seen in Appendix A and focused on the first research question. It was divided so that the first part included information regarding the interviewee and their role, age, work experience etc. The second part of the interview focused on the learning process and what it looked like as well as the role of the SVs, TLs and tutors when it comes to the learning process of new operators. The second template can be seen in Appendix B and also included a first part regarding role, age and work experience but focused more on the second research question regarding improvement work. It included questions regarding how the improvement work looks like today as well as how new operators are introduced to the improvement work of the organisation.

In total 28 interviews were held with people from the organisation including SVs, TLs, Tutors, Instructors at the introduction to assembly, Operators and New operators. Both the interview templates were used with people of these roles but occured at two different occasions because the researchers wanted to keep the interviews shorter and to the topic. This means some people were interviewed twice but based on different questions and topics. Each interview conducted lasted for approximately 10-15 minutes and was conducted over a span of approximately 4 weeks.

3.2.2.1.Unstructured Interviews

The interviews held with the instructors at introduction to assembly were unstructured interviews because the environment there allowed for open conversations and follow up questions to gain understanding of the learning process there as well as how the different instructors worked with the new operators. The interviews were held with several different instructors at basic skills and at different times to complement the answers with more follow up questions.

3.2.2.2.Semi-structured Interviews

It was shown that the learning process of new operators when being introduced at the assembly line involved a lot of different people with different roles. Semi-structured interviews were held with Supervisors, Team Leaders, Tutors and new Operators. The prepared interview templates can be found in Appendix A and Appendix B but there was a lot of room for follow up questions

to follow interesting topics which were brought up during the interviews. All interviews were also recorded to make sure that nothing important was missed when conducting the interviews.

3.3.Analysis of the research questions

The analysis of this study was based on three different parts, the literature study, observations and interviews. The observations and interviews were the foundation to map the current state of the learning process and the improvement work. The literature study in combination with the current state worked as the base of analysis. The analysis was structured based on the current state of the learning process identified in the empirical findings. How the analysis was conducted for the different parts of the learning process to be able to answer the research questions and how that was done will be presented below.

The first research question was: "*How does the learning process for new operators look like today and what improvements can be done to avoid disturbances in the takt when new operators are introduced at the assembly line?"* To answer this firstly the current state of the learning process of new operators had to be identified and that is why observations were made through the entire process of learning for new operators. Starting from when they get introduced to the organisation at introduction to assembly work to when they are deemed ready to work on their own at the assembly line. The current state was then compared with established literature regarding learning in general, factors that affect learning, learning time, learning curve and how toyota are introducing new operators to ensure performance. The important thing when conducting the analysis was understanding how the current state of the case company related to the literature and in what ways the mismatch/match would have an affect on the takt and quality of the operations of the organisation.

The second research question was: "*How are new operators introduced to the improvement work of the organisation?"* To answer this question similar steps were taken as for research question one. First the improvement process of the organisation was mapped based on interviews and observations to create an understanding regarding the process. Then established literature regarding improvement work, continuous improvement, organisational culture, organisational learning and learning theories were used to compare the current state of the case company to what established literature said. Not only did the research include an analysis of how new operators were introduced to the improvement work of the organisation but also what effects that can have on the performance and the overall vision of the organisation.

3.4.Research Quality

To make sure that the research conducted has credibility different aspects need to be considered. According to Denscombe (2014) it is important to consider aspects connected to validity and reliability to gain credibility. It is described by Denscombe (2014) that it can be hard to ensure validity of qualitative research since it is hard to replicate a social setting as well as the fact that the researchers are involved in the collection of data as well as the analysis of that collected data. This will make it almost impossible for others to replicate the research and get identical data or come to the same conclusions. In this part of the thesis the steps taken to ensure validity and reliability will be presented.

3.4.1.Validity

The researchers have done several things to try and ensure the validity of the research to convince the reader of the credibility of the research. Firstly, it is recommended by Denscombe (2014) that the researchers validate the findings with the participants to make sure that the data gathered is correct. If this is done the researchers' understanding of the information gathered can be confirmed by the ones that were interviewed or studied in the observations. For this thesis all information gathered was double checked with experienced personnel within the areas to make sure that the understanding was correct.

The researchers also validated the data collected by conducting interviews regarding both the learning process and the improvement process with different roles of the organisation. Not only did the interviews include different roles but also different people with the same roles to ensure that the information gathered was credible. Both the authors of the thesis were present at the interviews and all interviews were recorded to make sure that no information was misinterpreted or neglected during the interviews.

One important aspect of this thesis was the impact of the global pandemic Covid-19. The case company was severely affected by the pandemic and had to lay off employees as well as shutting down the operations over a couple of weeks. This affected the research because it made it harder to collect data over a certain time which also limited the work because the amount spent on gathering data became longer meaning that the establishment of understanding regarding the current state took more time. This in turn took time from the possibility to perform the analysis and evaluate the recommendations of improvements.

3.4.2.Reliability

It is also common in qualitative research that the researchers are very close to the research and is a big part of how the research is conducted. Therefore a question of reliability can be raised since it is important to understand if the same research conducted by a different team would end up in the same conclusion or if the authors had an impact on the overall results of the thesis. This is discussed by Denscombe (2014) where it is important to consider how the overall result of the research is affected by the researchers conducting the research. The question of reliability is hard to answer but measures have been taken to ensure the reliability of this thesis. First, the researchers have tried to verify the established theory with different sources to make sure that the information used in the analysis of this work is credible and good to use. The researchers have also conducted semi-structured interviews where the interview templates consisting of the same questions to all interviewees ensures that the same information is gathered from the different roles.

4.Empirical findings

In this section of the paper the collected data will be presented as empirical findings that act as a basis for the analysis of the research questions. The empirical findings section will start with a description of the case company including the final assembly where the study was performed as well as the different roles involved in the learning process of new operators. The tutor course and what information new tutors are introduced to regarding their work will also be presented. After that the current state of the learning process of new operators will be described which is in line with the first research question of this thesis. Finally, the current set-up regarding improvement work will be explained to help answer the second research question of this study.

4.1.Case company description

The case company is a manufacturing organization and the thesis will focus on one of their engine plants. The plant has three engine models with the capacity of producing approximately 600 000 engines per year. The plant is located in southern Sweden with a size of approximately 140 000 square meters. There are currently around 2000 employees from 16 nationalities where 77% are male and 23% women. The production plant located in Sweden is both working with manufacturing and assembly.

The overall vision of the different manufacturing units of the parent company is to: “Become best in class in manufacturing”. This overall goal has been translated to an internal goal for the organisation that is: “World class manufacturing of propulsion systems and components in lean systems designed around people produced where consumed” and the purpose of the engine plant is to manufacture with operational excellence in demand driven flows. To become best in class in manufacturing the organisation is working with: Ideal state to ensure that there are a vision in place for how to create the ideal manufacturing state, model line where the optimal assembly area is created and M3MU (Management of Muri, Mura, Muda) workshops to train participants on how to find losses. To achieve the vision, focus areas and targets were set for 2020. These targets were broken down by top management of assembly to create specific targets to be achieved at the end of 2020. This thesis was conducted during the spring of 2020 where new targets had been set based on a 5 year plan. For assembly this 5 year plan includes targets such as: create a continuous flow, to be andon implemented, gain a fully synchronized tacted operations, standardised work, zero losses when introducing new operators and to create good conditions for the operators (Muri, Mura, Muda).

The assembly is divided into an inner and a final assembly where the work at the inner assembly has a higher level of automation and the final assembly consists more of manual labour. This thesis will focus on the final assembly part of the organization.

4.1.1.Description of final assembly

In the final assembly plant there are 4 different manufacturing areas also called modules, where a supervisor (SV) is responsible for one of the manufacturing areas. Furthermore each module consists of 2-4 assembly loops with approximately 6-8 workstations for each loop and about 10 operators and one team leader (TL), see *figure 6*.

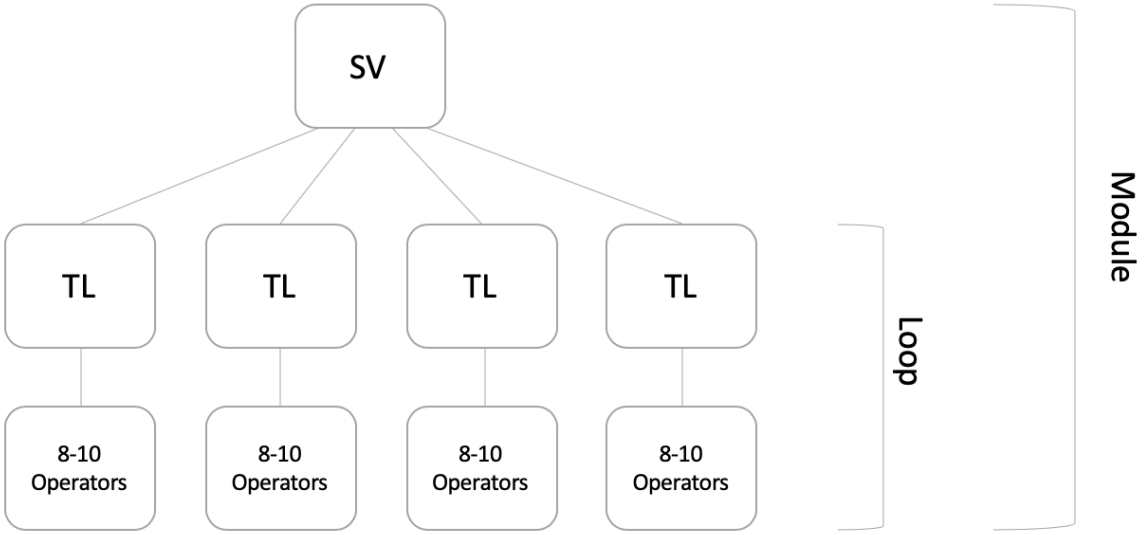

Figure 6: Hierarchy levels for one module of final assembly.

The assembly plant is open three shifts and the production is running with the start of a night shift on sunday and stops after the dayshift on friday. However, approximately 8 times throughout the year the production is extended with an evening shift. They have a two shift system, which means the people who work day and evening are shifting every week. They call it fmj and fmu which stands for morning even weeks and morning odd weeks. Meanwhile the night shift people always work the night shift. As seen in figure 6, every module has a supervisor and each assembly loop has a team leader with approximately 8-10 operators. In every team operators rotate to the next workstation after a certain number of assembled engines, this could differ depending on the team, which means that some teams rotate to the next workstation after a couple of minutes and some can stay at the same workstation for about 20 minutes.

The engines move along the workstations on Automated Guided Vehicles (AGV) and at the end of each module there is a quality checkpoint station. After leaving the module there is an additional quality checkpoint station, which is the last step for every engine no matter the module which also is the last step before delivering to the customers, see figure 7.

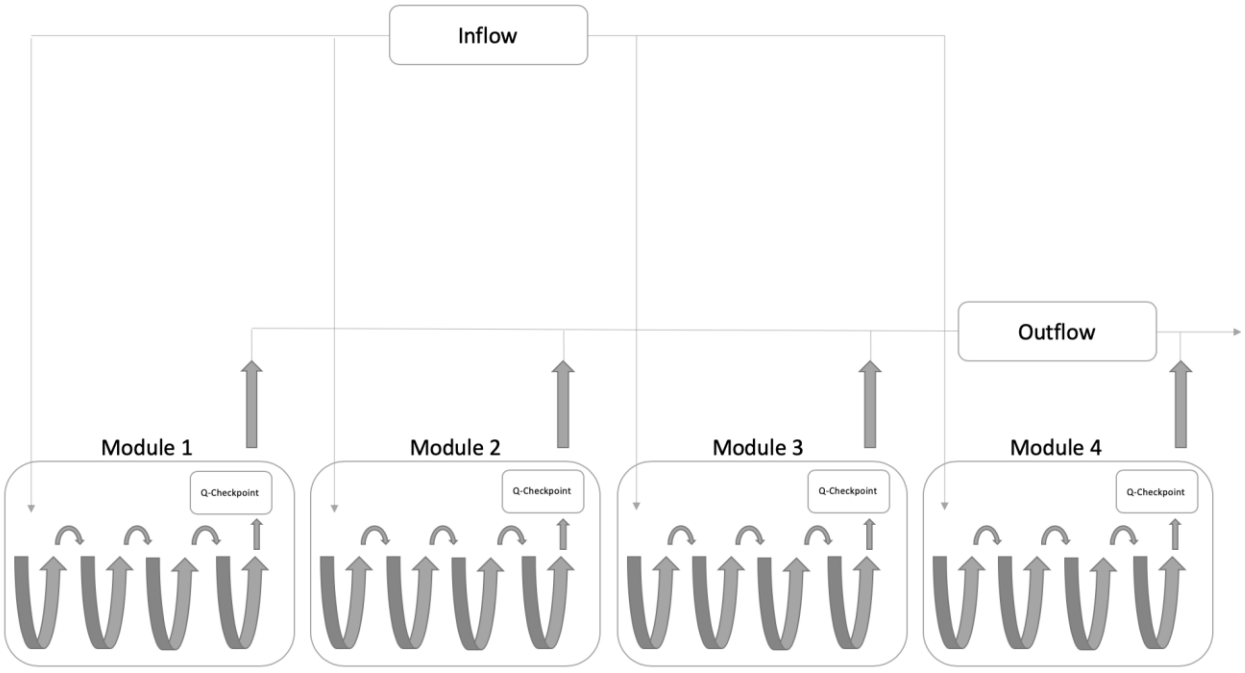

Figure 7: Illustration of the layout of final assembly for the case company.

Today module 3 and 4 have a synchronized takted flow which means that the operations performed at the workstations are dependent. The engine will not be transported to the next workstation until everybody at that assembly loop has confirmed the activities and even if they are done before the takt the engines will not move. The average time to perform a station is between 1 to 2 minutes. There is a buffer station between the assembly loops that can hold up to two engines which helps in preventing problems in one assembly loop affecting another loop. Modules 1 and 2 however are at the moment not using this synchronized takted flow. They are working based on a takt, calculated by demand, but in these modules the engines are pushed forward in the loop to the next workstation when an operator confirms that all work activities are done in the previous workstation. Today they are also working with Real Time Management (RTM) at module 3 and 4 which means that they have operational control by constantly checking that they are managing the takt and quality in order to maintain the functions of the organisation (Borovits and Segev 1977).

4.1.2.Role description of Supervisor

The role of the supervisor has been described by the organisation in a document in the Business Management Strategy (BMS) routine. The role Supervisor (SV) is responsible for a defined process within the Manufacturing & Logistics (M&L). The SV works with activities and assignments within a professional area and has the authority to organize, lead and manage assigned resources to fulfil the managerial responsibility. They have the authority to escalate unsolved issues to support functions or managers and they have financial authority in accordance with the overall guidelines of the organisation. The SV's have a lot of responsibilities and the main responsibilities of the SV is listed in *table 1* below:

Table 1: Generic description of the main responsibilities of the SV

Main responsibilities of the SV
Responsibilities of the deliveries, improvements and coaching of the team towards decided priorities.
First responder to the teamleader.
Execute solid Real Time Management.
Continuously drive improvements to optimise performance of Safety, Quality and Delivery.
Always act immediately on deviations.
Plan group activities and implement company initiatives.
Is responsible for people management for his/her area.
Execute buffer management and line containment.
Break down tasks and give assignments to increase team members' skill levels.
Training and coaching of team members on a daily basis and fostering the culture.
Coordinate all training and team members development

The documentation on the role of the SV also describes competence requirements including skills and behaviours. The skills required are defined as: 5S, ownership and responsibility areas, Visual management, monitor, andon, coach and train standardised work and improvement mindset. Behaviours of the SVs' included the building of trust, collaboration, self-development, resilience and achieving results.

The SVs are responsible both for the development of the team members and the work with Real Time Management which for final assembly means managing takt and quality. A large part of SVs work is performed at gemba. During the interviews with the SVs they were asked about prioritization and what is considered more important; takt or that the learning process is as fast as possible. Depending on who you asked the answer to this question could differ a lot. Some SVs thought that the most important thing is that the new operator can be counted as an operator in production like the other operators. Other SVs thought that the most important thing is that the takt is affected as little as possible and if that means that the learning process will take more time then so be it.

How the work was done also differed a lot depending on where the SVs worked. Most of them said that the main responsibility was delegated to the tutor but that there were guidelines and a vision to work more standardised with the learning process. However, this was not the case for most lines in production. In module 3 and 4 where the production flow is synchronised and the work with Real Time Management is more present, the SVs together with TLs and tutors worked to standardise the way stations are broken down into shorter activities to better cope with the takt but this was a work in progress. However, they tried to work according to the step-by-step model, which will be presented in this section, in module 3 and 4 but this was not as important in the other modules where the tutors worked more individually showing all the stations and letting the new operator follow the same rotation as everybody else, meaning they switch stations approximately every 12 engines.

4.1.3.Role description of the Team leader

The role Team leader (TL) is allocated to a specific production team within Manufacturing & Logistics (M&L). The purpose of the TL is to support the team and coordinate the team to deliver products and services on time based on defined standards. They have the authority within their own team to coach, divide tasks and escalate unsolved issues to support functions or SV to secure fulfillment of the defined responsibility. The defined responsibilities of the TL are presented in the *table 2* below.

Table 2: Generic description of the main responsibilities of the team leader.

Responsibilities of the team leader
Training and coaching of team members.
Support team members over cycle, relief, repair and fix concerns.
First responder to team member andon.

Coordinate and support team improvement activities of process and standardised work.
Coach the development of the team and support the culture.

The competence requirements of the TL is connected to both skills and behaviours. They need skills in 5S, Visual management, andon, required competencies to execute and train standardised work and problem solving methods, which is much alike the skills required for the SV. The behaviour necessary for the TL is trust building, collaboration, self-development focus and result-oriented.

Based on the documentation the TLs are responsible for the training of team members but based on the interviews with the TLs it was made clear that all responsibility for the learning process of new operators is put on the tutor. The TL together with the SV makes sure to appoint operators that are pedagogic and good with quality rather than performing the tasks the fastest. They have a responsibility to choose tutors that they deem can perform the job the best and will ensure that the new operators that start in their team will be able to learn the different workstations as fast as possible.

4.1.4.Role description of the tutor

As described previously the tutor is assigned by the SV and TL and has the responsibility to help teach and coach new operators. The competencies required to be a tutor is a continuous improvement mindset, focus on quality and takt and a pedagogic mindset to be able to help the new operator to learn all the different workstations. How the tutors are supposed to coach new operators is learnt based on a two day tutor course where guidelines from the organisation are presented, this is described more in the next part of this section. However the reality is that there is not one standard on how tutors work today, the tutors work based on the way they think is best and do not always follow the instructions provided at the tutor course. In some cases the operators working as tutors haven’t even taken the tutor course.

4.1.5.Role description of the instructors of the introduction to assembly

The instructors at the introduction to assembly have the role to guide and develop the new operators to have more tools and preparation when being introduced to the line. The main areas that the instructors focus on is to train the new operator in regards to quality, ergonomics and safety. There are however no written instructions on how the instructors work with the learning process but they have agreed on a method of working and based on the interviews everybody follows these steps. The instructors are also responsible for the tutor course where their role is to prepare and educate operators to become tutors at the assembly line.

4.2.Tutor Course

The Tutor Course is a two day course that you need to attend in order to be able to tutor new operators in line. The course mainly includes information about safety, ergonomy, pedagogy and how to think when tutoring someone new. The course contains a total of three exercises. The course is given by the instructors of introduction to assembly and is structured both in a classroom setting and practical experience in the introduction to the assembly workingfield.

4.2.1.First Day of the tutor course

Day one starts with getting to know each other, so all the participants in the course and also the instructors introduce themselves, where they work, why they want to become a tutor etc. The participants receive two booklets, one that contains pictures of the course powerpoint and the other one contains movement exercises. The instructors go through their powerpoint where main topics are ergonomy, safety, pedagogy, explaining what Operator Instruction Sheet (OIS) and Work Element Sheet (WES) is and how important it is to work according to them. Engine and tools knowledge is also presented to the participants of the course. The instructors go through their engine models and basic information about their products. This info is said to be important to know since the new operators will be curious and ask many questions. It is deemed important for the tutors to be able to know and give answers to the majority of the questions. This is to set an example of the culture and set a standard of the operator's knowledge.

Tutor exercise one was to study introduction to assembly exercise one and read the OIS/WES in 30 min. After the 30 min, the attendant's assignment is to show the working place, prepare an operator, show and instruct, allow practice, follow up with tips. To make this exercise more realistic the instructor brought one of the new operators from introduction to assembly, to be the person that the attendants will do the exercise on. After the sequence the rest of the group gives feedback on how they tutored, then the instructors also give feedback.

After the first tutor exercise the rest of the day is in a classroom setting, where the instructor talks about the step-by-step model. It is described by the instructors that the best way is to teach the operators one step at a time and the entire loop or even the station at once. The tutors need to directly disrupt missconduct and ask open questions to verify that the new operators understand why they perform certain steps. The step-by-step model is explained and contains four steps: Prepare the operator, show and instruct, practice practice practice and the last step is to follow up see *figure 8*.

