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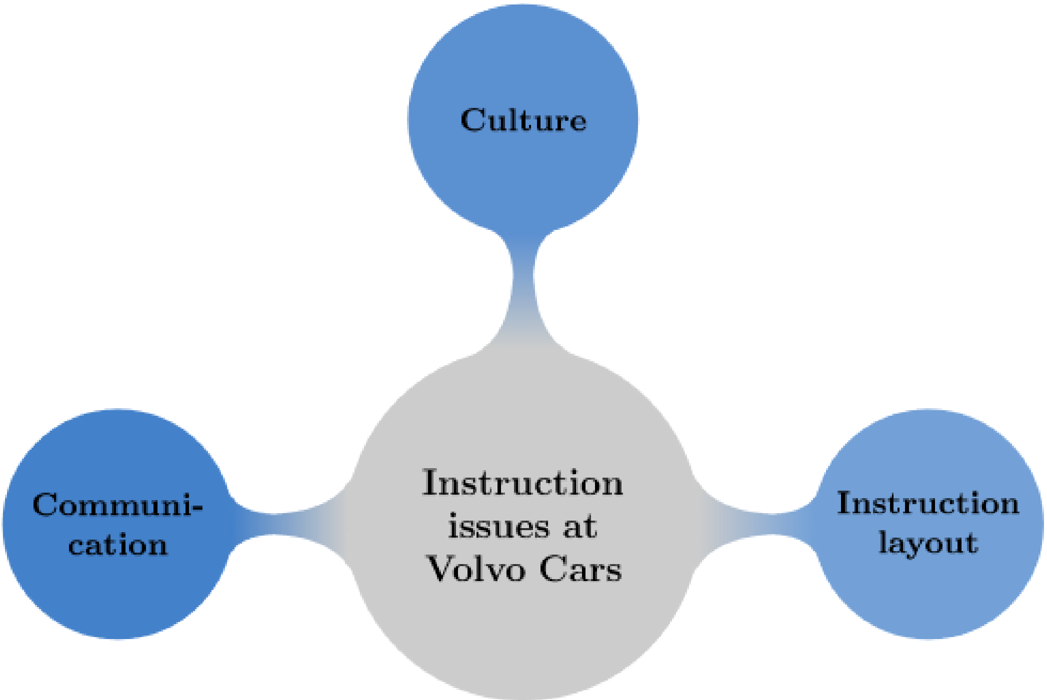

Volvo Cars' assembly instructions evaluation

Identification of issues related to the assembly instructions used at Volvo Cars' final assembly plant in Torslanda, Sweden.

Master's thesis in Production Engineering

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Industrial and Materials Sciences
CHALMERS UNIVERSITY OF TECHNOLOGY
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Cover: The three main issues found related to the assembly instructions.

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Abstract

This thesis has investigated the development, implementation, and usage of the assembly instructions within Volvo Cars, focusing on the humans and their behaviors and experiences. The purpose was to reveal, analyze and give recommendations on how to handle issues connected to the instructions. A study including a literature study, interviews, surveys, observations, and an internal document review, was performed. Initially, a theoretical framework was formulated based on the literature study. Data from interviews, surveys, and observations were gathered within a limited part of Volvo Cars.

The research questions aimed at revealing the main issues connected to the instructions, and how these issues can be handled. The identified main issues were; communication, culture, and instruction layout and content.

The main communication issue was the lack of sharing information, both upstream and downstream. This problem was found both between manufacturing engineers and process technicians, and the production manager and the operators. Further, the culture issue included two main problems; the differing goals and prioritization between manufacturing engineering and the plant, and the shop floor culture allowing for undesired behavior. The final issue is the instruction layout and content, where the main problem is excessive complexity, leading to misunderstandings and incorrect usage.

The problem concerning the communication between the manufacturing engineers and the process technicians is likely based on unawareness of the other party’s work. Therefore, it is important to increase understanding. This research indicates that the communication problem within the plant is caused by an undesired culture, partly caused by deficient leadership skills. The culture within the plant leads to undesired behavior such as incorrect usage of the instructions and neglecting of helping tools. This can be handled by developing the leadership structure, which requires further investigation.

The issue regarding the differing goals and prioritization between ME and the plant are not reasonable to try to change. Instead, it is important to improve the relationship and adapt to the other party’s work situation.

The issue connected to the instruction layout and content can be handled in several ways. The instructions could be simplified, including less information and clearer formulations. Additionally, the need for detailed instructions will decrease if the work station supports the operator and if the training period is sufficient.

Keywords: manual assembly, automotive, production, instructions, communication, culture, organization, work design

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Operators at Line X, Volvo Car Corporation

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Jeanette Malm and Fanny Johansson.
Gothenburg, April 2020.

Acronyms

ME *Manufacturing Engineering*

OIS *Operator Instruction Sheet*

PcE *Process Engineer*

PcT *Process Technician*

PII *Process and Inspection Instruction*

PM *Production Manager*

TL *Team Leader*

TMU *Time Measurement Unit*

VP *Verification Prototype*

VBE *Virtual Build Event*

WES *Work Element Sheet*

Glossary

Falling behind	When an operator, due to a lowered working pace, cannot finish the work station's operation within the given amount of time, they fall behind. If the product exceeds a predefined, physical limit, the entire line stops.
Key symbol	Key symbols are used in the instructions, i.e. WES's and OIS's, to indicate when an operation requires extra precaution, and is decided by the team leader. There are six different symbols; safety/environment, ergonomics, critical operation, quality, error proofing, and visual factory.
Line X	Line X includes two laterally reversed lines, i.e. two principally identical but reflected lines. Line X is located in Plant C, and is the part of the plant where the majority of the data was gathered from.
Manufacturing Engineering (ME)	Organization constituting the interface between product development and manufacturing by securing that the developed products are possible to manufacture. ME are responsible for the development of the PII's.
Operator Instruction Sheet (OIS)	The instructions for an assembly sequence at one work station, for one product type, with the cycle time 60 seconds. The OIS includes all the operations performed at the work station. The process technician, production manager, and safety officer have a shared responsibility for the development of the OIS.
Operator	In this project, the term operator refers to the people performing the manual assembly work.
Process and Inspection Instruction (PII)	The PII is an instruction including all the information necessary to assemble one part, to one car model, e.g. the required operations and tools. The PII's apply to all of Volvo Cars' assembly plants, producing the specific car model. The operations in the PII are split and assigned to different work stations in forms of WES's. The PII's are created by the manufacturing engineers at ME.
Plant C	Volvo Cars' final assembly plant in Torslanda, Gothenburg, Sweden
Plant Launch	Volvo Cars' launching organization in Torslanda, Gothenburg, Sweden.

Production managers	The production manager is responsible for an entire line, including several teams of operators and their team leaders.
Slow build	The product is built with a lowered pace in the test-factory, focusing on evaluating ergonomics, tools, and work methods.
Team leader	The team leader is responsible for one team at a line. One team consists of six to twelve operators.
Time setter	One of the time setter's responsibilities is setting the time, in seconds, for the operations in the PII. Initially, the PII includes an estimated time in TMU's.
Time measurement unit (TMU)	The TMU is a time unit corresponding to 0.036 seconds. For the PII's, it is used when estimating the required time for the operations.
Virtual Build Event (VBE)	The manufacturing engineer, responsible for a PII, builds a VBE to test suitable tools and work methods.
Verification prototype (VP)-series	The product is built in a test-factory with the purpose to test and evaluate the PII.
Work Element Sheet (WES)	An instruction describing one operation, e.g. assembly of one component, which is divided into several steps, i.e. picking a component or screwing a screw. The WES consists of a PII description in English, and a translated description in Swedish. It also includes a re-worded description of the operation as well as the reasons for performing it. Additionally, pictures are added as well as key symbols, if necessary. The process technician, production manager, and team leader add information to the WES, but the team leader is responsible for the final version.

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1 Introduction

This chapter introduces the master thesis project and gives the reader all the information necessary to understand the following chapters. The introduction begins with the thesis background and continues with presenting the scope, the limitations, and the problem description. Further, the pilot study is presented, followed by the aim and the research questions.