Figure 8: An illustration of the four steps included in the step-by-step model.

The instructor explains that when preparing the operator you have to be kind, ask questions, and be relaxed in order to reduce stress. Ask questions about their past experiences and listen to them in order to understand what level of explaining and training they need. Explain the workplace includes safety and ergonomy in order to make sure that there are no misunderstandings. Explaining the workplace also includes describing the work task by explaining the production, showing a finished product and going through the OIS and WES. When this is done the tutor can move on to step two which is show and instruct. The tutor should demonstrate the work as many times as needed and this should be done by explaining what they are doing, how they are performing the work task and why they do it this way. The third step is to let the operator practice, let them try as many times as they feel they needed. Ask questions and let the operator explain, what? how? and why? The fourth step is to follow up, where the operator is expected to do everything themself, the tutor can ask questions and only jump in to coach if needed, in this step the tutor should continuously reduce the follow-up.

Day one ended with tutor exercise two, which was that they had two hours to go around in the production factory in groups to gather as much information as they could about three articles that they would like to learn more about connected to the production and assembly of engines.

4.2.2.Second day of the tutor course

Day two started with the groups introducing the articles they have gathered information about and explaining them to the rest of the participants as if they were explaining this to a new operator. Here the instructors observe what they say and how they explain. After that they gave feedback on what was good and what they could have done differently.

After that the instructors go through engine knowledge and screw joints. The engine knowledge is not included into the introduction to assembly but screw joints is information that the new operators received during the introduction to assembly week, this information is shared in order to explain why and how they should assemble. The tutor receives information about the engine and screw joints in order to have the knowledge and to be able to answer the questions from the

new operators. Not only know what and how to assemble but also why it is done. The preparation for tutor exercise two, tutor exercise two, the engine and screw joints presentation took in total 6 hours of the entire tutor course.

Tutor exercise three started after lunch, which was performed in two groups and where the participants studied station 110 at introduction to assembly for 50 minutes. After the 50 minutes, a new operator from introduction to assembly is the person that they should introduce to the station, give instructions by following the step-by-step model and tutor for that station. The exercise had four stages, introducing the workplace, preparing the student, practice and guide. After the two groups completed the exercise, the instructor gave feedback on what was good and what could have been done better.

The instructors then started talking about andon, that it is a system that creates possibility for improvements and that they should encourage the operators to use the andon system if something is wrong and not be afraid or ashamed to do so. Andon should be used when there is wrong material, something is not safe, quality deviation, uncertain situation etc. The instructor moves on to explain how quality is everyone's responsibility and that it is crucial that the tutor do things the right way to encourage the new operators. If something is wrong the new operator has to understand that they press andon and alarm that, since quality has to be on top. They talk a little about 5S, safety rules and show them a checklist on what a tutor should explain to a new operator. The OIS, WES and key symbols was also explained, what they are, how to read them and what everything stands for. Here the instructor explains that OIS and WES is the current best way to work and they are often updated which is why Pcpt, which is the system where the OIS and WES is updated digitally, is an important tool for the tutors where they can always go in there and see the latest updates in OIS and WES. This was the last part of the tutor course and the instructors asked each and everyone, before leaving, to do an online survey to receive feedback of the course.

4.2.3.Interviews regarding the tutors

Based on the interviews held with SVs it was made clear that the tutors often do not have the resources or the time to be able to conduct their work in accordance with the guidelines given at the tutor course. It was explained in an ideal world that they would have the time and resources to show everything that could be of importance in the production and also show the work activities in an environment that was less stressful. However, the reality is that from day one the new operator together with the tutor counts as a regular operator and are expected to produce engines at the same takt as everybody else. This puts a lot of pressure on the tutor to save the takt. This is more evident in module three and four where they have a synchronised flow since every other workstation is put on hold if they do not finish the activities in time. The SV of

module four however talked about how they are working with Real Time Management today to help the tutors to find standardised ways to divide the workstations into smaller activities and letting the new operator learn one activity at a time until they can perform an entire station in regards to both takt and quality. Not before they know an entire station they should move on and learn a new station and the supervisor explained that this had helped a lot with managing the takt. But it was also evident that this was not always the case, sometimes the tutors moved on to the next station before the new operator could manage takt and quality because they did not want to get stuck for too long.

4.3.Current state of learning process for new operators

The learning process that every new operator goes through can be divided into two separate parts: Introduction to assembly work and Introduction to line as shown in *figure 9.* This section will start off by describing how the introduction to assembly work looks like today and move on by explaining how the introduction to line looks like.

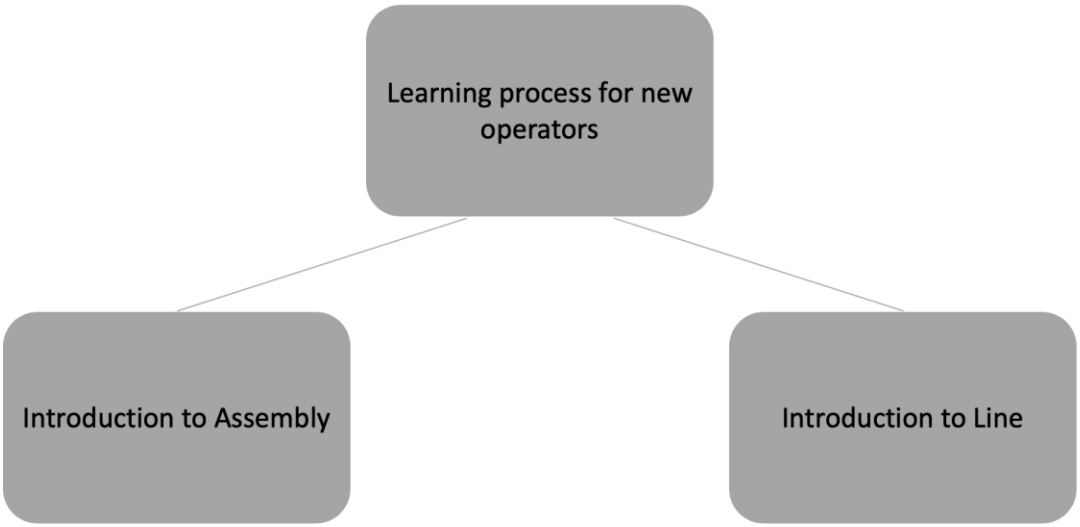

Figure 9: Illustration of the different parts of the learning process of new operators.

4.3.1.Introduction to assembly work

When a new operator is hired there are certain requirements that have to be fulfilled before working in the main production. Introduction to assembly is a learning environment where each new operator gets to train and learn the basics of an operator with regards to quality, ergonomics and safety. Introduction to assembly consists of four different stages: Theory, Basic skills,

Simulated line and Special skills as seen in *figure 10.* Every new operator is supposed to manage each of these before they get to work in the main production.

There are instructors at introduction to assembly who work with developing the new operators and introducing them to the assembly work. The instructors at introduction to assembly are working according to their standard to teach the new operators the different stages. They work by using the work instructions to show how the work is performed and also explain important steps as well as why it is performed. After that the new operators get to try it out and practice with guidance of the instructors until they can manage the takt and the quality of the station. There are no written instructions on how the instructors work with the learning process but they have agreed on this method of working and based on the interviews everybody follows these steps.

The operators have an unrestricted amount of attempts to complete each station, it differs a lot how long it takes to complete the different tasks but the average time for a new operator to finish the entire introduction to assembly is 5 working days.

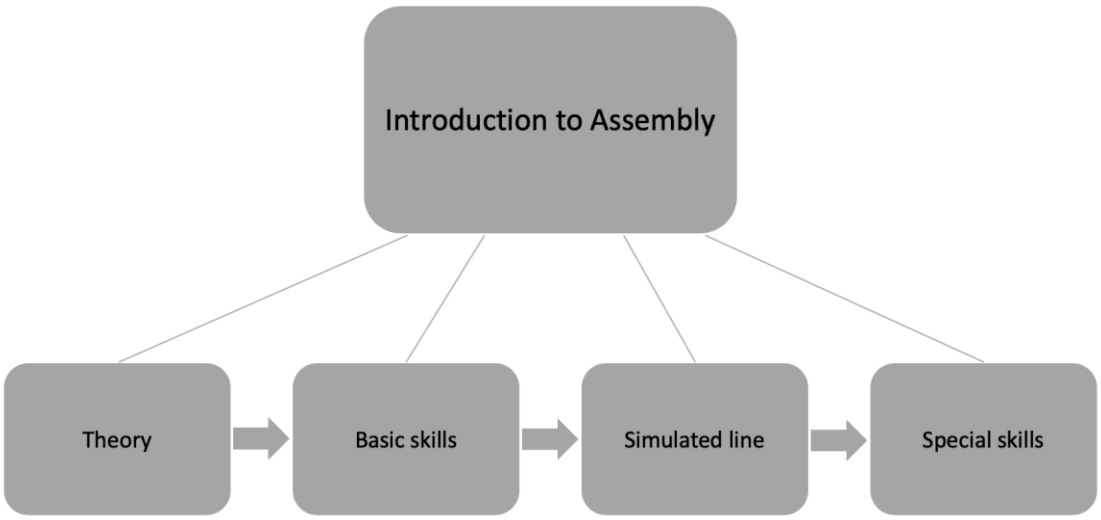

Figure 10: The four different parts of introduction to assembly.

4.3.1.1.Theory

All new employees no matter the position in the organization have to attend the theory presentation where they get information about the company, safety, ergonomics, quality, health and working rights. The theory presentation lasts throughout a full working day. During the first week of introduction the operator will also undergo a guided tour of the production and also get to know at which working module they will work at later on. This is done whenever they can get

some spare time and is primarily done to give the new operator a feeling of their new workplace environment.

4.3.1.2.Basic skills

Basic skills consist of exercises that will teach the operators how to do the most basic activities of assembly such as entering screws with both hands and from different angles. Basic skills are divided into four stations with different exercises. To pass Basic skills the operator needs to successfully manage each exercise five times. To successfully manage an exercise the operator needs to finish within the time limit of that specific exercise, they are not allowed to drop anything and they also have to fulfill the quality level. When all exercises are passed the operators move on to work on a simulated line where these skills are further developed and tested together. The time it takes to finish these first steps varies a lot from operator to operator but the average to pass the basic skills exercises and more on to the simulated line is two days. The different stations of basic skills are not always done in the same order since there are limited resources and most often there are more operators than there are stations so they start at different stations.

For each station the instructor at introduction to assembly follows the same steps, first they show the new operator how to perform the exercise based on the work instructions, describe why the exercise exists and what is important to know. Secondly, the new operator gets to try and practice the exercise a couple of times to get a feel for how the exercises work. In this step the instructor gives important advice to the new operator to help them complete the tasks faster and in a correct way according to the safety and ergonomy instructions. When the new operator is comfortable they try out the entire exercise and clock it to know if they can perform the exercise at the required pace. The instructor is responsible for controlling that the new operator is performing the task in a correct way as well as within the time and quality requirements.

4.3.1.3.Simulated line

After the previous exercises are completed the operator should know how to pick material from the component rack station, how to enter a screw, how to place different items, how to use different screwdrivers and change sockets. In the simulated line the operator is trained to combine these skills in a situation similar to the actual production line. In addition to the previous skills learned the operator needs to know how to operate the Automated Guided Vehicles (AGVs) that hold the engine in place as well as acknowledge when they are done.

At the simulated line there are six different stations which include activities that are based on work conducted at the production line. These activities differ from each station and to pass this part of the introduction to assembly a new operator needs to successfully complete each activity

of the six different stations at the simulated line five times. To be able to pass these stations the operator needs to finish the activities within a time limit. There are different time limits at each station and they are shown in *table 3*. The time requirements to finish a station at introduction to assembly are much more forgiving than the time requirements at the outer assembly line.

Table 3: Time limit of the different stations at the simulated line.

Station	**Time limit**
110	1 minute 38 seconds
120	1 minute 47 seconds
130	2 minutes 2 seconds
140	2 minutes 6 seconds
150	1 minute 45 seconds
160	1 minute 36 seconds

The instructor starts with describing how the safety system works and how the operator starts the instructions. The instructor then gives information regarding the pick by light system, andon system and how to use the tools available at that specific station. Focus is put on safety and ergonomy to make sure that the operator knows how to complete the activities of the station in a good way. The instructors also try to create an andon culture in this stage to encourage the new operator to press andon and understand the reasons behind andon. The instructor also explains how the AGV works and all the functions of the AGV as well as safety and ergonomic instructions regarding the use of the AGV while operating.

After the introduction to the safety system and the AGV the instructor gives information regarding the Operator Instruction Sheet (OIS) and the Work Element Sheet (WES). OIS is the work instructions which explains the current best way of working including the time it takes to perform every single activity. WES is a clarification of key activities including pictures on how to perform these steps. This step is not always done for each station even though the instructor is teaching according to the OIS it is not always shown to the new operator.

The instructor continues to show all the different activities to the operator to show how the instructions work in real life at that particular workstation. After the instructor has shown how it works the new operator gets to try out the work at that workstation with the instructor watching

and guiding the operator along the way. At the simulated line the operator also has to disassemble the parts to be able to do the activities again. There are a total of six workstations and when a new operator has managed to complete the activities of a workstation within the given time at five different occasions they pass that workstation. The operator needs to pass all six different workstations before they are allowed to work at final assembly and for each new station the instructor shows how to complete the different activities and how the tools at that particular station works first before the operator will do it with the instructor as a guide.

The instructors of introduction to assembly also talk a lot about the difference in environment between introduction to assembly and the assembly line in the interviews. It is much more calm at introduction to assembly and they have talked about how they can develop their simulated line to make it more similar to the final assembly but as of now it is a big difference. Even though the environment at introduction to assembly is much more calm it is still a lot of pressure experienced by the new operators. The instructors state that most often they struggle with the time requirements because they put pressure on themselves to complete the different activities of introduction to assembly.

4.3.1.4.Special skills

Special skills are needed since some assembly loops in different modules of the final assembly require special equipment and/or processes. When the new operators have finished the stations of the simulated line the ones that are going to work at these modules have to undergo the step of special skills. The instructor gives a pass after observing and determining that the operator has understood the skill enough to use at the final assembly, there are no requirements on time in this step.

An observation was made of one special skill required to work at a specific assembly loop in module four. There is one very important and tricky part of assembly at module four which is the assembly of the timing belt. This is why it is a requirement for the operators that are going to work at the assembly loops at module four that performs the assembly of the timing belt to familiarise with this before starting at final assembly. The instructors start off by explaining why it is such an important step and how the camshaft and crankshaft works to give knowledge and understanding to the new operator on why this step is so important. When the new operator understands why this specific assembly is made and why it is of importance the instructor shows the different steps included in the assembly. They explain each step in detail and show how it is done. After that the new operator gets to try out the different steps and after disassembly they get to try it out again with the instructor on hand to help and guide the new operator. When the instructor deems that the new operator has understood why and how this assembly step is made they are ready to move on to the final assembly and get introduced to the work at the line. The

time is not of essence here but rather the importance lies with understanding the importance of the step and trying out tools and equipment that is specific to that line in production.

4.3.2.Introduction to line

The introduction to line is not as standardised in reality as the case company wants it to be. The current state is written and defined based on the author's observations but also interviews. However, the general observations identified four different steps that all new operators go through when being introduced to the assembly work done at the modules which are: Preparation for upcoming new operator, Introduction to workplace, Learning the activities of the workstations and verification of takt and quality, see figure 11.

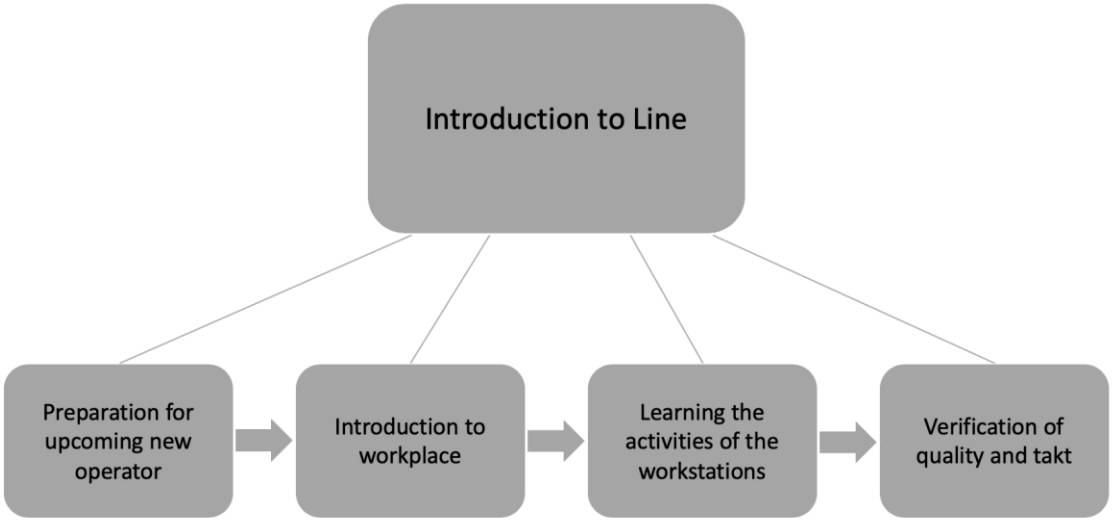

Figure 11: The different steps of the process of introduction to line.

4.3.2.1.Preparation for upcoming new operator

Information regarding when new operators are going to start in their team is most often known about a week before they should start. This is not always the case and it is explained that there are occasions where the team does not get the information until right when the new operator starts. Sometimes the SV can have information regarding a new operator but it is not yet decided which team they will start at which in turn affects the preparation of the tutor in order to give the new operator a structured and well prepared tutoring.

From the interviews with the tutors it is worth mentioning that there is often very little time for preparation in regards to what is required for the tutor when teaching a new operator. It is emphasized in the tutor course that they should have time to prepare the workstation, refresh their memory of all the steps to be able to perform well when interacting with the new operator.

However this is not always a reality on the assembly line, several tutors mention that most often they do not get any notice. Instead they learn that they are supposed to tutor a new operator at the same time as they arrive.

4.3.2.2.Introduction to workplace

When a new operator completes all the exercises at introduction to assembly they are guided by one of the instructors from introduction to assembly to their upcoming workplace. While walking the instructor shows and explains the different modules and gives basic information. Upon arrival at the module a TL and a tutor are expecting them and greets the operator by introducing themselves. The introduction to the assembly work instructor leaves at this point and after some small talk the TL leaves the responsibility to the tutor. The tutor conducts a roundtour showing the public areas such as the locations of where they eat, microwaves, where they can take fresh air, put their belongings and have daily meetings. However, sometimes the tutor is locked at the assembly loop due to staff shortage and then the TL welcomes the operator alone instead and does a quick roundtour on where the public areas are. The TL then goes to introduce the new operator to the tutor before leaving them alone at the station connected to the assembly loop. It was stated in an interview that the new operators that do not receive the full tour around the module directly, get an introduction to the entire module when they have time and no staff shortage.

After the roundtour of the public areas, the tutor should introduce their module. Some explains very thoroughly while some more basic, some even shows all the way from the beginning where the material is picked up to the end which is the quality station. Some tell and explain the different sections but do not walk there to show the operator everything in person. All the observed tutors introduced their assembly loop and explained the basics of what is done at every station, but stated that they would go through the stations more in depth when working on the particular stations. The safety precautions, AGVs, safety systems and all the information that the operator needs to know about the workplace is mentioned from every tutor. However, some of the shared information was specific and differed from module to module such as explanation of special equipment, skills etc. During the time that the tutor does the tour with the new operator, the team either had extra staff or the TL could work on the assembly loop to fill in for the tutor.

According to several SVs the main responsibility they have when a new operator is introduced is to make sure that they feel welcome and have the best possible prerequisites. Their work includes introducing the TL and the appointed tutor to the new operator already at the stage of introduction to assembly work. This varies from SV to SV but most of them discussed that it was important to do this as early as possible to make sure that the new operator knew who they were going to work with and where to go when they finished introduction to assembly. However,

some SVs only briefly introduced themselves at introduction to assembly to the new operator. The SV also has an important role in making sure that the right people are appointed as tutors and have undergone the tutor course which provides important guidelines on how to work with new operators.

The process when being introduced at the assembly line after finishing the introduction to assembly work was also described with a lot of differences. Some people got to meet their TL and SV already at the introduction to assembly work and others did not know who their TL or SV were until they got to the assembly line. When the new operators get introduced at the assembly the essentials such as the lunchroom, toilets and lockers are shown so they know where to go. The workplace and different teams are also shown to give the new operator understanding for the different stations at that specific module. This can differ however depending on time and resources and some operators describe that they started working right away maybe with only a short tour of the workplace.