1.1 Background

Volvo Cars is a global car manufacturer, developing, producing, and selling premium cars. The company was founded in Sweden in 1927 and has approximately 43 000 employees and 2300 local dealers around the world. In 2019, Volvo Cars hit a new sales record with over 700 000 cars sold in over 100 countries. In 2010, Volvo Cars was purchased by the Chinese car manufacturer Geely. [1]

Volvo Cars' car development is characterized by an extensive structure of the organization as well as a high level of engineering. The development is organized in a cross-functional matrix system where the tasks are optimized upstream and downstream to reduce time-to-market. A traditional plan-based approach is adopted, including a stage-gate model, with the purpose to control the final car design.

The product development at Volvo Cars is convoluted due to the complexity of the cars. The cars not only consist of the physical car, but also a high amount of software requiring specifications, standards, requirements, and integration. Further, the car consists of over 2500 interacting functions and 300 systems, all having several subsystems. The functions, systems, and subsystems are frequently updated and improved, leading to an increased level of complexity.

During the development, there are several engineering disciplines involved such as mechanical, electrical, software and manufacturing engineering (ME). At Volvo Cars, ME is an organization responsible for ensuring the manufacturability of the car designs. To ensure successful launching and efficient production, it is essential for ME to be involved early on in the product development process.

Volvo is growing as a global company, leading to changes in the organizational structure. Recently, ME was divided into two sections: local and global. Global ME is responsible for the development of the assembly operations, while local ME is responsible for the implementation and the continuous maintenance. Engineers within global ME are mainly located at the headquarters in Torslanda, while the local ME's are assigned one plant. The purpose of dividing ME is to ensure that all plants use the same operations, making them as equal as possible. This is complicated since all plants have different production paces, and layouts, making it difficult to have identical processes.

The purpose of having an organization like ME is to establish an interface between product development and manufacturing, i.e. the production in the plants. As ME is involved throughout the product development phase, it is possible to develop an efficient manufacturing system for the cars. To do so, ME develops global, adaptable tools, material handling solutions, and production processes. ME is also responsible for the development of the operations constituting the assembly instructions.

Volvo Cars' brand is strongly associated with caring about people, and therefore the assembly instructions aims at being highly focused on the human and her senses. This by ensuring a sustainable and ergonomic work situation for the operators. Further, the instructions are developed to ensure standardized, and equal, work methods in all the assembly plants. Due to the aforementioned, and to the fact that Volvo Cars invests extensive resources, it important to understand to what extent these assembly instructions are used.

1.1.1 The final assembly plant in Torslanda

Volvo Cars has production in several countries; China, USA, Belgium, India, Malaysia, and Sweden. This thesis will focus on the production in Torslanda, Sweden. The car production in Torslanda consists of three plants;

- Plant A: Body
- Plant B: Paint
- Plant C: Final Assembly (FA)

Plant C is the final assembly plant in Volvo Cars' production in Torslanda. The production in Plant C is continuously running, at minimum five days a week, divided into three shifts. Thousands of employees work in the plant, and each shift holds hundreds of operators working at the assembly lines. The lines are divided into smaller teams, each consisting of several work stations. The most common set up is one operator per work station but some work stations require several operators. The layout of a work station is illustrated in Figure 1.1 The product is transported in och out of the work station by a running line or other autonomous processes.

The time intended to perform the operations is decided by the amount of time required for the product to enter and leave the work station. If the operator fails to perform the operations during this time, the operators will fall behind. If this occurs subsequently, the operator might not finish within the given amount of time and thereby stop the line. If the line is stopped, there are often buffers in between different lines, allowing for shorter local stops without stopping the entire production.

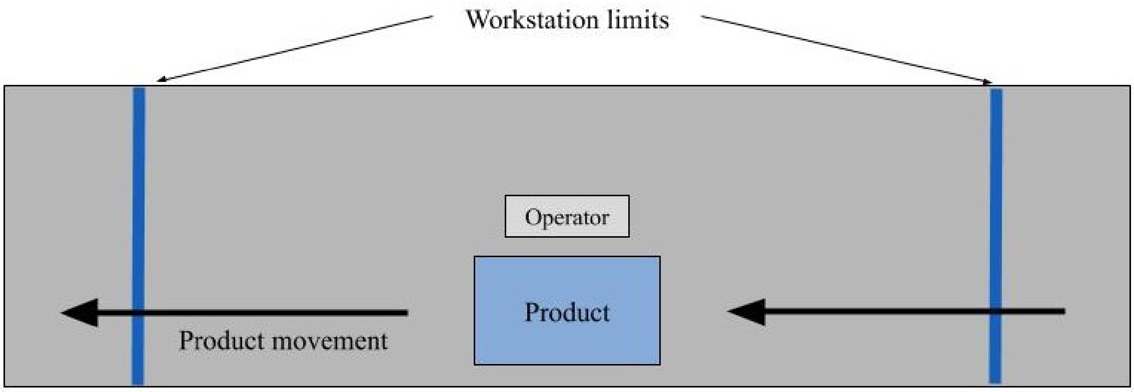

Figure 1.1: Workstation layout

The work performed at the work station contains several operations which are described in a folder of instructions. The instruction describes all the required assemblage for one work station and one product type, e.g. car model. The instruction consists of several operations and shows the sequence in which they have to be performed. Each operation consists of the steps necessary for assembling one component, to one car model. The team has a shared set of folders for all work stations within their line.

The hierarchy in Plant C is linear, where the shop manager is responsible for the entire plant. The plant is divided into departments managed by superintendents, which are divided into smaller sections, each run by a supervisor, or in an academic context commonly referred to as *production manager*. The supervisors are responsible for one section which includes one or several lines. These lines include several team leaders and teams. The team leaders are responsible for several work stations and a team of six to twelve operators. Lastly, the operators are responsible for one work station during a limited amount of time, half an hour or one hour, and rotate between the work stations.

In this report, the supervisors are referred to as production managers since it is an established and commonly used term within the academic world as well as the industrial one. Further, it is more explanatory regarding their work tasks and responsibilities.

1.2 Scope and limitations

The scope of this project is Line X, consistent of two, laterally reversed lines in Volvo Cars' final assembly plant in Torslanda, Sweden. Line X and its inputs are visualized in Figure 1.2.