4.3.2.3.Learning the activities of the workstations

When the introduction of the workplace is completed the next step is to take over a station in the assembly loop to instruct and teach the new operator their workstations. From here on, the tutor has the responsibility to keep up with the takt while tutoring. Some tutors want to start teaching at a particular station, some solved that by talking to the team to change stations. Other tutors go to their TL and say they are ready for the assembly loop and the TL releases their extra resource to start acting as andon, assists when anyone in the team needs help, and the tutor takes over that random station the andon was at. Some TLs take over the tutors place while the tutor is doing the round tour and when the tutor comes back they swap with whatever station the TL is currently working at. When the tutor takes over a station it is the tutors responsibility to keep up with the takt time at the same time as teaching the station to the new operator.

4.3.2.3.1.Sequence of teaching the workstations

Different tutors teach in different ways; some tutors teach one station at the time to the new operator until they pass the takt time and the quality requirements before moving on to the next station. Some tutors change the station when they see that the operator passes the quality but are still a few seconds behind the takt. There were also some tutors that rotated stations along with the rest of the team, which means that the new operator learns a piece of each station before moving on to the next. There were other tutors that first went around the assembly loops 3-4 turns and then stayed at each station until the new operator passed the quality and takt for that station. So this process in what turn a tutor should teach a new operator is not standardised and is

changing depending on what the people in the module, team or even tutor that is tutoring the new operator consider is the best way for them.

4.3.2.3.2.Teaching the activities of the workstations

The way the tutors tutor the new operator at the workstations also differ depending on what module they work in. This is because the environment is very different from one module to another and the priorities differ a lot. In the synchronised flow at module three and four they have started working by the guidelines that the workstation should be divided into smaller activities to be able to manage the takt and not lose any time during the learning process. This is rather new and was introduced when they started working with Real Time Management because they saw that it was really important not to lose any takt. How the stations are divided are not yet standardised and the tutor manages this by themselves where some divide the station into two work activities and some divide it into six work activities. In the modules one and two however they are not working by the step-by-step model and it is more individually based where all tutors work how they see fit. It is described how some learn the entire assembly loop at the same time and some try to learn one station at a time but it is not standardised at all.

Even though the workstations are divided into smaller activities most of the tutors say that it is not possible to keep up with the takt anyways and that the takt will be affected during the learning process of a new operator. The synchronised flow is still affected but by working more based on a the step-by-step model and breaking down the work stations into smaller elements the tutors say that the effect is no longer that big. One tutor also mentioned that the step-by-step model helps to make the new operator more secure in every activity which in turn will help to not affect the takt when they are deemed ready to work on their own.

When starting to tutor at a station all tutors started with demonstrating and explaining every working activity at the station while the new operator was observing. Then some divided the working sequences into six parts and allowed the new operator to do one part of each engine until they did that correctly then kept adding a part until the new operator could do the whole station at the required quality and takt. Some divided the station into two parts, while the new operator is trying to do one of the parts the tutor is ready to assist and take over to keep up with the takt. When the new operator managed to do the first part, the tutor switched and started to allow the new operator to only do the second part. When that was accomplished the new operator could start training on doing the entire working sequence. Then there was a case where one assembly loop had three stations but for two operators. In this assembly loop a cycle is doing all three stations, however each station has its own takt. The tutors at that assembly loop allowed the new operator to do all three stations and the tutor was close by and constantly assisting and telling what to do next if the new operator hesitated. The interviews and observations did not go

hand in hand regarding that tutors are constantly stressing to make sure not to overcycle the station time. The authors observed overcycling in every station that had a tutor with a new operator. Some tried to make sure the overcycle was not too long but some allowed it to overcycle with no concerns. The biggest differences identified connected to the way the tutoring was performed was dependent on the module and if it had a synchronised flow or not, which SV and TL they have and also how the tutors in each assembly loop are used to tutor. TLs confirms in different interviews that sometimes the tutors do not even follow the work instructions and provides the new operator with different ways to work and that it is important that the TL notices and prevents this from happening while making sure that the tutors are working according to the guidelines and standards that are provided.

No tutor showed the OIS or WES but talked a lot about key activities and that this was very important. Many of the new operators did not get information regarding why the key activities are important more than that they are important.

4.3.2.3.3.Observations from the learning process at the workstations

Throughout the entire process the tutors constantly ask if there is anything they wonder or does not understand. The tutor asks about previous experiences and their thought of introduction to assembly, to get a better understanding of how they should tutor. The tutors also explain to the new operators to try and relax and not stress. The tutor mentions that they will jump in if something goes wrong, and that it is the tutors responsibility to handle the takt so the new operator does not have to worry about that. The authors asked one of the tutors why they said that and the tutor answered: “I wanted her to feel safe, secure and not to feel stressed or that she is doing anything wrong since every new operator makes mistakes".

Another thing that was observed was that even if the tutors used a lot from their tutor course such as introducing the new operator to workplace, making the new operator feel safe, talk about safety, explain how to work ergonomic, reduce the stress levels by explaining what is going to happen, constantly telling them to ask if there is something they do not understand or forget etc. However there was some key advice that the instructors in the course constantly talked about that was not always used by the tutors. One key advice was to ask open questions in order to allow the new operator to explain to the tutor what they have understood and remembered. In this way the tutor can make sure that the new operator has understood and that they have consensus regarding the same information. Another key advice was to tutor according to the step-by-step model. While some tutor tutored closely aligned with the step-by-step model some did not. The authors did however not observe any tutor explaining that they are following the step-by-step model, it was not mentioned in interviews either. Many of the tutors did not know what the step-by-step model was when asked about it.

It was observed that when tutors were working the new operator was standing aside either observing the work or taking a rest, they answered questions and thoughts that the new operators were asking. Here the tutors managed to both answer questions and keep up with the takt. There were also scenarios where the new operator asked questions and had conversation with the tutor not about the station but of general topics. In these scenarios it was observed that the new operators did not finish their station within the takt time and quality requirements. It happened that the TL and even sometimes SV came by and talked to the new operator, while the new operator was assembling. When the TL and SV do come by, they ask "how is everything going" and some of them tell jokes with the new operator and they could even joke about the tutors. The intentions from the SVs and TLs is according to the authors to create a relaxed and not so serious environment. The observations showed that approximately every two hours the TL came by three to four times and SV once.

It was also described that the takt is affected during the learning process for new operators but also when they are deemed to be ready to work on their own. Stress and high demands was discussed as a possible cause for the takt being affected even after they were allowed to work on their own. However one of the supervisors even said that: "the most important thing is that the quality is okay and that the new operators understand the key activities, the takt will come with time and it is more important for us to be able to count the new operator as an operator in production." The difference in priorities makes a difference in how the takt is affected but it is made clear from the interviews that the takt is affected a lot by introducing new operators.

The pressure to manage the takt even though the tutors are supposed to teach all workstations to a new operator is discussed during the interviews. Almost all tutors mention that there is a lot of top-down pressure on managing the takt at the same time that they are supposed to minimise the learning time of the new operator. Some tutors therefore move on to the next station before the new operator can manage the takt because they do not want to get stuck on the same station for too long. Overall when asked about problems or possible improvements of the learning process most tutors agreed upon that time and stress were the biggest issues. They describe it as a lot of pressure to be able to manage the takt from the SVs and TLs, the pressure on the tutors also transfers to the new operator who gets stressed which will affect the quality of the learning they undergo.

All tutors think that the tutor course gave them good tools on how to interact with new operators and make sure that they really understand why they are performing certain activities. However it is stated that it is a huge difference in the environment at introduction to assembly and the one they have to deal with at the assembly line. They most often do not have the time to thoroughly go through the different steps and why they are performed since they are counted as an operator that are expected to produce engines at the same takt as everybody else. This creates a challenge

for the tutor to be able to perform the work at the same time as being pedagogic towards the new operator. In some cases the TL or another resource can take over and let the tutor go away from the line for a bit but this is not always possible and hinders the tutor to perform the tutoring as they were instructed at the tutor course. Some of the tutors working with new operators haven't taken the tutor course at all.

4.3.2.4.Verification of quality and takt

When the tutor feels that the new operator is ready and does not need more tutoring, the tutor should, according to the case companies instructions, contact the SV that should verify with a checklist if the quality, takt and key activities are approved before allowing a new operator to work on their own. However, in practice this is not always how it is done.

Some supervisors had full faith in their tutors and if they said that the new operator was ready then they were deemed ready. Other SVs said that they always checked all stations when the tutor said that the new operator was ready to make sure that the new operator understood the key activities, managed the takt and also had good quality on the work. It could vary a lot on who had the responsibility to verify that the new operator was ready, it could be the tutor, the TL or the SV. Even if there is a standard way to approve a new operator it is not always followed.

The time it takes for the new operators before they are considered ready to work on their own varies a lot and from the interviews the understanding is that most of them do not feel pressured to be ready in a certain time. The operators verified the variation regarding how and who verified them. It could vary from the tutor leaving them when they felt that they were ready to the supervisor checking every station to make sure that the new operator could handle the takt and quality of each station.

4.4.Improvement work

In this section the way the case company works with improvement work will be presented. In order to be able to answer the second research question: "*How are new operators introduced to the improvement work of the organization?"* It is important to create an understanding regarding how the process of improvement work looks like to be able to understand how the new operators are introduced to that work. The section has been divided into two parts connecting to the learning process presented previously with Introduction to assembly work and Introduction to line. How the improvement process looks like in these two parts as well as what information is introduced to the new operators in these parts will be presented below.

4.4.1. Improvement work connected to introduction to assembly work

The instructors of introduction to assembly work are performing improvement activities to develop the different stations at this stage but this is not a process that the new operators are involved with. The new operators are a part of the evaluation that the instructors do when they observe how they perform the work but they do not help in the process of finding ideas for potential improvements. The main responsibility that a new operator will have when it comes to improvement work is to develop the work process that they will work within and how this process is conducted will be presented in the next part describing improvement work within the introduction to line.

The vision of the company is that every operator should own their process and it is described by the senior director of production that the main focus when it comes to improvement work is to create an organisational culture of ownership. Every operator should feel like they can affect their own process and in that way the organisation can generate ideas of improvement from the people who work within the process.

According to interviews with instructors, previously in the introduction to assembly work it included a lot of information about improvement work and kaizen workshops, but the hands-on practical work to improve the assembly skills were less. Today they focus a lot on the practical skills and to prepare the new operators to be able to conduct the assembly work. The information regarding how they work with improvements is not included at all anymore. The instructors explained that they can sometimes talk about improvements but they have no structured or standardised way to work with introduction to improvement work for new operators.

There is a belief at the final assembly that the new operators get introduced to the way the case company works with improvements in the stage of introduction to assembly work. Almost all SVs and TLs that were interviewed stated that they believe that all new operators are introduced to the process of improvement work in this early stage. But as stated in the previous paragraph this is not the case, the new operators do not get any introduction to the process of improvement work at the case company in the stage of introduction to assembly work.

4.4.2. Improvement work connected to introduction to line

The work process connected to improvement work is not standardised at the moment and based on the interviews the work conducted at the different modules differ a lot. It was mentioned by the senior director of production that the environment is very different between the modules because they work with a model line and do not implement all changes across all modules at one time. Regardless of this the vision of the company is to find a standardised way to work with

improvement work to create a sense of ownership of the process for every operator in the organisation. The way they do that today can be divided into two parts. First, they work with M3MU-workshops (Management of Muri, Muda, Mura) which are dedicated resources to be able to find potential improvements closely connected to the work method. These M3MU-workshops are done during a specific point in time and are conducted by a team that is separated from the assembly to be able to observe and make studies on the current processes. The second part is the way the case company tries to work with continuous improvements. The case company has introduced the IMT-role which includes a process that is ongoing where every operator can lift their ideas and a designated IMT-role works with these improvements on a daily basis. These two parts of the improvement work and how new operators are introduced will be presented in this section as well as the specific roles the SV, TL and tutor has when it comes to improvement work.

4.4.2.1.Role of the Supervisor in the improvement work

The role of SV regarding improvement work is to facilitate and encourage their staff at their module to work with improvements. They have the authority to accept or decline some improvement ideas if the SV does not believe the improvement will be worth the investment. However, SVs also have the responsibility to lift out some ideas, when the team can not perform the improvements themselve, to other departments such as production engineers, maintenance and IT.

The role of the SV is described by the management, to develop the people of the organisation and get them engaged in the improvement work. They are supposed to coach the employees and give them time and resources to be able to perform the improvement work. They are also responsible to create understanding and knowledge regarding the M3MU work method to help the operators become better at working with improvement work.

Throughout the four modules different SV's were interviewed and some of the SV stated that they do not really know what their role is regarding improvement work, but they help with what they can to enable and assist their team to do the improvement work by giving them time and resources. Some talked about how they are doing their best to encourage and include everyone in their team. One SV explained the awareness that some people are not as open as others but they can be sitting on great improvement ideas, and that it is the SV's job to make sure that everybody is comfortable with presenting ideas to not miss out on potential improvements from the people who work in the environment everyday. The SV continued stating that it does not matter to whom they share their ideas as long as they share them with someone in the team to lift them up. Another SV explained that a big part of his way to keep the team motivated to share ideas is to

let the team members know why some ideas are not implemented and make sure that they can affect their own work environment, these small things can have a huge impact on them.

4.4.2.2.Role of the Team leader in improvement work

The generic role of the TL is described for the entire organisation but it is important to focus and understand what their role is when it comes to introducing new operators to the work process connected to improvement work. As stated previously two of the main responsibilities for the TL is to coordinate and support the team improvement activities of processes and standardised work and to coach the development of the team and support the culture. How are these generic responsibilities realised at the case company and how do the TLs actually work to support the improvement work of the organisation? Were two topics that were in focus during the interviews with the TLs.

It was made clear that the work conducted by the TLs is not standardised and many of the TLs had a hard time defining what their role when it comes to improvement work really is. However, it was mostly described as a middleman role where the TLs are supposed to support and encourage the operators to come up with improvement ideas as well as lifting ideas to the SV that can not be performed by the team. The coaching done by the TL to develop the people varied a lot depending on modules and even shifts one looks into. Some thought it was very important to encourage and coach the operators to make them understand that they own their own process and can improve things on their own even if it is only small things. While others did not see any problem and thought that the operators in the team are already motivated and do not need to be encouraged since they have a RTM board where everybody can post their improvement ideas. The TLs are often involved in the M3MU-workshops as well to help coordinate the improvement activities of their specific assembly loop. These M3MU-workshop will be explained more in detail below.

4.4.2.3.Role of the Tutor in improvement work

The role of the tutor is not really defined when it comes to the introduction to the improvement work. There is a lot of responsibility put on the tutor to be able to train the new operator and at the same time they are expected to introduce the new operator to the improvement work of the organisation. There is no standard way to work with this introduction today, not when it comes to the way the tutor introduces the new operator to the work nor how they introduce them to the improvement work. From the interviews with SVs and TLs it was made clear that there is an expectation that the tutors do in fact introduce the new operators to the improvement work but it was also stated that most likely the most focus was put on the new operator being able to manage the takt and quality and not much on the improvement work. It was also stated in the interviews

that several SVs counted with the new operator understanding the culture of improvement work by being a part of the team.

It was observed that the tutors did not focus on the improvement work at all when introducing new operators to the work conducted at the final assembly. All the work that is done in the step of introduction to line is to make sure that the new operator can manage the takt and the quality of the different workstations. It was explained in the interviews that the understanding is that a fresh set of eyes that the new operator has is good and can generate many ideas of improvement but if they do not get encouraged to lift their ideas and get introduced to the mindset of continuous improvement and owning their own process most likely many of the ideas that the new operators have will go lost. Even if the case company understands this they still do not have a standard way to introduce the new operators to the culture of improvement work which means they do learn how to work according to the standard but they do not get the understanding that the standard is there for the operators to be able to make improvements.

4.4.2.4.Management of Muda, Mura and Muri-workshops

The improvement work can be generalised to the Management of Muda, Mura and Muri (M3MU) workshops performed by the organisation. This is directed resources to a specific assembly loop to try and improve the work methods and balance the workstations. The workshop consists of SVs, TLs, operators but even the safety representatives, production technicians, IT and more assists depending on what resources the workshops need. The focus is to involve the teams at the assembly instead of fully relying on the production technicians. However, since the main improvement work is driven by the operators and TL there is, according to the management, big responsibility on the SVs.

These groups are lifted from the production and observe different stations as well as timing them to analyze and find possible improvements. The main focus is on the stations that vary in order to reduce the variation. Currently at the case company there is a big focus on working on the processes, having ergonomy, quality, safety, working sequences in mind, in order to achieve the best methods to assemble at the different stations. The goal is to balance the stations to be able to reduce the amount of stations performed in each assembly loop.

Every M3MU workshop starts with introducing and teaching the M3MU mindset to the people included in the workgroup. The work looks different depending on what module the workshop is performed at but time studies and element studies are conducted to find the best way to work with the process. Testing is also important to make sure that it works not only in theory but also in practice.

It was also noted that not all operators are included in the M3MU workshops; instead most often the experienced operators are handpicked by the SV to participate. It is, however, mentioned at the interviews that it is important that the entire team is a part of the improvement work. The SV's pushed for that it is up to the individuals of the team to lift their ideas to the M3MU-workshop group since they are not all a part of the group. New operators are most often not picked to be a part of these improvement groups and it is also made clear from the interviews that the new operators are not introduced to the way the organisation works with improvements rather the focus lies on takt and quality.

When M3MU workshops are conducted some modules do not work as much with the continuous improvements; instead all focus is put on the M3MU workshop. This is not a continuous process since it is directed resources to achieve a specific target when that is done the resources are directed elsewhere. According to an interview with a TL it was stated that he can not even remember how they work with the continuous improvements since they have had an ongoing M3MU workshop during the past five months. When they work with M3MU workshops the other operators have to present their ideas to the M3MU team instead if they have any suggestions on improvements. The work with M3MU differed a lot depending on the module, it was clear that modul 4 already had a big M3MU workshop and works right now alot with continuous improvement while module 3 and 1 are much more focused on M3MU-workshops. Module 2 is when this report is written in a transformation project where the new engine models will be assembled and therefore are more in a try out phase before starting with M3MU-workshops.

4.4.2.5.Continuous improvements and the role of IMT

Based on the interview with the senior director of production the daily improvement work intended to be continuous improvements performed by the team is tightly connected to the role of IMT, which is a role of working with improvements at the assembly loop. This work is done to move the ownership of the process from the management team to the operators working with the process everyday and give them resources to work with the improvements on their own, not being dependent on engineers to perform the changes. How the role of the IMT works however looks a lot different depending on the module. At some modules the role of IMT is given to one person in the team, in other modules everybody in the team is working as IMT on different occasions and in some cases the operators who show interest get to work with the improvement work. Most often there is only one assigned person working with the IMT role in one team and the purpose is to take the ideas from the entire team and try to implement them if possible. The work conducted by the IMT-role is supposed to work a lot based on an M3MU-mindset to see and eliminate waste when working with improvements to be able to improve the work process at their assembly loop. All employees are encouraged to come up with ideas for improvements and

there is a board where operators can write down ideas that the role of the IMT can work with. Often an evaluation is made regarding if the change is possible or not and sometimes a discussion is made with the entire team to see if it is worth to make the change but this is not a standardised process instead most of the times the changes are made and an evaluation is made afterwards to see if it improve the process or not.

The board where the operators can write down their improvement ideas is a part of the work with RTM where quality deviations and other problems are also reported. The SV and TL focuses on working with the quality deviations and other problems trying to understand why they occur and make sure it won't happen again while the role of the IMT is more focused on working with the suggestions lifted by the operators. The work conducted is described based on the interviews as very free, it is not very standardised and it is up to the person that is designated to work with the role of IMT to take a suggestion from the board and start working with that.

The role of the IMT has traditionally been connected to responding andon calls as well as working with improvements. This means that they are used as an extra resource to be able to answer andon calls and uphold the quality and takt in the processes as well as when time is available they can work with improvements that are suggested by the operators. The Interviews with TLs described a situation where sometimes the work with improvements can not be done due to the fact that not enough resources are available then focus is to produce according to the takt rather than using the resources to work with improvements.

New operators are not working with the IMT role at all since the focus is that the new operator should learn to manage the quality and the take as well as all the work conducted around the assembly work such as material feeding. When an operator is deemed to be able to conduct all work included in the module they can take on the role of the IMT, this is however not true for every module. In some modules not everybody in the team works with the role of the IMT since only the once that shows that they are interested and motivated to work with improvements get to work with improvement work. In other modules all operators are included and as long as you are considered to know all the processes included in the module you can work with improvement work. This is done in order to get everybody involved in the improvement work and make sure that every operator feels that they can affect the process they work in.

5.Analysis

In this section the empirical findings will be analysed based on the established literature presented in the theory section. The main objective of this section is to analyse the empirical findings to be able to answer the two research questions. The section is therefore structured based on the current state that was presented in the empirical findings. The first part of the analysis includes the analysis of the tutor course. The following two parts that were identified in the empirical findings, Introduction to assembly and Introduction to line, will be analysed after that. Both of these parts have been analysed to answer the first research question: "*How does the learning process for new operators look like today and what improvements can be done to avoid disturbances in the takt when new operators are introduced at the assembly line?"* Literature used to answer the first research question of this study included topics such as learning organisations, learning time, learning curve, factors that affect learning as well as the documented approach of the job instruction method used at Toyota. The empirical findings regarding the tutor course and the learning process at the case company was compared with the established literature. This was done to identify gaps that could explain how the takt and quality was affected when introducing new operators to arrive at suggestions on how to increase performance. After that the second research question: "*How are new operators introduced to the improvement work of the organisation"* is analysed based on the current state of the improvement work process of the case company. Literature regarding standardised work, continuous improvement and the Toyota way was mainly used to identify how new operators can be involved in the culture of improvement work of the organisation.

5.1.Tutor course

The tutor course is two full working days in a classroom setting giving new tutors information regarding what is needed to become a tutor at the case company. It gives a lot of value to the upcoming tutors since it gives a standard of what is needed to tutor a new operator. A lot of the content in the case companies tutor course is supported by the content of the job instruction method presented by Liker and Meier (2007), such as directly interrupting and correcting mistakes, with a focus on reducing the operator's stress level. The participants are allowed to try out what they have learned and demonstrate their take on the methods to learn from each other, Which can be compared to the job instruction method. Liker and Meier (2007) states that most of the time of the job instruction course is used to let the new operators demonstrate their take on the job instruction method to help them learn from each other. This course has a big impact on how the new operators can be introduced at the assembly line without disturbing the takt, due to it creates a standard for how tutors should introduce the new operators to the assembly line. In

this section of the thesis the contents of the tutor course will be analysed mainly based on the theory connected to the job instruction method presented by Liker and Meier (2007).

5.1.1.Step-by-step model

The step-by-step model is a tool that is taught at the tutor course, this model builds the base for how to tutor a new operator. The model consists of four steps: prepare the operator, show and instruct, practice practice practice and follow up. According to Liker and Meier (2007) Toyota has a job instruction program to train new operators which has been identified to be similar to the step-by-step model, but with some differences. The job instruction method is one of the reasons why Toyota are able to develop the people of the organisation and remove the impact on performance when introducing new operators and therefore the step-by-step model will be analysed and compared with the job instruction method (Liker and Meier, 2007).

The first step of the step-by-step model is about preparing the operator by identifying previous experiences, helping the new operator relax, reduce stress and give information about safety and ergonomy. This step was identified to be similar to the first step of the job instruction method presented by Liker and Meier (2007) called Prepare the student.

The second step is show and instruct and in this step the new operator should demonstrate the work as many times as needed and this should be done by explaining what you are doing, how you are doing it and why you do it this way. Toyotas job instruction program defines that it is important to first explain the major steps then show the major steps plus key activities of the job and at last explain the reasons behind the key activities (Liker and Meier, 2007). The base for this step matches with toyotas job instruction program and it is stated by Chaffin and Hancock (1966) that learning time is faster when understanding why it is done and not only what and how to perform a task. However, the main difference that was noticed was that no specific directions of how to break down the job and in what order the tasks should be taught was lacking as well. Breaking down the job into elements and sequencing the work is required to be able to provide the student with manageable tasks and not provide too much information at once (Liker and Meier, 2007).

The third step is practice practice practice and this step is done to allow the new operator to practice at the given tasks as many times as needed while the new operator explains what, how and why they are doing these tasks. A factor that is important when it comes to learning is the job classification factor mentioned by Chaffin and Hancock (1966) which should not just include what is being done but also how and why. This is why it is important for the new operators that are learning to simultaniasly orally explain what is done to show they understand how and why it is done. This step goes hand in hand with the job instruction program, however, the job

instruction program has a structured order of letting the new operator first explain the major steps followed by key points and lastly the reason behind the key points. According to Hess (2014) it is important to have the right process in order to achieve high performance learning. This can be done by standardising, giving the tutors a standard way of how to work and know in what order they should allow the operator to explain the steps they are performing. Both models agree that wrong behaviours and mistakes should be directly disrupted. The fourth and last step is, follow up, where the operator does everything themself. The tutor should ask questions and only jump in to coach if needed, in this step the tutor should continuously reduce the follow-up. This step matches with the job instruction program.

Overall the step-by-step model is good and consists of guidelines of how to tutor. However, it lacks the detailed explanation of what and in what order sequences should be explained. The reason to give detailed explanations to the tutors is in order to create a standard for all the tutors to work the same with all the new operators at every module. A standardised way to work is defined by Liker and Hoseus (2008) as the best way to perform a job today until there is an improved and established way that can become the new standard. It is further described as the foundation for continuous improvements of the process but also the foundation to training (Liker and Hoseus, 2008).

To be able to improve the process it is therefore required to have a standard repeatable process that is clearly defined by breaking down a job into elements which will help in achieving a standard best way of teaching the job (Liker and Meier, 2007). By breaking down the tasks and achieving a standardised way of working it would help the case company accomplish a standard throughout the entire final assembly. It is described by Liker and Hoseus (2008) that the environment of other organisations is often different and the level of standardisation is most often not as good as in Toyota. This means that it is important to start off with creating a stable process based on standardised work to be able to effectively train the new operators (Liker and Hoseus, 2008). For the case company the step-by-step model could work as a standard way of teaching the job to new operators. It has to be clearly defined first though and achieve a stable process that can be effectively taught to the tutors of the organisation. Another reflection that was made by the authors was that the step-by-step model wasn’t used by the instructors on the participants of the course and to create better understanding for the participants they should conduct that training based on the step-by-step model as well.

5.1.2.Course length

The case company has their course two full working days approximately eight hours each day while Toyota’s job instruction program is set over five days for two hours each session (Liker and Meier, 2007). There are benefits and disadvantages doing either way, therefore it is

important to pick the strategy for what benefits the case company. It was identified that it would require much more planning and resources when having a course due for five days and only two hours each day, since it will require a lot of scheduling to make sure that the participants can join for two hours over five days. They would have to book rooms and affect the instructors working at the introduction to assembly since there are many other activities occurring there. However, a good reason to do the course like Toyota is that according to Hess (2014) when learning something new system two way of thinking of our brain is used, this system two thinking requires a lot of energy and therefore eight hours of system two thinking is not sustainable.It creates a risk that the participants in the course gets information overload, loses focus and misses valuable information given at the course. It was observed at the assembly line that some tutors did not use key instructions from the course. The authors believe that the reason can be that the tutors do not value the key information or have not registered it, since they did not register the information when participating in the course. This can either be because of information overload or forgetfulness since they may have lost focus during the intensive two day course (Colman, 2015; Schafer, 2001).

5.1.3.Learning at different levels

Today in order to become a tutor for a new operator you have to be sent by your TL and SV on the two days long tutor course. After the course you are a fully educated tutor and can start tutoring new operators. The tutor has the major responsibility for the learning process of new operators and only gets a course of two days to learn how to tutor a new operator. The tutors are deemed ready to train new operators at final assembly but it is emphasized by Liker and Meier (2007) that a new trainer is far from ready to teach new employees just based on Toyotas job introduction course. At Toyota each new trainer that returns from the job instruction course to the workplace is mentored by other skilled trainers and the team leader who also should be trained in the job instruction method (Liker and Meier, 2007). This is done because each of these leaders have a lot of practical experience working with the job instruction method and are skilled in the process. It is important to understand that becoming a tutor is a continuous process of learning and the layered learning cycle described by Liker and Convis (2012) explains how the students require coaching and help from a mentor which for the case company could be other skilled tutors, TL or the SV. Just like the new operators have a learning curve so do the tutors and they need to go through the Shu Ha Ri phases explained by Liker and Convis (2012) with a sensei before reaching the maximum knowledge required to perform the task. This can also be compared to the learning curve presented by Rubenowitz (1992) which defines a process before reaching the maximum knowledge which will take time. A new inexperienced tutor can be the reason for directly affecting the takt and quality, since they are also still learning how to tutor a new operator and therefore it is crucial that they are supported and trained as well.

The Toyota job instruction course has more focus on job breakdown, the information is much more detailed and reviews previous course days. However, the authors recognize that the biggest difference is that the case companies tutor course has a lot of focus on engine knowledge and screw joints instead of the step-by-step model. It was calculated that the preparation for tutor exercise two, performing the tutor exercise two and the engine and screw joints presentation took in total six hours of the entire tutor course of 17 hours including all the breaks. Even if this information was appreciated by the participants this information is not connected to learning and training. The main learning takeaways from the exercise was that the participants explained to the rest of the participants about articles and that is a training on how to explain and transfer information to someone else. According to the authors this type of training can and is utilized in the other tutor exercises. There should be more focus on the tutors and how they can work to help new operators in the learning process since the course is only two days. Factors that affect learning and learning time presented by Chaffin and Hancock (1966) is divided into three different factors: The job classification factor, motivation to learn and ability to learn. This information can be important for the tutors to understand in order to know what factors they are able to affect and what factors that can affect the learning process in general. Shifting the focus of the tutor course from engine knowledge and screw joints towards a focus on the learning process and how to train new operators based on the step-by-step model could help give the new operators tools to use to understand what affects the learning process as well as being able to standardise and improve the learning process. This in turn will help the tutors to reduce the impact on takt and quality when training a new operator.

5.1.4.Tutor Exercises

The course consisted of three tutor exercises which will be analysed in this part of the paper. Tutor exercise 1 was about allowing the participants to tutor a station with the use of OIS and WES. Tutor exercise 1 is performed before the instructors had given information regarding teaching techniques and the step-by-step model. This goes in line with Toyotas job instruction course, where it is explained by Liker and Meier (2007) that their first demonstrations are often not good since they have not yet learned the breakdown process. The main reason for this is to allow the participant to understand how important preparation and effective training is (Liker and Meier, 2007). Liker and Meier (2007) also states that the participants should be allowed to spend time to demonstrate the exercises to help them learn from each other. This is also done at the case companies tutor course, where they receive oral feedback by the participants as well as the instructors.Tutor exercise 2 is about engine knowledge. Where the participants gather information about an article that interests them and present this information to the rest of the participants as mentioned previously in this section.

Tutor exercise three is the last exercise of the tutor course, where the participants have got all the theory and guidelines regarding tutoring a new operator. The exercise is at the stimulated line of the introduction to the assembly work area. Tutor exercise three is the process of tutoring a new operator to learnstation 110 at the simulated line. This process is repeated and after every time the new operator completed the activities of the station, the participants and the instructors gave oral feedback. Tutor exercise three is a good exercise since the participants are training and getting valuable practical experience that they can use after the course at the assembly line with new operators. However, it was noted that not once did the instructors show how it really should be done; instead they gave feedback of what they could have done. A reflection that was made by the authors is why the instructors do not follow the step-by-step model when teaching the participants in the tutor exercises? According to the layered learning cycle of Shu-Ha-Ri the instructor should demonstrate how it should be done so the participant can mimic and do right from the beginning while the instructors could directly disrupt misconduct behavior (Liker and Convis, 2012). The instructors are the participants' mentors and the participants are at the Shu stage when entering the course. Liker and Convis (2012) states that first the student has to see the sensei perform before doing it themselves, this because it is important that the student works correctly according to the standard. This is something that is also mentioned as a part of the step-by-step model that is taught to the tutors at the tutor course. However, when the instructors teach the new tutors they do not do it according to the step-by-step model. The instructors should tutor the way they explain that the participants should teach to help them learn how the step-by-step model works.

5.2.Introduction to assembly work

The first step of the learning process presented in the empirical findings is the introduction to assembly work. In this part of the paper an analysis of the current setup will be presented to establish how the performance is affected. Following this part an analysis of the second step will also be presented which is the introduction to line.

5.2.1.Establish a clearly defined written down standard of working with new operators

As seen previously the introduction to the assembly work can be divided into four steps: Theory, Basic skills, simulated line and special skills. Similarities between these steps were identified such as the way that the instructors work and the environment they work in. It is mentioned by Liker and Hoseus (2008) that standardised work tasks are based on three requirements: takt time, work sequence and work-in-progress. The tasks performed within the introduction to assembly work are standardised work tasks based on all the above mentioned requirements which also is the foundation for continuous improvement according to Liker and Hoseus (2008). This makes it

possible to evaluate the current setup and make improvements of the current standard. However it is not only the work performed by the new operators that is standardised also the way the instructors work is standardised. They work according to a sequence to teach the new operators how to perform the different workstations and work accordingly at all stations, this standardised way of working is however not written down but is rather a consensus between all the instructors working with the new operators at introduction to assembly work. A critical part of Toyota culture mentioned by Liker and Hoseus (2008) is based on continuous improvement which is possible only by setting standards in order to define how to work and train people in their organisation. For the case company to be able to improve their process of training the people of their organisation a well formulated and written down standard would help since there is no best way of working written down.

5.2.2.Difference in environment from introduction to assembly and introduction to line

Another reflection made based on the empirical findings was that the environment across all steps of introduction to assembly had big differences from the environment at introduction to line. To become a learning organisation one of the cornerstones explained by Hess (2014) is to enhance learning throughout the organisation by providing a learning environment focusing on employee engagement. The environment at introduction to assembly was recognised as more in line with a learning environment described by Hess (2014) where the instructors worked in a systematic way with learning and focused a lot on providing the best possible environment for the new operators to learn. The differences to the assembly line however are big since there is a much higher tempo at the assembly line and the pressure to perform in a production setting makes it harder to call it a learning environment. It is a much more forgiving environment working with “cold” engines, which means working on engines that are not going to a customer, than it is working with engines that are intended for the customer due to quality. The new operator that is learning is counted as an operator at the assembly line from day one which puts pressure on the new operator together with the tutor to deliver engines within the takt and quality. The focus is rather on productivity than creating a learning environment for the employees which can create stress that can have a negative impact on productivity and performance instead (Purwandini et al, 2012).

5.2.3.Factors that affect learning at Basic skills

The intention of the step of basic skills is that the new operators should learn the basics that is how to pick material, how to enter screws, how to place different items and how to handle different screwdrivers. All of these basic skills are deemed to be of high importance when starting to work at the assembly line and therefore to save time in production and to make it

easier to prevent disruptions at assembly all new operators go through the step of basic skills. It is important to the organisation that the learning time is as short as possible for the new operators. At the same time the quality and takt should not be affected at the assembly when the new operators are being introduced. According to Rubenwitz (1999) previous experience is a factor that affects learning and if the previous experience is considered positive then the learning process will take less time. By introducing the new operators to the basics of the assembly work they create previous experience for the operators before they start the work at the final assembly. Therefore, the step of basic skills intends to improve the learning process and shorten the learning time at assembly and prevent disturbances of the takt time.

It is mentioned by Regström and Andersson (2006) that factors that affect learning are: forgetfulness, motivation to learn, exhaustion, previous experience, age, repetivity, complexity and stress. This is something that is important to understand when working with new operators. Factors such as age and motivation to learn is something that is hard to affect for the instructors at basic skills but it is important to have the understanding to be able to help the new operator learn in the best way. Some operators can have previous experience of similar work tasks and that can help shorten the overall learning process but most of the new operators observed did not have previous experience of assembly work.

The work tasks performed in this step are standardised and all new operators go through the same steps. The work tasks have been broken down into elements to help the operator learn all the basic skills deemed necessary before starting the work at assembly. In the case of basic skills it is not only the work tasks that have been standardised but also the way the instructors work with the new operators. The instructors work based on the step-by-step model that can be compared to the job instruction method used by Toyota mentioned by Liker and Meier (2007).

To create a culture focused on takt and quality each station of basic skills has requirements of time and quality which sets the standard for the new operators from the start. The idea is to mimic the environment that is at the final assembly and create an environment that is similar with focus on time, quality, safety and ergonomics from the beginning. As previously mentioned Hess (2014) emphasizes the importance of creating a learning environment in order to work towards becoming a learning organisation.

5.2.4.Reducing complexity through environment and special skills

As stated previously the main objective of the simulated line is to combine the basic skills and test them in a setting similar to the environment at the final assembly. According to Chaffin and Hancock (1966) the learning time is directly affected by the complexity of the work tasks. It is also stated by Regström and Andersson (2006) that a high degree of complexity can lead to an

impaired performance, uncertainty and stress. This directly affects the learning time but by improving the environment at the introduction to assembly to create a more similar environment to the final assembly the complexity can be reduced. A more similar environment would thus reduce the learning time required at the final assembly as well as increasing the performance and reducing stress for the new operators before they start working at the assembly line.

However the reality today is that there are big differences between the environment at the simulated line and how the work at the final assembly looks like. The environment at the simulated line is much more forgiving, the engines are locked in one place and are disassembled by the new operator after performing the work activities. This means that the work will look a lot different when starting to work at the final assembly which can create problems of stress for which is a factor that affects learning mentioned by Regström and Andersson (2006). There is work being done to improve this part of the introduction to assembly but to mimic all different work activities performed at the final assembly huge investments will have to be made. It would require a lot of resources to be able to produce a setting that looks like the final assembly with for example expensive special tools.

The special skills step is something that not all new operators have to go through. The reason special skills are needed is because some work activities are more complex and require more information and skills of the new operator. The complexity is mentioned as a factor that affects learning by Chaffin and Hancock (1966) and by reducing the complexity the learning time can be reduced directly. The organisation is working today to reduce complexity at the final assembly by introducing the new operators to the more complex work activities in an early stage. However, the stage of special skills is short and does not include any requirements on time or quality. It is mainly just performed to prepare the new operators regarding the more complex work activities that they will perform at final assembly. It is good that this stage exists but to reduce the complexity further the special skills could be developed to help reduce the overall learning time of the new operator. To develop this step investments would most likely be required to invest in more special tools and instructors would have to work more with the new operators and develop time requirements of the work activity which would shorten the overall learning time but prolong the time required at introduction to assembly work.

5.2.5.Learning time at introduction to assembly

As mentioned before the learning time is important to the organisation and it is presented by Sjölander (1985) that factors that affect the learning time are: Prototypes, Assembly instructions, Pictures of the object, The appearance of the object, The number of activities, Hidden activities, Asymmetry, Exposure of the material, The sequence and precise movement. Based on this the fact that there are prototypes available of engines as well as the different parts of the engine in

the environment of introduction to assembly work the new operators have good possibilities to gain information regarding the different activities performed to understand the importance of each step and why it is performed. Assembly instructions are available both in the OIS and WES as well as provided at each station at the screen in front of them which also can help reduce the learning time. The workstations are also structured to not include too many activities which could make it easier to remember all the steps of each station. The sequence that the activities are performed as well as the exposure of the material is also something that can help in shortening the learning time. The material feeding station is structured to make all material visible and easy to access, the work of breaking down jobs into elements and performing them in a certain sequence is also evident at the simulated line making it possible to reduce learning time. Overall it seems like the organisation has structured the simulated line in a way that goes in line with the factors that affect the learning process meaning the overall learning time is relatively short already.

5.3.Introduction to line

The learning process for new operators when starting to work at the final assembly has been divided into four steps: Preparation for upcoming new operators, Introduction to the workplace, Learning the activities of the workstations and Verification of takt and quality. Overall it was identified that the work performed in relation to learning and training of new operators is not standardised. Different teams work in different ways and that affects the overall disturbance in takt and quality because it is hard to define the process and make sure that the takt and quality will not be affected when introducing new operators at final assembly. In this part of the thesis an analysis of the different steps and how that can affect the overall performance will be presented.

5.3.1.Information regarding upcoming new operators

It was identified in the empirical findings that most often the tutors do not have the time to prepare beforehand when introducing new operators to the workstations of their team. Based on the interviews with the tutors almost all tutors stated that they do not get information regarding new operators in time. They also agreed that it would be appreciated to get the information at least two working days before when they are expected to start the training of a new operator. It should also be noted that the instructors stated in the tutor course the importance of preparation and that the tutors should receive this information a couple of days ahead. As mentioned by Liker and Meier (2007) Toyota is using a job instruction program when introducing new employees which is very similar to the step-by-step model used by the case company. To be able to perform the work with introducing new employees effectively a prerequisite is that the tutor is well prepared which is not the case if they get the information the same day. The first step of the

job instruction method presented by Liker and Meier (2007) is to prepare the operator to know what previous knowledge they have and make sure that they have the right conditions to be able to perform the work task. If the tutor gets information regarding the new operator beforehand it would be easier to get an understanding of the previous knowledge which is an important factor that affects the learning process (Rubenwith, 1999). If the tutors get the information earlier they will also have time to prepare the work which in turn could help reduce the impact the new operator can have on the takt time at the final assembly.