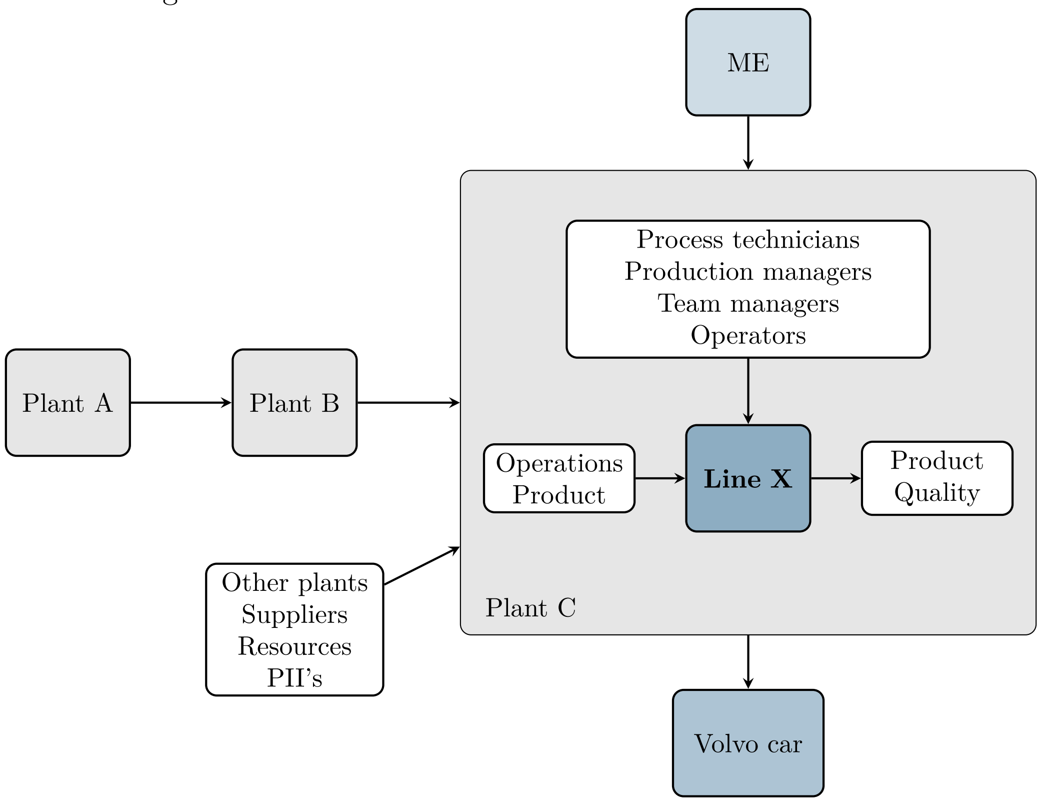

Figure 1.2: System description

The study will be performed at Volvo Cars' final assembly plant located in Torslanda, Sweden. Therefore, the results might not apply to other car manufacturers, industries, or businesses. Additionally, the findings might not apply to other Volvo Cars plants.

The thesis is physically limited to Line X, two laterally reversed lines located in Plant C. The data in forms of observations, surveys, and interviews with operators, team leaders, and production managers will solely be collected within Line X. The observations will be performed at three work stations within Line X.

The interviewees are limited to people working with the instructions, i.e manufacturing engineers, process technicians, production managers, team leaders, and operators. Data from interviews with process technicians and process engineers are gathered within Plant C. Further, engineers will solely be interviewed within ME.

The instructions will not be analyzed with the purpose to develop or improve the work method. Instead, the focus will be on the layout and content as well as the practice of the work methods.

1.3 Problem description

Various people at Volvo Cars suspects that the instructions are not properly practiced in the plants. This thesis was initiated based on personal experiences of one of the authors when working as an operator in plant C, which indicated that deviations from assembly instructions commonly occurred. The thesis scope was further established based on interest from ME in the issue.

Volvo Cars invest extensive resources in designing and developing standardized work methods for the manual assembly in their plants. At ME, major efforts are committed to the formation of the assembly instructions, to ensure that standardized work methods are practiced in the plants. When the work methods are not practiced correctly the risk of incorrect assemblage might increase. Further, the work method is not only designed for the sake of the product but also to improve the working situation for the operator, enabling proper ergonomics. If working according to personal preferences, the ergonomic situation might lead to injuries for the operator. Further, if the operator is assigned as a supervisor, junior operators may be taught the incorrect work method.

Even if there are several benefits with working according to a given standard, ME suspects that the extensive resources dedicated to the instructions might be in vain. Additionally, the production organization has recognized how operators' assembly methods differ from the ones in the instructions. They have observed how the instructions are incorrectly introduced to the operators during their training period, and that operators assemble based on individual preferences rather then the instructions. Due to the aforementioned circumstances, ME wants to investigate to what extent the instructions are practiced in one of the assembly plants. Further, they want to identify the reasons for not practicing the given work methods. The main aim, from Volvo Cars' perspective, is to enable a discussion on whether or not the resources invested in the development of the instructions are defensible.

Based on the given situations, a thesis proposal was formed concurrently between the mentors at Volvo Cars and the thesis workers.

1.4 Assembly instructions

A pilot study was executed in the initial stage of the project. This was partly for increasing the understanding of the assembly instructions; Process and Inspection Instruction, PII, Work Element Sheet, WES, and Operator Instruction Sheet, OIS, and their correlation. During the study, six Volvo Cars employees from different parts of the organization were interviewed. The interviewees' work titles and expertise are listed in Table 1.1.

Table 1.1: Interviewees for the pilot study

Work title	Number of interviewees	Area of expertise
Technical leader	1	Development phase
Process technician	2	Production phase
Production manager	2	Production phase & Use phase
Process manager	1	All phases

During the interviews, the problem description was formulated, see Section 1.3. Further, the interviews increased the knowledge of the PII's, WES's and OIS's, enabling the formation of a general life cycle.