It is described in the empirical findings that even though the tutor does not know that new operators are beginning to work in their team the information is often known by the SV and TL. Often it is known that a new operator is coming to the module but it is not specified in which team they should start working in or who will tutor the new operator. If this is decided too late the information does not reach the tutor two days before the new operator starts which makes it hard for the tutor to prepare the works. It is mentioned by Liker and Meier (2007) that it is important that the job instruction training is done by someone that is capable of following the standards as well as having the right capabilities to train and teach others. Therefore it is necessary to make sure that decisions are made earlier regarding what team the new operator should work in to help the tutor be able to follow the standard. According to Liker and Meier (2007) the reason Toyota works with the job instruction method is to enhance productivity by reducing the break in period and increase safety and quality by making sure that the workers understand the critical work elements. Making earlier decisions on what team the new operators should start in would help the TL of that team to have time in deciding which tutor would be an appropriate fit for the new operator. However based on the empirical findings it is not always known beforehand that a new operator is coming, often they go through the step of introduction to assembly work but sometimes there are operators switching from one module to another and that can be decided the same day. In these cases it is hard to anticipate and prepare the tutor but when the operators are going through the step of introduction to assembly work that means they know one week before that a new operator is going to start working at a specific module which is enough time to make sure that the tutor has that information at least two days beforehand.

It is important to understand how the information regarding new operators is processed to be able to make improvements. Today the information is mediated to the SV of the module whose task is to place the new operator in one of the teams of that module, this is done in correspondence with the TLs and when that is decided it is up to the TL of that team to decide which tutor works best at the time. This means that teamwork is important to make sure that the SVs, TLs and tutors can work together. Teamwork is described by Liker and Hoseus (2008) as one of the foundations in the Toyota way and by focusing on teamwork it is believed that the organisation can enhance both individual and team performance. The different roles in the module have to work together to

make the process more standardised and help make decisions faster to facilitate the important work that the tutor handles in the learning process. The earlier decisions are made the more possibilities there are to give information of new operators to the assigned tutor well beforehand which would help them prepare and ensure that the work performed is done more effectively reducing risks of disturbances in the takt.

5.3.2. Variation in engagement of Introduction to workplace

It has been described previously that when a new operator arrives at their new workplace they are counted as an operator together with the tutor right away. Depending on the amount of time and resources available the introduction each new operator gets varies. The tutor course provides all tutors with guidelines that specifically say that it is very important to make an introduction of the workplace including essential areas as well as the workstations at their loop. However, since they are expected to produce engines this process can be shortened or even totally neglected at times. As described by Liker and Meier (2007) an important part of the first step of the job instruction program is to make the new operator feel relaxed and relieve some stress. The initial introduction to the workplace plays a huge part in that and it is very important to make sure that the new operator knows how to locate in their new workplace as well as understands the different work tasks they are supposed to learn. It is described in the role of the TL that one of the main responsibilities is to support team members and take over at the assembly stations if needed. This can be utilised to give the tutor more time to prepare the operator but through observations it was identified that some team leaders were not interested or did not have the time to support the tutor in that way. Sometimes a spare resource was available other than the team leader to support the team and help whenever necessary, this was not so common though due to lack of resources overall.

It is also worth mentioning that even though some tutors had the time to make a proper introduction to the workplace this was not always done. The work is not standardised and every tutor does what they think is the best way resulting in different introductions at all times. The introduction process is not prioritised by either the tutor, TL or the SV at the moment. If more time was put into helping the new operator relax and reduce stress levels the overall productivity and effectiveness could improve (Purwandini et al, 2012). This would in turn help improve the quality and help manage the takt. Stress is mentioned by Purwandini et al. (2012) as one of the factors that affect the learning process and by improving the first step of the job introduction process at the case company the stress of the new operators can be reduced. Not only can the stress be reduced but by gaining more knowledge of the new operator factors mentioned by Regström and Andersson (2006) that affect learning such as motivation to learn, previous experience and age can be controlled and evaluated to help improve the learning process of the new operator. By improving the learning process and reducing the impact of factors such as

stress and previous experience the learning time can be reduced (Rubenwitz, 1999). This would help avoid disturbances in takt and quality in accordance with the first research question.

5.3.3.No mentoring of new tutors

The SV and sometimes the TL introduce themselves to the new operator already at the stage of introduction to assembly work to give the new operator some faces to recognize when they start their work at final assembly. It has been identified that information regarding new operators is not always in place but regardless it is not all SVs that introduce themselves to the operators in that early stage of introduction to assembly work. When the new operators arrive at the final assembly both the SV and TL have a responsibility of introducing themselves as well as the assigned tutor but it is the tutor that is responsible for the learning process and this is handed over already at this stage. Almost all of the responsibility is handed over and there is no active coaching or mentoring of the tutor so they manage the entire learning process. It is emphasized by Liker and Meier (2007) that the tutor always should have an experienced mentor either another tutor or the team leader that both has more practical experience of tutoring. Some of the tutors at the case company have only taken the two day tutor course and have no experience so it is very important that the case company understands that they are not finished with their training and they have to be mentored by more experienced people in the organisation. It is stated in the role of the SV and the role of the TL that they should help train and coach team members but in reality they do not work with training or coaching with the tutors to help them in the learning process of new operators. It is even mentioned by Liker and Meier (2007) that it is important to remember that new trainers are not ready to teach according to the job instruction method and that they need mentoring. For the case company this means that the new tutors that have taken the tutor course have gotten an introduction to the step-by-step model and how the organisation wants them to work with tutoring. But they are not ready to teach according to the step-by-step model and therefore needs coaching from a person in the organisation with more experience when it comes to the step-by-step model and tutoring.

5.3.4.Breaking down jobs into elements

The way tutors work in training a new operator when it comes to the activities of the workstations differ a lot. There is not a standardised process for how tutors work even though the tutor course introduces the tutors to the step-by-step model. The job instruction method includes breaking down the job into smaller elements that are more detailed and can help enhance the learning process of new operators (Liker and Meier, 2007). The break down of jobs into smaller elements is not done at the case company today. Some of the tutors break down the activities and work according to the step-by-step model learning one station before moving on to the next. There are however tutors that train the new operator on the whole loop right away, not taking one

station at a time and not breaking down the job into elements. One of the most common mistakes when teaching a new operator according to Liker and Meier (2007) is that the new operator gets too much information in one job which becomes the reality for the case company. This is supported with the statement presented by Lundh et al. (1992) that the learning process will be longer if one is learning several tasks in parallel to each other because it becomes harder to remember everything. It is also stated by Hess (2014) that system two thinking is very effortful reasoning where focus and concentration is needed, system two thinking is active when learning new things and by adding too much information to the learning process at once it can create a loss of concentration for the new operator. This in turn can lead to missing important information which can affect the quality of the work task performed by the new operator.

Too much information also mentioned as information overload which is the result of lumping together too many different elements in one work task can also lead to exhaustion according to Colman (2015) which in turn will make it harder for the new operator to complete work tasks. To avoid this it is important to work with breaking down the workstations into small elements and only teach one element at a time to the new operator, this also needs to be standardised so that all different modules work in the same way when it comes to training new operators. The breakdown of activities is a responsibility that the tutor has and is a part of being able to teach based on the job instruction method (Liker and Meier, 2007). This is used at some modules at the case company but the tutors do not get any information regarding how to break down work activities which has resulted in some dividing workstations into two elements and some into six elements. It is important to teach the concept of breaking down jobs into elements to the tutors from the beginning and this should be a part of the tutor course that is provided by the case company. It is stated by Liker and Meier (2007) that when you think the workstation is divided into elements that are detailed enough, Toyota would do it five times more detailed.

It has previously been identified that the environment differs from module to module and that can be a reason to why they work in different ways when it comes to training new operators. However, it is clearly described by Liker and Meier (2007) that the job instruction method, which includes the breakdown of activities to help with the learning process, works for all processes of an organisation. This would be applicable to the case company in the sense that all modules regardless of environment can be able to work according to a standard based on the job instruction method. If the workstations are broken down to more detailed elements, reducing the amount of information being processed for each work task presented to the new operator, the cognitive learning or system two thinking mentioned by Hess (2014) can be reduced to focus more on the motor learning preventing exhaustion which in turn can have a positive effect on the learning process.

Even though there is no standard way to work with new operators today that is aligned for all modules, the case company has stated that the goal is to align and create a standard for all of the final assembly. Based on interviews and observations it was clear that the takt was affected when introducing new operators but in the modules where they have started breaking down workstations to work according to the step-by-step model the overcycling of takt time had been reduced. In order to avoid disturbances in the takt when introducing new operators the breakdown of activities need to be more detailed to help standardising a way of working for the entire final assembly. By standardising the work the case company can according to Liker and Hoseus (2008) define the standard best way to do the job today until there is a new established improvement that becomes the new standard. Training is always done in a stable environment at Toyota and the work conducted is always broken down to the smallest detail (Liker and Hoseus.2008). Standardising the process of breaking down a workstation into elements and how to train new operators can help the case company to reduce complexity because not as many elements will be included at once. This will in turn reduce the learning time (Chaffin and Hancock, 1966). By reducing the amount of elements lumped together in the training process it is also possible to avoid exhaustion as previously mentioned which would help the new operators to perform the work tasks (Colman, 2015).

5.3.5.Top down pressure to manage the takt and minimise the learning process for new operators

As mentioned in the empirical findings the tutor is always expected to perform the work activities within the takt time even when they are training a new operator. They are counted as one operator and are expected to produce an output of assembled engines. Based on the interviews it was made clear that a lot of top-down pressure was experienced by the tutors when training a new operator. They were pressured to be able to manage the takt at the same time as there was pressure to make sure that the learning time was not too long so that the new operator could start to work on their own as fast as possible. Because the tutors felt pressured they moved on to the next workstation even though the new operator could not yet manage the takt to avoid getting stuck at one station for too long. This can become a problem since it is important that the new operators gain the maximum knowledge to avoid forgetfulness when returning to that station. According to Schafer (2001) forgetfulness can occur if there are breaks in the learning process before the task has been fully learned. Forgetfulness will in turn make the learning process longer according to Lundh et al. (1992) and that is also supported by the learning curve presented by Sigrell (1995) which introduces learning plateaus that will occur before reaching the maximal knowledge within the current learning process. If the tutor moves on to the next station when one of these learning plateaus are reached instead of making sure the maximal knowledge is reached the learning process will be longer. Sometimes the SV and TL do not intentionally put pressure on the tutor but it was identified that often both the SV and TL

constantly check up upon how it is going for the new operator creating pressure resulting in stress for both the tutor but also the new operator. It was stated in the interviews that it can create a feeling that they should be learning faster when the TL or SV constantly asks the tutor how it is going.

5.3.6.Stress as a factor that affects the learning process

Stress is one major factor that affects the learning process according to Regström and Andersson (2006) and it can be hard to remove all stress from a workplace that is based on a certain time requirement. It is however according to Purwandini et al. (2012) possible to reduce the stress for the operators to help them create a healthy work environment that is not hindering the learning process of new operators.

Stress is mentioned by Regström and Andersson (2006) as a factor that affects the learning process. At the simulated line the time requirements of each station are not as hard as they are in the final assembly. However even though the time requirements are not as difficult many operators still have problems with managing the takt at the simulated line. One of the reasons described by the instructors why new operators are not being able to manage the takt is stress. It is mentioned by Purwandini et al. (2012) that stress can create burnout, anxiety and depression which can lead to reduced effectiveness, lost productivity and healthcare issues. It is important to understand that stress is a major factor and in what ways the instructors can work to relieve some stress. It can be hard to remove all stress since the work of assembly is stressful but it is important to have understanding and work to reduce stress in the workplace.

5.3.7.The importance of preparing the student by identifying factors that can affect the learning process

It has been established that stress is a factor that has a negative impact on the learning process of the case company today but based on the work presented by Regström and Andersson (2006): Forgetfulness, Motivation to learn, Exhaustion, Previous experience, Age, Repetivity and Complexity is also important factors that can affect the learning process.

Motivation to learn, age and previous experience are factors that can’t be changed but it is important for the tutor to establish these as a part of the first step of the job instruction method mentioned by Liker and Meier (2007) which is to prepare the student. It is important to understand where the student is coming from and which factors can have an effect on the learning process to be able to help make the student feel safe and relaxed when starting the training. This is something that is mentioned during the tutor course and it was also observed that the tutors at the case company tried to establish these things right away in the step of preparation of upcoming new operators. The repetivity of the workstations is high since the job instructions

at the case company are standardised but at every loop variations of different engines exist creating some kind of variation. But overall the repetivity is high creating good opportunities for learning according to Chaffin and Hancock (1966) and by having high repetivity the complexity can be reduced as well which have a direct impact on the learning time according to Chaffin and Hancock (1966). As mentioned previously in this section by breaking down the workstations the complexity can be reduced as well and in that way enhance the learning even more.

5.3.8. The layered learning cycle of Shu-Ha-Ri at different levels

The learning cycle of Shu-Ha-Ri explained by Liker and Convis (2012) connects to forgetfulness. Shu-Ha-Ri describes the three different stages of learning according to Toyota and the learning process for new operators at the case company can be connected to the layered learning cycle of toyota. It is not until a student reaches the Ri stage of the learning cycle that they can perform the work without thinking and to avoid forgetfulness it is important that the new operator at the case company masters one workstation before moving on to the next. As described previously many tutors of the case company move to the next workstation even though the previous workstation is not mastered because they do not want to get stuck To reduce the impact of forgetfulness the student has to move past the learning plateau mentioned by Sigrell (1995), by for example explaining the reasons behind the work activities to reach the maximal knowledge at the top of the learning curve.

The huge responsibility put on the tutors by the case company to handle the learning process with only a two day tutor course as a way of training the tutors is not really fair. The Shu-Ha-Ri learning cycle as well as the learning curve discussed from the perspective of the new operator also applies to the tutor. It is a learning cycle where a lot of experience is required to be able to reach the maximal knowledge or the Ri stage. The tutor needs to be mentored by a more experienced tutor or the TL to make sure that they have the tools required to be able to teach according to the job instruction method (Liker and Meier, 2007). Just like for new operators it is important that the tutors are mentored as well, as it is stated by Liker and Meier (2007) trainers are not ready after taking a course in a classroom setting, they also need to be trained and mentored by a skilled and experienced mentor/sensei.

5.3.9. A lack of prioritisation: Takt and quality vs Learning time

There is also a lack of clear prioritisation by the SVs and TLs. Based on the work with Real Time Management it is really important that the workstations are performed within the takt time as well as within the required quality. However, there is also a very high interest in making sure that the new operator is not being trained by a tutor for too long because in the end that will also cost money for the organisation. The learning time is something that is discussed in the theory

section and the factors that can affect learning time is according to Sjölander (1985): Prototypes, Assembly instructions, Pictures of the object, The appearance of the object, The number of activities, Hidden activities, Asymmetry, Exposure of the material, The sequence and precise movement. Based on the interviews it is not only the disturbance of the takt that has to be avoided but the reduction of the learning time is also a priority.

There are prototypes available at final assembly to show final products and complex parts but the fact that the work cycles are so short and there are no buffer in between the stations makes it hard to actually use the prototypes in the learning process and as established previously the tutor does not have time or resources to actually leave their workstation to show prototypes to the new operator. The job instructions however are presented on a screen at each station which according to Sjölander (1985) would decrease the learning time as well as the fact that pictures of the objects are available in the WES. The appearance of the objects and the number of activities at each station can also affect the learning time of these stations. Large objects can often be easier to learn to assemble and less amount of activities on each station will also decrease the learning time (Sjölander, 1985). Overall the case company has identified the importance of balancing the workstations which also can help decrease learning timet. Hidden activities are also not a big problem for the case company today and the material feeding stations at each loop is used to make all material available to decrease the amount of activities resulting in a shorter learning time. Too many precise movements can also make the learning time longer and it is important to consider this when forming the different workstations. The last factor mentioned by Sjölander (1985) that is important to consider when it comes to learning time is the sequence of the work tasks performed at a workstation. As also mentioned in the learning process of toyota the elements that you break down a workstation to do not always have to be taught in the order they are performed in. This is something that the case company could improve to decrease the learning time, as mentioned previously the tutors do not get any information regarding the breakdown of workstations into elements. By training the tutors in how to breakdown workstations and informing them on ways to sequence these elements the overall learning time could be significantly decreased.

5.3.10.Focusing on the right information while learning the activities of the different workstations

According to both the step-by-step model and Toyota's job instruction program presented by Liker and Meier (2007) the operator should state what, how and why they are doing while performing the work tasks. This mainly because it will keep them focused and move faster from system two thinking to system one. However, it was observed that not all tutors told the new operators the importance of understanding why the tasks were performed. Sometimes the new operator even started asking and talking about general topics that had nothing to do with the

work station, while trying to learn the work tasks of a specific station. This removed focus from the operator and it was observed that not once did the new operators manage the takt time while talking about something else at the same time as learning the station. When the focus and flow is disrupted by talking about something other than relevant information to perform the work it will, according Regström and Andersson (2006) prolong the learning process since forgetfulness is a factor when the attention is not at the right place.

5.3.11.Not training according to the work standard

The case company is using OIS and WES to define the standard of the workstations. The standard can be updated and changed in the system but the newest version is not always printed out at the assembly line. It is important that the current best way to perform the work tasks is written down and defined according to Liker and Hoseus (2008) and this will also make it easier to follow the standard as well as improving the process. Today not all operators are following the standard and apply their own ways of performing certain tasks because they feel that it works better in their way. This is also evident when it comes to the learning process of new operators. Not one time did the tutor actually show the OIS and WES to the new operator explaining that the standard is written down and that is how they should work. Instead they are working based on their "own" standard from their head and teaching accordingly. The tutor should use the OIS and WES in the learning process to help give the new operator the understanding regarding standardised work. Standardised work is the foundation for continuous improvements and training (Liker and Hoseus, 2008). It is further explained that within the work tasks at Toyota there are also requirements on developing the process and generating ideas for improving the job (Liker and Hoseus, 2008). The new operators should be provided with information regarding the fact that they should own their own process and that improving the workstations is a big part of their work.

5.3.12.The importance of verifying that new operators can manage takt and quality

The guidelines of the case company is that the SV should always be the one to verify that the new operators are ready to work on their own. This verification is done based on that the new operators can perform the work activities of the loop they are going to work within according to the takt and also that they know the key activities and the reasons behind the key activities to ensure that they can perform the work activities with good quality. However, today even though there is a standard way to perform the verification of new operators it is not followed. Because the work looks different depending on what module or even what team you work at it is hard to verify that operators that are deemed ready to work on their own will not affect the takt or quality in a negative way. It is important to establish a standardised work task but just as important to actually follow the standard that has been developed. If the standard work is not followed it is

impossible to make improvements. Standardised work is according to Liker and Hoseus (2008) the foundation for continuous improvements and if the different modules work in different ways with verification of new operators it is impossible to evaluate the standard and make improvements.

The case company has decided that a new operator can be counted as a single operator and ready to work on their own when they can manage the takt and quality at the workstations within their team. It has already been established that there is different ways to ensuring that the new operators can manage the takt and the quality but it has also been identified through interviews that the takt and quality actually is affected not only during the learning process but also afterwards when new operators are deemed to be ready to work on their own. The process of verification of takt and quality may not affect the disturbances in takt directly but if a new operator is verified before they can handle the takt and quality there is a great risk that there will be disturbances in the takt which means that the verification process indirectly can have a negative effect. It is explained by Liker and Meier (2007) that the last step of the job instruction method is to follow up and make sure that the student can perform the work independently. The same goes for the step-by-step model used by the organisation and it is important that the tutors have the knowledge to be able to verify that new operators really can perform the work task within the time- and quality requirements. To be able to avoid disturbances in the takt when the new operators start working on their own criterias that every tutor works after is necessary. Criterias for new operators need to be aligned across the organisation to ensure that the standard developed for this process is the same for the entire final assembly plant. These criterias need to include all the different parts deemed important by the organisation such as safety, ergonomy, quality, time and health, most importantly the standard needs to be followed to be able to evaluate and make improvements based on the current criteria for new operators.

5.4.Improvement work

The last part of the empirical findings was connected to the improvement work of the case company and how new operators are introduced to the improvement work. An analysis has been made regarding the general approach to the improvement work and how new operators are introduced to the improvement work to answer the second research question of this thesis.

5.4.1.Creating a sense of ownership of the process for the operators

Based on the empirical findings describing the improvement work of the organisation the new operators do not get any introduction to the improvement work at this stage. The senior director of production described a situation where the organisation is going through a lean transformation and that focus is to try and change the way the improvement work is done. Traditionally

improvements have been pushed down by management but the vision of the organisation is to change this to create a sense of ownership of the process for the operators. The intention is that suggestions for improvements should be created by the operators and also performed by the operators working in the process. The organisation is trying to change the organisational culture to give more responsibility and ownership to the operators working on the shop floor to be able to improve the processes. Supervisors and Team leaders have a responsibility to encourage and coach the operators to truly own their own process (Liker and Hoseus, 2008). This is an important aspect that needs to be considered by the case company to be able to change the ownership of the process from top management to the operators.