A PII is a set of operations describing the assemblage of a part. The PII contains the process of mounting the part to the car, the required tools and other requirements connected to the part. The PII is text-based, including graphics, e.g. CAD models. For a fictional example, see Figure A.2. Each operation in the PII has an estimated time, measured in TMU's. The PII is created and developed by manufacturing engineers at ME. Each operation in a PII is extracted from the software used at ME and uploaded to the software used in the plant where the framework of a WES is created. The actual time required for each operation is decided by the time setter, who performs a work-study and thereafter sets a time measured in seconds.

In the plant, a process technician allocates these operations to one or several work stations. These work stations are generally within the assigned line, but might be re-balanced to other parts of the plant depending on factors such as repetitiveness, ergonomics or complexity. The instruction for one work stations, for one product type, is called an OIS and consists of several WES's. The WES is a more detailed description of a PII operation, where the process technician translates the PII text from English to Swedish and adds it to the WES and OIS. The PII text is thereafter reformulated and added to the WES by the production manager. The WES includes text, i.e. the PII text and its translation, and pictures attached by the production manager. The pictures are shot in reality, i.e. an operator assembling the operation mentioned in the WES, showing the components and tools. The critical operations are assigned key symbols, indicating when extra precaution has to be taken. The different types of key symbols are; safety/environment, ergonomics, critical operation, quality, error proofing, and visual factory. In this project, the types of key symbols are not investigated and therefore they will solely be referred to as *the key symbols*. Since the key symbols are connected to a specific operation, they can be found in both WES's and OIS's. For fictional examples of a WES and an OIS, see Figure A.4 and A.3.

The life cycle of the PII is visualized in Figure 1.3, where PcT is short for process technician, PM is short for production manager and TL is short for team leader. For a more detailed life-cycle, see Figure A.1 in Appendix A.