To create a culture focused on improvement work it is important that all operators feel that they can affect their workplace and can be involved in the process of improvement work. When it comes to new operators they therefore have to be introduced to the mindset of owning the process and improving it continuously in an early stage. The development of the work is a requirement on operators within Toyota and this has to be clear for new operators (Liker and Hoseus, 2008). It takes a long time to change the organisational culture and most often the reason organisations fail when trying to adopt the lean principles is because they do not consider the overall culture of continuous improvements that is present at Toyota (Liker and Hoseus, 2008). It is therefore important to introduce the new operators already from the start to get them focused on the mindset of standardised work and kaizen from the start. Standardised work is described by Liker and Hoseus (2008) as the foundation for the work with continuous improvements and it is important that the new operator has that understanding. The new operators need to understand how standard work tasks and continuous improvement are connected. To achieve ownership of the process for the operators they need to understand that it is a requirement to develop the process and provide ideas of potential improvements (Liker and Hoseus, 2008). The new operators need to learn the standard way of performing the work activities to be able to improve the process. If the operator learns how to perform the different activities without getting information regarding standardised work tasks and improvement work many good suggestions can get lost. Many good suggestions that the new operator has can go lost because they do not understand the reason behind standardised work and will just perform the work based on the standard and not try to improve it.

5.4.2.Culture of continuous improvements

Learning organisations is focusing on a culture based on learning and developing people of the organisation to develop the organisation. To become a learning organisation it is important for the organisation to have the right people, right environment and right processes (Hess, 2014). This is also true to create a culture of improvement work, the right people have to be driven and motivated by the fact that they can affect the workplace and improve the process in what way

they work. The environment has to be focused on developing the people and the processes with focus on the operators. They have to create an environment that is focused on the ownership of the process so that all operators understand that they have the responsibility of the process and great opportunities to improve the process. According to Hess (2014) critical thinking processes and communication processes are important to facilitate the learning of the people within the organisation. To create a learning environment with innovative- and critical thinking the leaders need to make sure that the operators feel trusted and valued at the workplace. According to Hess (2014) there are two important factors within the processes and that is that the employees should be able to speak freely and be accepted even if something goes wrong. For the case company to be able to facilitate the learning capabilities as well as the culture of improvement work they need to make sure that they have an environment where the operators are allowed to speak freely and that their suggestions are taken seriously and that it is okay even if something goes wrong..

How operators are introduced to the organisational culture and the way SVs and TLs facilitate and encourage employees is an important part of creating a culture of continuous improvements. It is important to have a standardised process for how the new operators are introduced to the improvement work as well as defining the roles of the SVs and TLs. The main roles of the leaders at Toyota are described as supporting, encouraging and coaching their group to make sure that they truly own their process (Liker and Hoseus, 2008). This will make sure that the operators are motivated to improve their process.

According to Liker and Hoseus (2008) the process of continuous improvements relies upon the operators working within the process and the culture of engaging people in the improvement process. The engineers who set up the process are not working within the process and can not identify all the disruptions. However, the operators working within the process observe all deviations and can act to stop these deviations to move forward to the next process (Liker and Hoseus, 2008). It is further explained by Liker and Hoseus (2008) that shifting the responsibility to the operators working within the process it is easier as well as cheaper to find deviations to be able to improve the process. As mentioned previously the case company wants to shift the responsibility to the operators, in order to do that they need to develop the work conducted by SVs and TLs to facilitate the culture of continuous improvements. They also need to include all operators in the improvement work and not just a few selected operators.

5.4.3.Perception of introduction to improvement work at introduction to assembly work

The introduction to assembly work was created and has been running approximately two years at the case company. During these two years the introduction process at introduction to assembly work has been developed and changed repeatedly. Since there previously was information

regarding improvement work at the introduction to assembly work, there has become a perception at the final assembly that the new operators get introduced to the improvement work at the introduction to assembly. According to the interviews this has mainly happened because of two things: 1. The SV, TL and tutors at the assembly line are not updated regarding what information that is taught at the introduction to assembly work. 2. Even if the step-by-step models first step, preparing the operator, has been used by all the observed cases there is no standard within that part by the tutors or anyone of the team to ask if they have received an introduction about improvement work at the introduction to assembly work.

The introduction to assembly are constantly looking at ways to improve their processes to become more similar to the assembly line, to be able to prepare the new operators more than today. However, the people at the assembly line are not constantly updating their information of what is happening at the introduction to assembly work. Even though the SV and TL are visiting the introduction to assembly work when a new operator will join their team, they are not there with the focus to update their information of what the new operator learns at the introduction to assembly work. It is important for the SV and TL to have understanding regarding what is learned at the introduction to assembly since previous knowledge is mentioned as one of the factors that affects learning according to Regström and Andersson (2008). If the SVs and TLs ask and constantly keep themselves updated to what their new team member is truly introduced to at the introduction to assembly they can gain understanding regarding previous knowledge. By understanding the knowledge acquired of the new operators they can align their processes and avoid risking the new operators missing out on important information or trying to learn the new operators the same thing twice. All the SVs that were interviewed either stated that the new operators are introduced to the improvement work at the introduction to assembly work or that they think that it is occurring but are not completely sure. As seen in the job instruction method presented by Liker and Meier (2007) and the step-by-step model that is used by the organisation both include the first step of preparing the operator. This step includes understanding of previous knowledge to make sure that the tutor knows what the student knows to help them relax and learn. The majority of the tutors have been at the introduction to assembly work themselves when they started or have tutored a lot of new operators, which has given them some kind of understanding of what is taught at the introduction to assembly work. It is often assumed that nothing is changed at what was learned when the tutors themselves attended the introduction is the same that new operators learn today. This is however not true and many changes have been made over the last couple of years. It is important that the tutor have this information regarding what is learnt at the introduction to assembly work either by asking open questions to the new operators or that all tutors, TLs and SVs get updates regarding what information is taught at the introduction to assembly work.

5.4.4.No introduction to improvement work at introduction to line

The tutor's job is to introduce the new operator to the assembly line and there is no demand for them to introduce the new operator to the improvement work. The introduction to improvement work is not standardised and this has resulted in that the new operators are not gaining any information regarding the improvement work more than being a part of the team. The majority of the SVs stated that according to their opinion the new operator should be introduced to the improvement work after they first learnt to perform all the stations at the right takt and quality. One of the SVs even said that they believe it is enough that the new operator just is a part of the team to become a part of the culture of continuously improving the process. That is however, not true and the new operator needs to be introduced earlier to the improvement work to create the culture of kaizen from the beginning. It is much easier to introduce a new operator to a desired culture from the beginning than trying to change the culture for people already working within the organisation. It is explained by Liker and Hoseus (2008) that the underlying assumptions, norms and values are parts of the culture that are hard to change. New operators are not a part of the organisational culture yet and therefore it is easier to introduce them to the desired culture. The new operator needs to be introduced to standardised work and the kaizen mindset from the beginning to understand that they are working according to the best standard way to perform the work task today to be able to improve the process (Liker and Hoseus, 2008). If the new operators are introduced to the kaizen mindset from the beginning and the fact that a big part of their work consists of improving the process they work within it can be easier to make them feel comfortable. As stated previously it is much harder to change the mindset or the culture when the operators are already a part of the process, instead they should already from the beginning learn that a part of being an operator within the case company is owning the process and improving it.

5.4.5.Lack of understanding of roles connected to improvement work

According to the role descriptions for SV and TL they have responsibility to coach and develop the new operators and lead the improvement work. As stated in the empirical finding there is no standard process of how to introduce the new operators into the improvement work. Not all the SVs and TLs take responsibility when it comes to new operators and introduces them to the improvement work. Some TLs did not even know what their role was regarding improvement work.

The process of improvement work is not a standardised process and the role that the SVs and TLs have when it comes to improvement work is not trained which creates big differences between the modules. There are not only differences between the modules but also there are differences between shifts at the same module. Since there is no standard way of working with improvement work the different SVs and TLs perform the work according to what they think is

best at the time. It is described in the empirical findings that some SVs and TLs take a lot of responsibility when it comes to the improvement work and the importance of involving all operators and encourage them to be a part of the process. It is also described that other SVs and TLs do not take any responsibility since their overall belief is that there is no problem with employee involvement today so they see no reason to involve and encourage the operators. As stated by Hess (2014) one of the most important factors when it comes to learning is to create learning conversations where people feel trusted and valued by their leaders. All operators therefore need to feel that they can speak freely when it comes to improvement suggestions and that their suggestions are valued for them to be encouraged to help in the improvement process. In the current setup there are problems since the different shifts at final assembly work differently. This has resulted in some of the leaders engaging to try and enhance the learning and encourage improvement work while some are not as good in this process. The work with improvements is not standardised and therefore as stated by Liker and Hoseus (2008) there is no foundation to improve this process. It is evident that a standard way of working with improvement work is necessary but also defining the responsibilities of the different roles involved is an important aspect.

Today the different SVs and TLs have a hard time defining what their role actually is and how they should work in regards to the improvement work of the organisation. Their roles are generically described as supporting the people of the team and leading the improvement work. But what does that mean? How do you work with improvement work? How do you encourage and coach the employees regarding improvement work? How should the new operator be introduced? All of these questions become interpretations and are the reason why SVs and TLs work so differently when it comes to improvement work. The layered learning cycle mentioned by Liker and Convis (2012) describes a learning process with focus on a student and a sensei/mentor. This is applicable to all levels of the organisation and it is mentioned by Liker and Convis (2012) that this is not only for assembly-line jobs. To better understand their roles it would therefore benefit the SVs and TLs if they also got coaching and training in their roles. This would help them understand their roles and learn how to perform their work tasks according to the desired standard of the organisation. This is not done today, focus is put on learning new operators how to assemble an engine but the SVs and TLs do not get any training in their role. Just as the operators being trained in how to perform the different work activities the SVs and TLs need to be trained in their roles and how they should work when it comes to learning and improvement work.

It was described in the previous paragraph that many SVs work according to what they think is the best way when it comes to improvement work which creates variations between the different modules and even shifts. Some of them felt that there is already a lot of information introduced

to the new operators which would make the introduction to improvement work unnecessary, therefore most often the new operators are not introduced to the improvement work until they can manage the takt and quality of all workstations. The Shu-Ha-Ri learning cycle described by Liker and Convis (2012) explains how one has to master the process before being able to improve it. The final Ri stage of the cycle is when the student can perform the work tasks without thinking and it is also in this stage that they can start focusing on the purpose of the job and if there are any possible improvements (Liker and Convis, 2012). However, the culture of continuous improvements and ownership of the process is something that can be introduced as early as possible. The intention is not to put pressure on the new operator to come up with ideas regarding improvements of the work activities before they even know how to perform them but to open the door to the mindset of kaizen and to help them understand that they own their own process and are able to affect the workplace. In this way the culture of kaizen kan come naturally for the new operators helping the change of organisational culture and improving the development of the processes of the organisation.

5.4.6.M3MU-Workshops

It was defined in the empirical findings that the main activity for improvement work of the organisation is M3MU-workshops. These workshops do not include all operators that work within the process and only a few of the operators are selected to work together with management to find possible improvements to the process they work within. This means that new operators most often will not be a part of these groups since more experienced operators and the ones that are deemed to be driven and motivated to work with improvements will be handpicked over the new operators. The senior director of production talked a lot about ownership of the process and that improvements ideas should come from the operators working within the process, these M3MU-workshops essentially mean that a few operators are selected to work in these groups in order to improve the work method of the process. To create a sense of ownership it is important to involve all operators in the process of improvement work and not just a few selected ones. As mentioned by Liker and Hoseus (2008) the improvement work should be included in the work done by the operators. The operators that are not chosen to be a part of the M3MU-workshops are anticipated to still come up with ideas and in that way be involved in the process meaning that the only way a new operator can work and be included in the improvement process is if they contact the group to present their own ideas of improvements.

5.4.7.Continuous improvements and the role of the IMT

The role of the IMT is not a standardised process and it is described in the empirical findings that the work performed by the role of the IMT looks different depending on what module or even what shift you look into. However this part of the improvement work has been compared to the

way toyota work with kaizen and it is the organisations take on working with continuous improvements. However, just as in the work with M3MU-workshops the new operators are not a part of this process. To be able to work with the role of the IMT a new operator first has to be able to conduct the work of each workstation within the requirements of the takt, quality and safety. When the new operators are deemed to be able to do this they also have to learn the activities around the workstations such as feeding material to the workstations.

The fact that one person is selected and removed from assembly to take on the role of the IMT and work with improvements is also something that can decrease the involvement from all the operators. Some modules tried to include everybody in this work but it was clear that at some modules only a few people actually work with the role of IMT and in that sense got to be involved in the improvement work. To shift the ownership from top management and make it easier to improve the process all operators need to be included (Liker and Hoseus, 2008). One designated resource working with improvements is not involving the employees and creating a feeling of ownership of the process. It is important that the improvement work is an integrated part of the daily work and that everybody that works within the process is involved and a part of the improvement work. The kaizen mindset should be trained to all operators to focus on improving the process and it is also important that the environment they work in allows and gives resources for the operators to also perform the suggested ideas of improvement.

5.5.Compilation of analysis

The identified steps of the current process of the case company presented in the empirical findings has been analysed in this section. Established literature presented in the theory section was used in order to compare it to the current state and identify gaps that can affect performance and the improvement process. The main findings of the analysis are presented in *table 4* and recommendations to improve these areas will be presented in the next section of this thesis.

Table 4: A compilation of the analysis.

Part of the process	**Main findings**	**Identified problems**
Tutor course	● Step-by-step model ● Course length ● Learning at different levels ● Tutor exercises	1. Lack of standard process of training 2. Concentrate information during 2 full working days 3. Tutors are deemed ready

		after 2-days of training 4. A lot of information presented not connected to the tutoring process
Introduction to Assembly	• Establish a written down standard • Difference in environment • Factors that affect learning at basic skills • Reducing complexity through environment and special skills • Learning time	1. Lack of written down standard hinders the improvement process 2. More of a forgiving environment 3. Complexity and stress affects learning time 4. Lack of resources to invest in special equipment
Introduction to line	• Information regarding upcoming new operators • Variation in engagement of Introduction to workplace • No mentoring of new tutors • Breaking down jobs into elements • Top down pressure to manage the takt and minimise the learning process for new operators • Stress as a factor that affects the learning process	1. Information regarding new operators are not provided to the assigned tutor 2. Lack of resources and time to provide the new operators with a introduction to the workplace 3. Tutors are not trained in the step-by-step model 4. Too much information presented at once 5. No standard way to how to break down jobs or in what sequence to perform the work stations

	• The importance of preparing the student by identifying factors that can affect the learning process • The layered learning cycle of Shu-Ha-Ri at different levels • A lack of prioritisation: Takt and quality vs Learning time. • Focusing on the right information while learning the activities of the different workstations • Not training according to the work standard • The importance of verifying that new operators can manage takt and quality	6. Experienced stress for both operator and tutor 7. Lack of patience resulting in tutors moving on to the next station before the student has achieved maximum knowledge 8. Differences in prioritisation from module to module 9. Lack of focus resulting in missing out on important information 10. Variations in how to tutor, deviating from the step-by-step model 11. Negative effect on takt and quality even after the new operator is verified
Improvement work	• Creating ownership of the process for the operators • Culture of continuous improvements • Perception of introduction to improvement work at introduction to assembly • No introduction to improvement work at introduction to line • Lack of understanding of	1. Lack of involvement of operators in the improvement process 2. No standardised process for working with improvements 3. SVs and TLs do not facilitate the improvement work 4. No alignment between introduction to assembly and introduction to line

	roles ● M3MU-Workshops ● Continuous improvements and the role of IMT	5. New operators are not introduced to the improvement work 6. All operators are not included in the process of M3MU and IMT 7. M3MU and the role of IMT is not standardised across the different modules

6.Recommendations

In this section the analysis will be used as a foundation to present recommendations that can help answer the two research questions. This will help the case company to understand how the organisation can work to reduce disturbances in the takt when introducing a new operator as well as how and when a new operator should be introduced to the improvement work of the organisation. This section is structured in the same way as the analysis, starting with recommendations connected to the tutor course followed by Introduction to assembly, Introduction to line and lastly Improvement work. Each recommendation has been evaluated based on the priority of implementation and the possible effects of the recommendation. The implementation of recommendations has been divided into low-, medium- and high priority and the possible effects have been divided into short-, medium- and long-term. The priority is based on associated costs, possible effects and time required to accomplish the change. Short-term is set to up to 1 year, medium-term is 1-3 years and long-term 3-5 years. In the last part of the section a compilation of the recommendations will be presented in a table showing the priority of the implementation as well as the possible effects based on short-term, mid-term and long-term.

6.1.Tutor course

The tutor course provides new tutors with important information that is necessary before they start to work with new operators. Based on the analysis made in the previous section of this paper, the authors found that a few recommendations connected to the tutor course could help the organisation to improve the overall learning process for new operators to be able to avoid disturbances in the takt and quality. All these recommendations associated with the tutor course will be presented below.

6.1.1.Develop the tutor course with focus on the step-by-step model

The tutor course enables the case company to create a standard way of working for all the tutors. However, today at the assembly line there was no standard observed and the tutors worked differently across all modules. This can and should be changed if the tutor course is developed more with focus on the step-by-step model. The instructors often gave general ideas and advice, which is good but in some areas the information should be more standard of how the case company wants it to be done. One recommendation would be to not only say to the participants of the course to ask the new operators what, how and why they are doing a task, but instead explain to them when and where in the process this should be done. This would make the tutors remember the advice given at the course since the information can be connected with an incident but also increase the standardisation for the tutors across the modules.

Another thing that the authors find crucial, which was found in Toyotas job instruction presented by Liker and Meier (2007), is to teach the participants how to break down the work activities and how they should help the student train on the different workstations. Overall the step-by-step model is good and consists of guidelines of how to tutor. However, it lacks the detailed explanation of what and in what order work sequences should be explained. The reason to give detailed explanations to the tutors is to create a structure for all the tutors to work the same with all the new operators at every module. By breaking down the tasks and achieving a standardised way of working it would help the case company accomplish a standard throughout the entire final assembly. Note that the authors are not stating that the breakdown should be identical at all the modules, but they should come from the same way of thinking. The authors however, state that every shift at the same module should break down the work tasks in the same way so every new operator is taught in the same standardised way no matter what tutor nor shift they work at.

It is recommended that this implementation is made directly in order to start the transformation to tutor according to the step-by-step model taught at the tutor course. No major costs is associated to changing the way the tutors of the organisation work but it is a change that can take time since the step-by-step model has to be taught to more experienced tutors, SVs and TLs first to make sure that there are mentors available for the newer tutors to learn the new work standard as well. Therefore this recommendation is deemed to be high-priority and the effects are going to be focused on long-term results.

6.1.2.Prolong the course

As mentioned in the analysis section, there are both benefits and disadvantages having the tutor course two intensive full working days. The authors recommend that the course should be prolonged to more than two working days and shorter sessions but not necessary five days with two hour sessions as the job instruction course. The biggest reason behind this advice is that according to Hess (2014), when learning something new system two of our brain is used, this system two thinking requires a lot of energy. Therefore eight hours of system two thinking is not possible and creates a risk that the participants in the course get information overload, lose focus and miss valuable information given at the course. It was observed at the assembly line that some tutors did not use key instructions from the course when tutoring and the main reason for this can be due to information overload, lost focus or forgetfulness.

The recommendation is to change the arrangement of the course from two full working days to make it possible for the operators to concentrate and take more information with them from the course. It is described by Liker and Meier (2007) that Toyota works with two hour sessions over five days but that does not mean that is the best arrangement for the case company. A thorough investigation has to be made to see what the best arrangement for the case company would be.

This will of course require resources and time which is one of the reasons why the priority of implementation is deemed to be medium. The effects of this change should come immediately when the arrangement of the course is changed since the participants of the course would be able to reduce the amount of system two thinking and process more of the information. This means that the recommendation would have short-term effects.

6.1.3.Instructors should use the step-by-step model on the participants

It was observed at the tutor course that the instructors did not use the step-by-step model when teaching the tutor exercises, instead they let the students demonstrate without being shown how to perform the exercises first. The reason for this was to show the participants what happens if one does not prepare the student beforehand. This was a good lesson and made the participants reflect and also received a lot of feedback. However, the author's recommendation is that even if there is a thought behind not preparing the participant prior to tutor course exercise one, the instructors should instead of only giving oral feedback actually demonstrate how the exercise can be performed using the step-by-step model. Tutor Exercise three is about presenting an entire station in their basic skills simulated line. At this stage of the tutor course the participants have gotten information regarding the step-by-step model and have more time to prepare. However, the instructors never demonstrate how they should perform the exercise instead they only explain and then give oral feedback. The authors find it confusing that the instructors do not use the step-by-step model when tutoring the participants when that is how they want them to tutor new operators. The tutor course should be focused on training the participants how to work according to the step-by-step model and the instructors are their mentors trying to teach the participants how to accomplish this. Therefore it is important that they work according to the step-by-step model and actually show participants how and why it works. The participants of the course want to mimic how the instructors work and if the instructors never demonstrate how then it creates more room for interpretations which affects the standardisation.

This is a recommendation that is deemed easy to implement since the instructors of the introduction to assembly work already have the knowledge of the step-by-step model. It would not require any costs, resources or time to change the way they work with the exercises of the tutor course and therefore this recommendation should be a high priority. By changing the way the instructors work more based on the step-by-step model the participants of the course can get to see exactly how the method works. This effect would be immediate and therefore the effects are deemed to be short-term.

6.1.4.Remove engine and screw joint knowledge

The author's advice is to remove engine and screw joint knowledge from the tutor course or at least reduce the time spent on it. It was calculated that approximately 35% of the entire course consisted of engine and screw joint focus. This is a high percentage of the total course on information that does not directly make the participants better tutors.The participants of the course have knowledge of how to perform their work at the assembly line, however, lack the information and training of how to introduce and tutor a new operator in a standardised and efficient way into the assembly line without affecting the takt and quality of their work. The course was created to train the tutors and the focus should be on training the tutors how to perform the tutoring according to the step-by-step model. The authors recommend that the information regarding engines should be replaced with the factors: the job classification factor, motivation to learn and ability to learn. This information can be important for the tutors to understand in order to know what factors they are able to affect and what factors that can affect the learning process in general. Shifting the focus towards the learning process and how to train new operators based on the step-by-step model could help give the new tutors tools to use. These tools could help in order to understand what affects the learning process as well as being able to standardise and improve the learning process. However, since the information of the engine and screw joints was very appreciated by the participants of the course, the recommendation is not to exclude it but instead teach another course focused on this available for all operators of the case company.

This is also a recommendation that is not associated with either costs, resources or time.To remove the engine- and screw joint knowledge from the tutor course should be a high priority recommendation since it does not really provide the tutor with information that is necessary to learn how to perform the tutoring according to the step-by-step model. The effects are deemed to be short-term since they should be evident as soon as the content of the tutor course is changed.

6.2.Introduction to assembly work

The most potential in order to achieve less disturbances in takt and quality when introducing a new operator was identified in the step of introduction to line. However, recommendations associated with the introduction to assembly work were also identified and will be presented below.

6.2.1.Invest in developing the environment at the introduction to assembly

As previously stated the work conducted at the introduction to assembly is standardised and is considered to help decrease the overall learning time based on the fact that the environment has a focus on learning. There is potential to improve the process at the introduction to assembly work

but it is believed that this would require heavy investments. The overall environment has been identified to differ a lot from the final assembly line. To mimic the work process of final assembly and to create a similar environment, that would help prepare the new operators, they would have to: Change the work process when it comes to the time requirements, look over the possibilities to have engines moving with the AGVs and reducing the work performed by the students by not having to disassemble the engines after ever station. This would however require big investments to rebuild the simulated line and therefore this is probably low priority when other recommendations can have a positive effect on the disturbance of the takt without having to invest heavily. The effects of investing to change the environment at the introduction to assembly work would also take a lot of time meaning that the effects gained from this would be more long-term.

6.2.2.Define the work conducted by the instructors

The way of working with new operators and the training process of the different stations at the introduction to assembly work is a standardised process, however the process is not written down but rather a consensus between the different instructors working within this process. If the standard way of working is written down it is easier to define and evaluate it in order to be able to improve the standard. The recommendation is that the instructors that are working with the introduction to assembly work together defines the standard way of working to make sure that everybody is conducting the work according to the best current way of doing so. This will help them to continuously improve their own process and make it easier for new instructors to quickly align with their process.

This recommendation is believed to be high priority since it is not an expensive process involved in establishing a written standard of the work performed. It would require some time from the different instructors of the introduction to assembly work but the impact could be great since they would establish a defined standard that is easier to improve. Not only would it become easier to improve the current best way of performing the introduction but it would also make it easier for new instructors to learn the standard. Since it would not require much time the effects are deemed to be short-term.

6.2.3.Develop the Special Skills part of introduction to assembly work

Another reflection that was made in the analysis section of this paper was that the special skills part of the introduction to assembly work was rather short and did not have any requirements on time for the new operator. It is good that the new operators are introduced to more complex processes of assembly to decrease the overall learning time. However, it is possible to decrease the complexity even further by focusing more on special skills and developing this segment of

the introduction process for new operators. Instead of just getting information regarding the complex steps the recommendation is that the new operators should have more time in this learning environment to familiarise with the more complex steps of assembly. It is also recommended that time requirements are introduced just as for the other stations to make sure that the new operators can perform the more complex steps already at this stage. In this way the learning time at the final assembly can be decreased and the probability of mistakes made on the assembly line will also decrease meaning that takt and quality can be affected in a positive way.

This recommendation is connected to the investments to improve the environment of the introduction to assembly work. It would require investments in special tools and a lot of resources to change the simulated line. If the investments made would generate great positive effects it could be worth making investments but as of now it is not believed that the change of the simulated line would greatly reduce the disturbances in the takt and quality when training a new operator. Therefore this recommendation is deemed to have low priority and long-term effects.

6.3.Introduction to line

As stated previously the most potential for improvements regarding the learning process of new operators to avoid disturbances in the takt was identified to be the introduction process at the final assembly. In this part of the section the different recommendations connected to the steps of introduction to line will be presented. The main problem identified through the introduction to line was that there were no standard way of working at any step of the process. The recommendations presented focus on handling this problem. Each recommendation will be presented with comments regarding the implementation priority and possible effects.

6.3.1.Provide tutors with information regarding new operators at least two days beforehand

First of all, the preparation for the upcoming new operator varies a lot in the current state and most often the tutors do not get the information regarding that a new operator is going to start working until the same day they arrive at the module. This information has to be given in an earlier stage so that the tutor knows that they are going to train a new operator. The preparation for the tutors include mentally preparing, updating their own knowledge of the workstations and key activities and also going through the different checklists to make sure they know everything that they should teach the new operator. It is of importance that the tutor gets this time to prepare to be able to make sure that they do not forget some information and teach according to the standard of the organisation to achieve takt and quality in an efficient way. The authors recommend that the tutors should receive this information regarding a new operator at least two

working days before they start so they have time to prepare their work. The main reason for stating two working days is based on what the tutors said in the interviews that they needed.

It was identified that it is important to give information to the tutor at least two days beforehand to give them an opportunity to prepare. However, to be able to do that first the process of transferring information and the collaboration between the different roles needs to be standardised. To be able to give tutors the information in time, the teamwork between the roles of final assembly needs to be improved as well as the way information is shared. Therefore the priority of this recommendation is only medium but the effects are still short-term.

6.3.2.Standardise the process of preparing for upcoming new operators

The standard way of working when it comes to introducing new operators has also been identified as a big problem. Almost all tutors work differently making it hard to ensure that the learning process is done to the current best way that in turn makes it hard to ensure the takt and quality when introducing a new operator at the final assembly.

The different roles in the module has to work together to make the process of introducing new operators more standardised. This starts from the beginning when the SVs receives information regarding new operators, the process of mediating this information to TLs and the tutors who are going to perform the coaching and training is an important process to standardise and make sure that the tutors get the information at least two days beforehand. The problem identified today is that the SVs have information regarding new operators but they do not know in which team they will start, making it hard to mediate information to the responsible tutor. Therefore decisions have to be made as fast as possible to make sure that the responsible TL and tutor of that team knows that a new operator is going to start in their team. The recommendation is to standardise this process to help SVs alligate the resources to the teams in an earlier stage. This will increase the possibilities for the tutors to prepare to ensure that the training can be performed more effectively reducing risks of disturbances in the takt.

As mentioned in the previous recommendation the focus should be to include all the roles to work together to achieve a standard for how to prepare for upcoming new operators and share information. This should be a high priority for the organisation to make sure that the work conducted gives the tutors enough time to prepare and make sure that everything is in place to be able to accomplish a good learning process for the new operators including all necessary information. It would take some time to be able to achieve this new standard since they need to work together to find the best current way of working. To then set the standard takes time so therefore the effects of this recommendation would be achieved medium-term.

6.3.3.Coaching and training all tutors

All tutors should attend the tutor course before being allowed to tutor. This is not the case at the moment and many operators working as tutors have not taken the tutor course. Even though an operator has taken the tutor course they can not be expected to learn how to perform the work as a tutor based on a 2-day course. The tutors need coaching and training in how to perform the work of training a new operator based on the standard, which is the step-by-step model, by a mentor or sensei. Every tutor should have a mentor that should be assisting them since a two days tutor course is not enough to be able to tutor a new operator to learn how to tutor according to the step-by-step model. This is why the authors recommend that both the TL and SV go through training in the step-by-step model to be able to act as a mentor for new tutors, as well as training in how to coach and train others. Tutors that are experienced within the step-by-step model can also act as a mentor for new tutors. The mentor has an important role in the learning process of the tutor to help support and coach them to learn how to become a good tutor teaching according to the standardised step-by-step model developed by the organisation.

To be able to coach and train all tutors in the step-by-step model first the SVs and TLs would have to undergo training. It is important that the tutors have a more experienced mentor and to be able to accomplish that the mentors need to go through the training process to learn the step-by-step model first. It would require resources and time to make it possible for all tutors to gain a more experienced mentor and get training in the step-by-step model. This is deemed very important but since it is time consuming and resource heavy this recommendation only gets medium priority. The effects of setting a standard and making sure that there are experienced mentors within the organisation would however have a great impact on the learning process of new operators. If the tutors work according to the step-by-step model it would greatly reduce the impact, long term, on the takt and quality when introducing a new operator to the work at the assembly line.

6.3.4.Standardise the process of introducing the new operators to the workplace

One big part of the preparation of the new operator is the process of introducing them to the workplace. It was identified that the process of introducing the new operators to the workplace was not standardised at the organisation and it was rather reliant on that there were resources available that could replace the tutor at the workstation. However, even though these resources were available the introduction to the workplace was not always done meaning that the new operator started the training at the workstations from the moment they arrived at the module. It is important to include the entire process in the introduction to the workplace. Showing the workstations at the assembly loop is important but it is not enough. The new operators need to be introduced to the entire module to give the new operator a broader understanding of the process

and be more relaxed. Essential areas such as where the toilets are, the lunchroom, the morning meetings etc, should also be included in the standardised process for introduction to the workplace.

The recommendation is to standardise the process of introducing new operators to the workplace to make sure that all new operators are introduced to the general process and all the essential areas. This can be done by collaborating within the organisation to decide what the new operators need in terms of information surrounding the workplace, thus to have a common view across the entire organisation.. If all tutors across the organisation follow the standard of introducing the new operators to the workplace it could help reduce stress and in turn enhance the learning capabilities of the new operators reducing the risk of disturbances in the takt. One way to standardise the process is to always have the TL replace the tutor when an introduction is starting, making sure that there always is a resource available for the tutors to be able to introduce the new operators to the workplace.

The possible effects gained from standardising the process of introduction to the workplace is that the new operators get more prepared and relaxed which could help avoid disturbances in takt and quality. The first step of the step-by-step model is to prepare the operator and if the tutors work according to this model the first step should be standardised. However, most often the new operators get an introduction at some point in time by either the TL or the tutor. It is also recognised that by standardising the process of teaching the activities of the workstations it would have a greater impact on the learning process and therefore this recommendation becomes medium priority. It is important that the organisation work to standardise the overall process of the learning process according to the step-by-step model but if they should start somewhere it should be on how the activities of the workstations are taught. The effects of this recommendation is deemed to be on medium-term since it will take time to change the standard.

6.3.5.Standardise the process of teaching the activities of the workstation

As analysed earlier there is a lack of standardised processes when it comes to the learning process for new operators. The same goes to say for the process of learning the activities of the workstations. The authors recommend that the organisation standardise the way the tutors work with training and teaching the different elements of the workstations of their loop. The tutors that have taken the tutor course have already gotten an introduction to the step-by-step model but they need to be trained to achieve a standardised process of teaching according to the step-by-step model.

The first action to take should be to help the tutors learn how to break down the workstations into elements and standardise this process so tutors know how to perform this. These breakdowns

should then be learned independently to make sure that the takt is not affected when introducing a new operator at the assembly line, one element should be taught at a time until the entire job is understood and the new operator can perform the job within the requirements of takt and quality. Not until it is clear that the new operator can manage the takt and quality of one station should they be allowed to move on to the next station and start the process over. The breakdown of jobs inte elements is important and should consider the sequencing, this process can be standardised because sometimes the most efficient way to learn is not by learning the stations in the order they are performed. Maybe the best sequence is to start with the last workstation of the loop or some station in the middle but overall it is important to consider the sequencing of the workstations as well as the elements within the workstations. The tutors need training to be able to break down the workstations into elements and sequence the work elements to enhance the learning of the new operators and decrease the overall learning time required.

It is important to consider how the different elements of the workstation are taught to the new operators. The recommendation is to follow the step-by-step model developed by the organisation and develop this according to the job instruction method presented by Liker and Meier (2007). The first step of the job instruction method is to prepare the operator that is mentioned in the process of introducing the new operator to the workplace. When learning the activities of the workstations the second step of the job instruction method which is to present the operation takes place. The tutor should show the major steps and key activities of the workstation and mention what, how and why the major steps and key activities are performed. Not until all this is done the tutor should move on to the next step of the job instruction method which is Try out performance where the new operator gets to try out the elements of the workstation. It is important in this step that the tutor encourages the new operator to describe what, how and why they are performing the different steps to ensure that they understand what they are doing to enhance the learning. Focus should be on the process in this step, not engaging in small talk or other discussion to make sure that the new operator is focused on the task at hand. If there is a lot of focus on other things than the process of learning in this step there is a great risk of disturbances in the takt, quality and learning time; therefore the conversation between tutor and student should be limited to the workelements in this stage. Advice would be to set up the rule that they only talk about relevant information for the station when the new operator is practicing/working. And the general questions and conversations can occur when the tutor is working while the new operator is taking a rest etc, or at breaks.

As mentioned in the last recommendation this is the process that is identified to have the greatest impact on the learning process if standardised. Today the different modules and shifts work very differently.By standardising the process of teaching the activities of the workstation, based on the step-by-step model, the tutors get tools to help the new operators learn and also verify that

they actually learn the necessary key activities. This would have a direct impact on the affectance of takt and quality during the learning process and therefore this should be a high priority for the organisation. It will take some time to change the standard way of working for the tutors of the organisation and therefore the effects are deemed to be medium-term.

6.3.6.Reduce top-down pressure on learning time and takt

It has been observed that both the tutors and the new operators feel a lot of pressure resulting in stress based on top-down pressure. The tutors are getting pressured to make sure that the takt is managed at the same time as they should be able to keep the learning process as short as possible. By standardising the process according to the job instruction method the learning process can be done more effectively making sure that the quality and takt is managed as well as the learning time reduced. However, the SVs and TLs need to train and coach the tutor to help them perform the work according to this work method instead of constantly checking in putting pressure on the tutor to improve their work. It is important that there is teamwork between the SVs, TLs and tutor in regards to training to ensure a disturbance free introduction of new operators.

It is recognised that by standardising the process of teaching according to the step-by-step model the overall affectance on takt and quality will be reduced. This in turn would help reduce the pressure put on the tutors from SVs and TLs. Therefore this is more of a medium priority since it becomes an effect of another recommendation but it is still important to consider that the SVs and TLs have given responsibility to the tutor to handle the learning process and should instead act as a support rather than pressuring them. It is however believed that by reducing the top-down pressure short-term positive effects on the disturbances in takt and quality can be achieved.

6.3.7.Standardise the process of follow up and give responsibility to the tutor to verify the new operators

The verification step is an important process to standardise inorder to make sure that the new operators have learned the different elements of the workstations. It is also important to make sure that the takt and quality will not be affected when the new operators are deemed ready to work on their own. Based on the standard at the case company today the SVs are responsible for the verification of takt and quality. If the case company would follow the recommendations of working according to the job instruction method as well as training and coaching of the tutors, the SVs should not need to verify that the new operators can manage the takt and quality. It is important that the tutor also owns their own process and if they are responsible for the training of new operators they are also the ones that should follow up and make sure that the new operator can manage the takt and quality. Therefore the recommendation is for SVs, TLs and tutors to

work together to make sure that there is a standard including criterias for new operators that is aligned for the entire organisation. These criteria should include all the different parts that are deemed important by the organisation such as safety, ergonomy, quality, time and health. So that not every module and shift verifies new operators based on different criterias and has a different process. If these standardised criterias are in place it would facilitate the work when it comes to the verification process helping the tutors in this process and relieving the SVs of this work.

It was identified that by standardising the process of teaching the activities of the workstations the affectance on the takt and quality can be reduced during the learning process. It is also important to consider what happens after the new operators are deemed ready to work on their own. If the affectance of takt and quality is high when new operators start working on their own, maybe there is something wrong with the learning process? It is important to make sure that the new operator has mastered the workstation and can complete the work elements within the takt and quality requirements. Therefore this should be a high priority along with the standardisation of the process of learning the activities of the workstations. The effects of this recommendation is also believed to be medium-term.

6.4.Improvement work

In this part of the introduction process it was identified that no information regarding the improvement work of the organisation was given to the new operators. Therefore, as previously established it is important to introduce the operators to the improvement work as early as possible. However, this information and knowledge needs to be facilitated and therefore the main recommendations of the process of introducing the new operators to the assembly line is connected to including the improvement work in the training process and also include the new operators in the improvement work as early as possible.

6.4.1.Introduce the new operators to the improvement work as early as possible

The general understanding at the assembly line is that the new operators get introduced to the improvement work of the organisation at the stage of introduction to assembly work. This is however not true and the new operators do not get any introduction to the improvement work at this stage nor in the assembly line until they have managed all the workstations and even then there is no standard way of how to introduce them to the improvement work. The recommendation of this paper based on the analysis of the current setup is that the new operators should be introduced to the standardised work and the kaizen mindset as early as possible. Since the introduction to the assembly work is the first step of the learning process the introduction to the improvement work should be included here. It is important to make sure that the new operators understand why they learn the standard way of performing a work task. They are

working based on the standard that is the identified best way as of now and the focus is for the operators that work in this process to improve the standard way of working.

The recommendation is not to take away focus on the learning process of introduction to assembly work but rather open the door to the mindset of continuous improvements. For the organisation to move towards a culture based on improvement work and ownership of the process the new operators need to be introduced to this culture as early as possible. According to interviews a lot of SV, TL and operators stated that it is easy to become comfortable within the standard and stop thinking outside the box. This is why it is crucial to introduce the new operator to the standard with the continuous improvements mindset as early as possible. The new operators have a fresh set of eyes and will come up with ideas based on their previous experience before their ideas become locked to the standard within the organisation. It takes a long time to change an organisational culture but for the people not working at the company today the shaping into the desired culture is much easier if they get introduced to it right away. It should therefore be a high priority to open the door to improvement work as early as possible for new operators, it does not really require any time or resources for the organisation so it is easy to accomplish. The effects would be short-term since it would be an immediate shift from how the new operators are introduced to the improvement work today.

6.4.2.Alignment between the introduction to assembly work and introduction to line

One other important aspect to consider is the transparency between the SVs, TLs and tutors that work on the assembly line and the instructors working within the process of introduction to assembly work. There is a misconception that the introduction to improvement work is done by the instructors based on how this introduction has looked like previously. It is important that the different roles working at the assembly line get updated information regarding what is actually done at the introduction to assembly work. They need to know what previous knowledge the new operators will have when they start their introduction at the line. It is important that there is an alignment between the two different parts of the introduction process to make sure that the new operator gets all the necessary information when learning to become an operator at final assembly. The recommendation is that the instructors should update SV, TL, Tutors when they change the content of the introduction to assembly. This to avoid wrong expectations of what the new operator has learnt.

It is important to create consensus between the two different parts to make sure that the people working at the assembly line know what information and previous knowledge the new operators have when they start working at the assembly line. This can hinder that information is given twice or not at all and would not require any big investments. Therefore this should be a high

priority but it can take some time to create the alignment across all modules of final assembly and to make sure that it is facilitated properly so the effects are considered to be medium-term.

6.4.3. Include the improvement work in the training process

Based on the assumption that the new operators already have gotten an introduction to the improvement work the introduction to the line does not include any information regarding the improvement work. The focus from the tutor is to learn the new operator how to perform the work activities rather than to train them in the kaizen mindset and how the organisation works with improvements. Even though the recommendation is to introduce the new operators at an earlier stage that does not mean they can remove it from this step of the training process. The tutors can not assume that the operator has gotten an introduction to the improvement work and therefore it is important to ask questions and update the view on what the new operators actually learn at the introduction to assembly work. The new operators need to be trained in the mindset of continuous improvements just as they are trained in how to perform the different work elements of the job. Therefore the recommendation is to include the improvement work in the training process. They should not push the new operators to work with improvements while learning the tasks. Instead they should facilitate the introduction to improvement work they already should have gotten and keep them updated in the mindset of standardised work and continuous improvements to improve the process they work within. A major part of their work is to improve the process and since the organisation wants to create a feeling of ownership for the employees it is important for new operators to be a part of the improvement work. Creating an understanding that the new operators can affect their own workplace and improve the process is the first step towards accomplishing this.

The work with improvements is a part of the work for all operators and the intention is not to put pressure on the new operators to improve the process but rather introduce them to the fact that it is a part of their job. The recommendation is to update the information that is taught to new operators which would not require time or resources meaning that the recommendation should be a high priority. The effect of this recommendation would be that the new operators understand why they work according to a standard which would help them develop a kaizen mindset from the start. The effects are deemed to be short-term.

6.4.4. Training and coaching of the SVs and TLs

The overall improvement work conducted by the organisation is not standardised which means that the different SVs and TLs of the modules are working with improvements based on their own interpretations and what they consider is the best way. There has to be clear roles on how the improvement work should look like across all the modules including the important roles of

the SVs and TLs to help them understand what their contribution to the improvement work should be. The most important role of both the SV and TL is to encourage and coach the employees of their teams to help them understand that they own their process. The operators should be able to come up with improvements as well as following through with these improvements. The SVs and TLs have a key role in creating a sense of ownership of the process and therefore it is important for them to understand their role.

The recommendation to achieve an understanding of the responsibilities and the roles of the SV and TL is to make sure that they also get training and coaching. As discussed by Liker and Convis (2012) the layered learning cycle of Toyota should be applied to all levels of the organisation and that means that the SVs and TLs also need to get training in their roles supported by a more experienced mentor. This is not really done today and to help align the improvement work across all modules it is important that the roles are taught to the different SVs and TLs in the same way to create a standard process for how to conduct the improvement work.

As stated previously the training and coaching of tutors to work according to the step-by-step model would require time and resources. The same goes for coaching and training the SVs and TLs based on their roles and how they should work when it comes to improvement work. The overall effects of giving the SVs and TLs coaching and training would connect to the research question of how new operators are introduced to the improvement work. By understanding their roles and how they can understand how they should work to help new operators understand the importance of improvement work. However, the roles of the SVs and TLs need to be updated based on the new standard on how to work with new operators connected to improvement work therefore this becomes a medium priority. The effects of changing the roles and making sure all SVs and TLs understand their roles connected to improvement work will take time and therefore the effects are deemed to be medium-term.

6.4.5.Include all operators in the improvement work of M3MU-workshops and the IMT-role

The M3MU workshops conducted as a part of the improvement work of the case company do not include all operators in the project, only a few selected operators together with management are included in the groups working with M3MU. It is important to include all operators in the improvement work if the vision of the organisation is to create a sense of ownership for the operators regarding their process. Therefore the recommendation is that all operators should be included in the improvement work considering their loop. It is important to consider all operators' suggestions and not relying on the fact that they will take their individual responsibility and go to the group working with the M3MU-workshop and present their suggestions of improvements.

The same goes for the IMT-role of the organisation. One designated resource working with the role of the IMT is not really involving all operators in the improvement work. Some teams included most of the operators in the process of IMT where they took turn to take on the role of the IMT. Rather than having one person that is designated to work with improvements, the recommendation is to include the improvement work as a part of the daily work for all operators. The kaizen mindset is to continuously work with improvements and that goes for all the operators working within the process. Therefore the IMT-role should not be one person but rather all operators in the team, constantly working on improving the process and getting the resources to be able to do so as well.

It is not clear to the organisation how they can benefit from including new operators in the improvement work. The author's argue that the long-term benefits will be great since by including the new operators it will facilitate an organisational culture of improvements. This will help generate ideas and suggestions of improvements from everybody within the process in the long-term and not just a few selected operators risking to miss out on great improvement ideas. This recommendation should be high priority with long-term effects.

6.5.Compilation of recommendations

The structure of the recommendation section is based on the research questions including both parts of the learning process which is the introduction to assembly and the introduction to the line. All recommendations presented in this section can be seen in *table* 5 together with the implementation priority and the possible effects of the recommendation. Connected to the first research question of how the learning process can be improved to avoid disturbances in takt and quality the main recommendations is: To create a standard connected to the learning process based on the step-by-step model and training and coaching both the tutors but also the TLs and SVs. Each step of the step-by-step model has been handled separately in the recommendation section to show the importance of standardising the process included in each step. For the second research question on how new operators are introduced to the improvement work the main recommendations is: To introduce the new operators to the improvement work in an earlier stage and facilitate that information and knowledge throughout the learning process. All recommendations seen in *table 5* are presented previously in this section.

Table 5: A compilation of all recommendations presented along with an implementation priority and the possible effects of the recommendations.

Recommendation	Implementation	Effects

1.Develop tutor course with focus on step-by-step model	High priority	Long-term
2.Prolong the course	Medium priority	Short-term
3.Instructors should use the step-by-step model on the participants	High Priority	Short-term
4.Remove “maskinlära”	High priority	Short-term
5.Invest in developing the environment at introduction to assembly work	Low Priority	Long-term
6.Define the standard way of working for the instructors	High priority	Short-term
7.Develop special skills	Low Priority	Long-term
8.Provide tutors with information at least two days beforehand	Medium Priority	Short-term
9.Standardise the process of preparing for upcoming new operators	High priority	Medium-term
10.Coaching and training of all tutors	Medium priority	Long-term
11.Standardise the process of introducing new operators to the workplace	Medium Priority	Medium-term
12.Standardise the process of teaching the activities of the workstation	High priority	Medium-term
13.Reducing top-down pressure	Medium priority	Short-term
14.Standardise the process of follow up	High priority	Medium-term
15.Introduce new operators to the improvement work at introduction to assembly work	High priority	Short-term
16.Alignment between the instructors and the final assembly	High priority	Medium-term
17.Include the improvement work in the training process	High priority	Short-term
18.Training and coaching the TLs and SVs	Medium priority	Medium-term

19.Include all the operators in the improvement work of M3MU and the role of IMT	High priority	Long-term

7.Discussion

The discussion of this thesis has been divided into two main parts. First a general discussion on the research that has been made will be presented connected closely to the analysis of the two research questions of this study. Secondly, a more specific discussion will be made connected to the recommendations for the case company studied. The discussion will also include some interesting topics identified that come outside the scope as well as recommendations for further research connected to this study.

7.1.Discussion regarding research questions

The overall aim of this study was to investigate how organisations can work to aid new operators in the learning process to avoid disturbances in takt and quality to enhance performance. It was identified based on the analysis of this thesis that the learning process in the setting of assembly work can have a huge impact on performance of organisations. First of all organisations can work with different factors that affect the learning process of new operators and based on the research conducted in this thesis some of the most important factors to consider would be stress, exhaustion, previous experience and complexity of the work.

Assembly work is traditionally a stressful job and it is important for organisations to consider how stress is affecting their workers and how that will impact the performance of the organisation. Stress is a factor that has a negative impact on learning and the time it takes to learn new work tasks, therefore reliving new operators of as much stress as possible during the learning time should be a priority for organisations striving to improve the overall learning of the organisation. The factor of previous experience is also important to consider when training new operators and by creating an introduction setting where the organisation can create the previous experience for the new operators they can directly reduce the learning time required at the assembly line. This goes hand in hand with complexity as well since if the organisation has a training setting before the actual assembly line the new operators can train and learn more complex work tasks to reduce the complexity at the line reducing learning time and the effect on the performance.

Complexity and Exhaustion is something that was identified to be able to reduce by breaking down the jobs into elements. By standardising the process of breaking down activities into elements organisations can control the amount of information being taught at once. By doing so they can make sure that the operator does not get too much information at once reducing the risk of exhaustion as well as reducing the complexity of each job. This is also a requirement to be able to work based on the job instruction method presented by Liker and Meier (2007).

Based on the analysis and research of this thesis the job instruction method used by Toyota is a great tool for reducing the impact of performance when introducing new employees to the organisation. It is a way to standardise the process of training new employees based on the breakdown of jobs into smaller elements to ensure that the right amount of knowledge is taught at once. It includes the breakdown of jobs as well as the most effective way to teach a new employee their work tasks. If an organisation can use this method of teaching the previously mentioned factors that affect learning can all be reduced and the organisation can make sure that the introduction of a new employee will not affect the overall performance of the company.

The second research question of this thesis was more related to the improvement work and how new operators are introduced to the culture of improvement work. The main findings of this research pointed at the fact that new operators are often not introduced to the improvement work but rather the focus is put on learning the work tasks as fast as possible. In the current fast-paced changing environment however the improvement work is becoming a part of the work tasks of blue-collar workers. Therefore it is important for organisations to consider the fact that it is really hard to change an existing organisational culture but when introducing new employees to the organisation they should be introduced to the desired culture already from the beginning. In this way organisations can introduce new workers to the mindset of kaizen and standardise work to ensure that the operators understand that they are expected to improve the process they work within and not blindly follow the current standard forever.

7.2.Discussion regarding the main recommendations of the case company

Connected to the research questions of this thesis some recommendations were made for the case company to improve performance and include new operators in the improvement work. In this part of the paper a discussion connected to the main recommendations based on the research will be presented.

7.2.1.SVs, TLs and tutors need training

This study included interviews and observations of different shifts at the same module, from this it was made clear that different SVs worked differently even if they worked at the same module. It was identified that there was a difference in the environment, team spirit, communication, improvement work and the training process. Since it is the SVs that are the leader of their modules and responsible for the staff, it could be stated that depending on who the SV is and how that SV works has a big impact on how the environment is at that shift and module. The authors are not blaming the SVs since they have a lot of tasks and responsibilities that are spread

out through different areas. However, the authors recommended that they also receive training on their role and leadership. It was evident based on the interviews that the SVs did not really know what their responsibility was when it came to improvement work and training of new operators. They all based their work on what they thought was the best way to work with it creating different situations in every shift of the final assembly.

By having a course for the SVs, it would be much clearer for the SVs what their role indicates exactly, and how the case company wants their SV to work with the staff, improvement work and learning. Also when asking what their role is regarding the introduction of a new operator to the assembly line, differences were identified, where some passed the responsibility on TLs and some on the tutors instead. No standard was set for how the SVs work with either improvement work or the introduction process of new operators. According to interviews the authors also got the information that currently when someone is promoted to become SV, they do not receive training. They get a small introduction with other SV that gives them tips and tricks and then they only get the tasks they should accomplish for the position. Even at this level there is no standard of how to be an SV, there is only a standard of what the tasks are and they are not trained.

This is something that is true for all roles investigated in this paper. SVs, TLs and tutors do not get any training in their roles which in turn makes the alignment of work responsibilities across the modules hard to achieve. Everybody creates their own perception of what their responsibility is and works accordingly. One of the main recommendations of this paper is to include training and coaching for all different roles of the final assembly. This is because the learning process is not only applicable for workers within assembly, the learning cycle, described by Liker and Convis (2012), is training on different levels and is something that does not end. The people of the organisation are constantly learning and focus should be put to help train all roles and not only the operators within assembly.

7.2.2.Standardise the learning process based on the step-by-step model

A lot of the recommendations mentioned in the previous section were connected to the standardisation of work tasks. The main recommendation in this case is to standardise the learning process based on the step-by-step model influenced by the job instruction method presented by Liker and Meier (2007). This includes four steps: Prepare the operator, introduce the operation, try out performance and follow up. All these are mentioned in the recommendation section and it is important that completeness is achieved by standardising the entire process including all steps of the model.

To be able to establish a standard throughout the organisation the people of the organisation need training in the step-by-step model to be able to teach it. This is not something that is done overnight and it requires patience to be able to get long-term results. The recommendation of standardising the learning process is tightly connected to training and coaching of SVs, TLs and tutors. All different roles need training in the step-by-step model to be able to change the way every module works with training across final assembly. If nobody knows how to perform the work based on the step-by-step model no mentors are available to teach new student learning based on the step-by-step model.

7.2.3. Change the arrangement of the tutor course

Another important aspect that should be a high priority of the case company is the arrangement of the tutor course. It is recommended to remove information regarding engine- and screw joint knowledge as well as changing the arrangement of the course from two full working days. These recommendations could help the case company to focus more on the standardisation of the learning process teaching the tutors how to perform the tutoring based on the step-by-step model.

As of today the new tutors get information regarding the step-by-step model but based on the interviews not many know what it is and do not perform their work according to the step-by-step model. It is important that the tutors get information regarding the step-by-step model, why it is important and also are shown exactly how it works in practice. This course is something that the SVs and TLs could benefit from taking as well since it can help in the process of assigning more experienced mentors to the tutors at the assembly line. It is important to create the knowledge of the step-by-step model for all roles working within the learning process of new operators to be able to work effectively according to the new standard and reduce the overall impact on the quality and takt.

7.2.4. Introduce and include new operators in the improvement work

The main recommendation associated with the second research question of how new operators are introduced to the improvement work is to introduce them earlier. It is easier to introduce the new operators to a culture than trying to change the current culture so it is important to introduce the new operators as early as possible to the improvement work but also make sure that they are included in the work being performed today.

For the organisation to create a sense of ownership over the process for the operators they need to look at the way they work with improvement work as well. It is not only the new operators that are not included in the improvement work, at many modules only a few selected operators are included in the work with improvements. The M3MU-workshops conducted are also not

including all operators; instead some are chosen as well as management to perform improvement activities of the workstations. The operators not included in the workshops are expected to present ideas of improvements to the group working with improvements but it is hard to encourage and motivate the operators to give suggestions if they are not included in the process. The case company needs to focus on encouraging and motivating all operators working within the process to make sure that ideas of improvement are born at the line and performed by the people working within the process.

7.3.Identified topics outside the scope and further research

During the research it was identified that the new operators that were verified and deemed ready to start working on their own still affected the quality and takt. Based on this the learning process is not done and the case company needs to work on the way they verify new operators. This is something that is deemed important and could be investigated further but came outside the scope of this research and will therefore be discussed in this section. This part of the paper will also discuss opportunities for other further research based on the findings of this paper.

7.3.1.Identified topics outside the scope

It was brought to the author's attention that some of the new operators has got the verification of quality and takt and can now work alone without the supervision of a tutor. Then it does not take long before they lose the level of quality and takt. According to Rubenowitz (1992), when an individual has got familiarized with the new system and learnet in a fast phase there is a risk that the individual overestimates their own ability. This in combination with that the individual can get bored due to the fact that they have learned how to perform the task but not why is the reason that problems may occur and that creates a learning plateau (Rubenowitz, 1992). Since this is happening at the case company it shows that something is not correct, how are some new operators managing to get the verification to work without the supervision of a tutor, but later on lose the quality and takt. Since this is occurring with some new operators and not all then it indicates that the standard is not followed when introducing a new operator. It can either be that the tutor did not give the information of the reasons to why some problems occurs, or it can be the TL and SV that stressed the process to verify the new operator in order to not have two individuals on one station, maybe due to personal shortage or costs.

7.3.2.Further research

Even though the authors are constantly pushing to create a standard and backing it up with theory and stating that if the case company works with the step-by-step model then the learning process can develop and the effect on quality and takt can be improved. The authors do not have raw data that indicates these statements, therefore a suggestion could be to analyze our recommendations

to calculate exactly what the effect could become. This thesis has focused on mapping the current state and identifying areas to improve based on previous established theory. Therefore, it is important for the casecompany start small to investigate these proposed recommendations before implementing throughout the entire organisation. By evaluating and calculating on the different recommendations the case company would be able to identify the effect on their organisation and this is one of our proposals for further research.

Regarding research question two, the authors found it difficult to analyse the improvement work of the new operators, since there was no process for introducing them. Instead the authors had to observe and interview regarding their improvement work on the more experienced operators. Therefore, an idea for further research could be to visit and analyse how other companies are working regarding the introduction of the new operators to the improvement work in order to receive all other angles of incidence.

8.Conclusion

The purpose of this thesis was to investigate how the learning process can be improved to increase performance as well as looking at how new operators are introduced to the improvement work and what effects that can have on the overall improvement work.

The findings from RQ1 showed that the learning process today was not standardised. By not having a standardised way to introduce new operators the training process often resulted in new operators affecting the takt and quality. To address the fact that the performance is affected by the learning process recommendations connected to the first research question was presented in this thesis. By implementing the recommendations it will help to reduce the learning time of new operators as well as ensuring that they perform the work activities within the time- and quality requirements.

The findings from RQ2 showed that new operators are not introduced to the improvement work at all. The overall improvement did not include all operators but instead just a few selected operators were involved in the improvement work. To address this issue the recommendation of this research is to introduce new operators to the mindset of improvement work as well as including all operators in the work with improvement to increase encouragement and motivation to develop the process.

This thesis's main contribution to research is to highlight the importance of learning on different levels of the organisation. Most often focus is put on the shop-floor and the training of blue-collar workers but this thesis suggests an attitude of applying a standardised learning process across all levels of the organisation. The learning process needs to be standardised including the break down of jobs into smaller elements as well as including a mentor/coach to help the student learn. To be able to have experienced mentors they also need training and coaching to be able to effectively teach and mentor others according to the set standard.

The recommendations presented have been evaluated based on established literature and no calculations on what costs or time required to implement has been made. For the organisation to understand the true potential of each recommendation further research is required to evaluate the recommendations presented. By evaluating the recommendations the organisation can see what the impact would be for their organisation before implementing it throughout the entire company.

9.Appendices

9.1.Appendix A

Intervjufrågor:

Frågor om dig:

- Vad har du för roll i företaget?
- Vad har du för erfarenhet inom den rollen idag, hur länge har du jobbat som det?
- Ålder?

Frågor till SV:

- Vad är viktigast för er när en ny operatör kommer in till er line? team?
- Brukar ni ställa krav på inlärningstiden av en ny operatör.
- Hellre lära sig snabbare med risk och tappa takt eller tvärtom?
- När anses en operatör inte längre vara ny och kan gå helt själv på line?
- Vilket ansvar har ni med avseende på nya operatörer? Hur ser inlärningsprocessen för nya operatörer ut idag?
- Ser inlärningsprocessen likadan ut för alla nya operatörer?
- Vad för förutsättningar finns det för handledare att lära utifrån vad de får för information på handledarkursen? Finns tid och resurser så de kan visa den nya operatören runt i fabriken etc.

Frågor till Teamledare:

- Vad är er roll när ni får in en ny operatör i ert team?
- Vilka förutsättningar ger ni er handledare innan ny operatör kommer?
- Hur ser processen ut när en operatör är upplärd? Är det ni som fattar det besultet, handledaren eller hur ser det ut?
- Hur arbetar ni med handledaren under inlärningsprocessen?
    - Hjälper ni och coachar handledaren under upplärningen eller är det handledaren som har allt ansvar?
- Jobbar alla handledare på samma sätt eller är det individuellt?

Frågor till Handledare:

- Kan ni förklara processen på hur ni lärt upp en ny operatör? och vad tycker ni är det viktigaste punkterna när ni lär up?
    - Arbetar ni likadant varje gång ni lär upp nya operatörer?
    - Arbetar ni utifrån några riktlinjer när ni handleder?

- Finns det faktorer som stoppar er från att utföra er handledning enligt instruktioner för handledning? om nej utveckla.
    - Får ni all tid och resurser för att handleda en ny operatör?
- Vad får ni för direktiv av SV och TL? påverkar det hur ni handleder, känner ni er pressade?
    - När får in information om att ni ska faddra? hur mycket innan vill ni gärna vet
    - Vem beslutar när en operatör är "färdiglärd"?
    - Hur lång tid brukar det ta innan en operatör är "färdiglärd"?
- Vad tycker ni om handledarkursen? gav den er det ni behöver för att lära upp en ny operatör? eller går ni mer på erfarenhet och hur ni skulle vilja bli upplärda?
- Hur påverkar nya operatören takten
- Vad tycker ni om inlärningsprocessen och ser ni några förbättringsområden med denna?

Frågor till operatörer:

- Hur upplevde du basic skills?
- Känner ni att ni får allt som behövs för att bli upplärd i line?
- Vad skulle du önska att få?
- Känner ni någon stress att lära er snabbt? eller takten som är jobbig? etc

9.2.Appendix B

Intervjufrågor:

Frågor om dig:

- Vad har du för roll?
- Vad har du för erfarenhet inom din nuvarande roll?
- Vad har din roll för syfte när det kommer till förbättringsarbete?
- Vad har du för erfarenhet inom förbättringsarbete?

Generella frågor:

- Hur arbetar ni med förbättringsarbete idag hur ser processen ut?
- Vi har hört att de plockar ut operatörer som medverkar i kaizen workshops men ser det verkligen ut så eller har alla operatörer möjligheter att påverka förbättringsarbetet?
- Vilka är involverade i processen?
- Jobbar ni ständigt med förbättringar eller sker det vid specifika tillfällen?
- Vad är SVs roll?
- Vad är TLs roll?
- Handledarna har stort ansvar för upplärningen men har handledarna något fokus under upplärningen på förbättringsarbete?
- Förväntas man som ny vara med och utvärdera och hjälpa till i förbättringsarbetet?

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