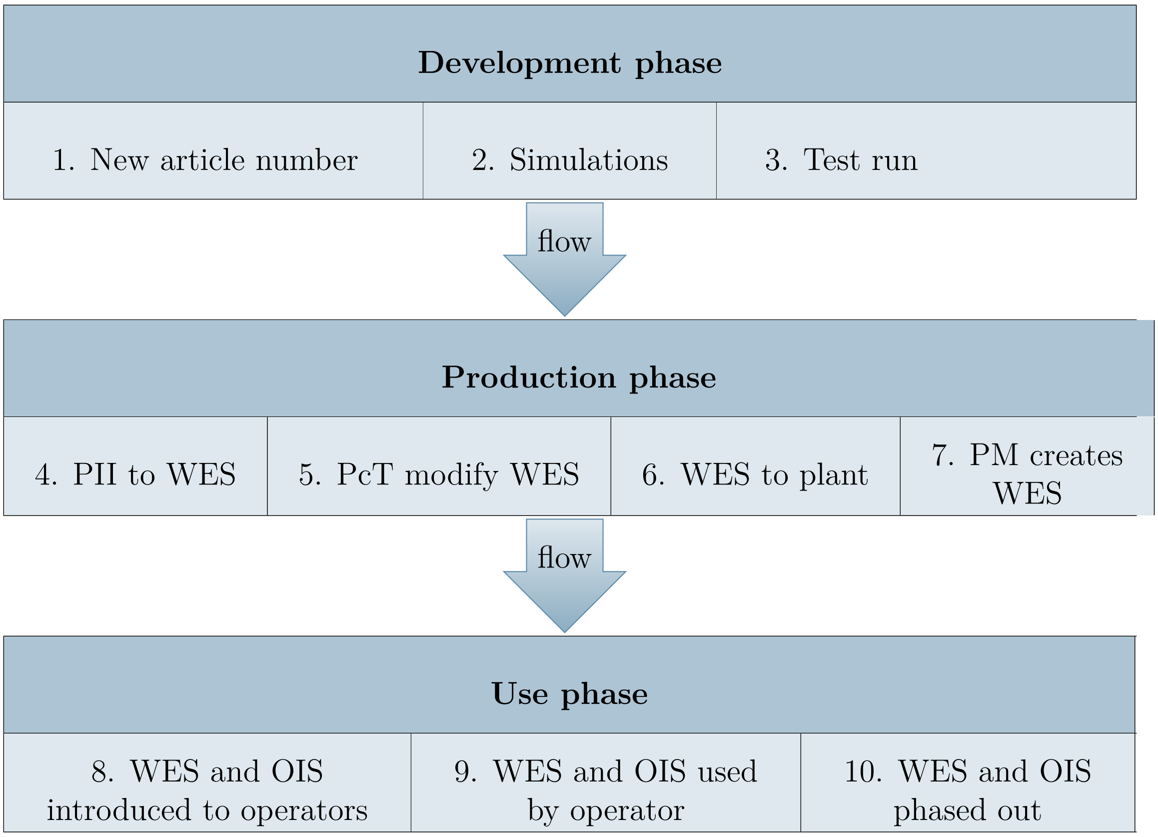

Figure 1.3: Simplified lifecycle of the PII and WES.

The life cycle of the PII can be divided into three phases: the development phase, the production phase, and the use phase.

1.4.1 The development phase

The first stage in the development phase is the stage where the formation of the PII begins. The life cycle starts with the construction of a new article number.

The new article number could originate from a new product or modifications to an existing one. The different requirements Volvo Cars has on its products are concurrently decided by the manufacturing and product engineers and later merged into the construction. For modifications to existing products, the engineers decide on the physical placement in the car. Here, the manufacturing engineers give their input regarding the complexity of the assemblage.

The second stage in the development phase consists of the simulation and starts when the requirements and placement have been decided. The manufacturing engineers build a *Virtual build event* (VBE) where the suitability of different tools and work methods are tested. Ergonomics, quality and time are the key factors when deciding on the tools and work methods. If new tools are required, the manufacturing engineers will purchase these tools during this stage.

Verification prototype series, or VP-series, is when the PII is tested in a test-factory. The manufacturing engineer responsible for the PII makes a *slow build*, meaning that the PII is tested without considering time. Instead, the focus is on ergonomics, tools and work methods. Potential improvements of the PII, or the new product, get reported. If necessary, the PII or construction is changed. PII's containing small adjustments are built by plant engineering and plant launch.

When the test of the PII is finished, it is extracted from ME's database and uploaded to the plant's database. Thereby the PII leaves the development phase and enters the *production phase*.

1.4.2 The production phase

When the PII leaves the development phase it gets exported to a new database. During the exportation, the PII becomes several WES's, i.e. the operations. The process technician is updated by email when WES's are created. The existing PII's are updated frequently and the process technician might receive several updates per week.

In the second stage, the process technician reviews, processes, and translates the WES's. If the WES requires rearrangement of the operations, the line is re-balanced by the process technician. To approve the changes made in the PII, the process technician uses the internal database. If accepted, the PII is updated and the implementation in the plant begins. The process technicians are not able to make changes in the PII.

The third stage starts with the formation of the final WES's and the OIS's. When rearranging a work station, the changes are decided in concurrence with the production manager and the safety officer. The OIS constitutes the work for one work station, for one product type, and consists of several WES's. The process technician purchases tools if necessary and rebuild the affected work stations. Since the WES's are balanced to several work stations, tools unforeseen by ME might be necessary.

The final stage in the production phase starts when the production manager implements and adds information to the WES's and OIS's. When the concerned work stations are re-balanced or updated according to the new WES's, the production manager is responsible for the implementation of the changes. In the WES, the production manager adds an explanatory, reformulated text in addition to the PII text. The reason for adding a text is to ensure that the operators understand how to assemble. Additionally, the production manager formulates the reasons for performing the operation as well as key symbols indicating if extra precaution is necessary. Further, the production manager develops individual work station instructions, which are placed at the concerned work station. These instructions include simplified versions of the WES's and OIS's for the concerned work station. Also, the production manager working the day shift is responsible for ensuring that the work methods are updated during the evening- and night shifts. Hereafter, the WES's enters the *use phase*.

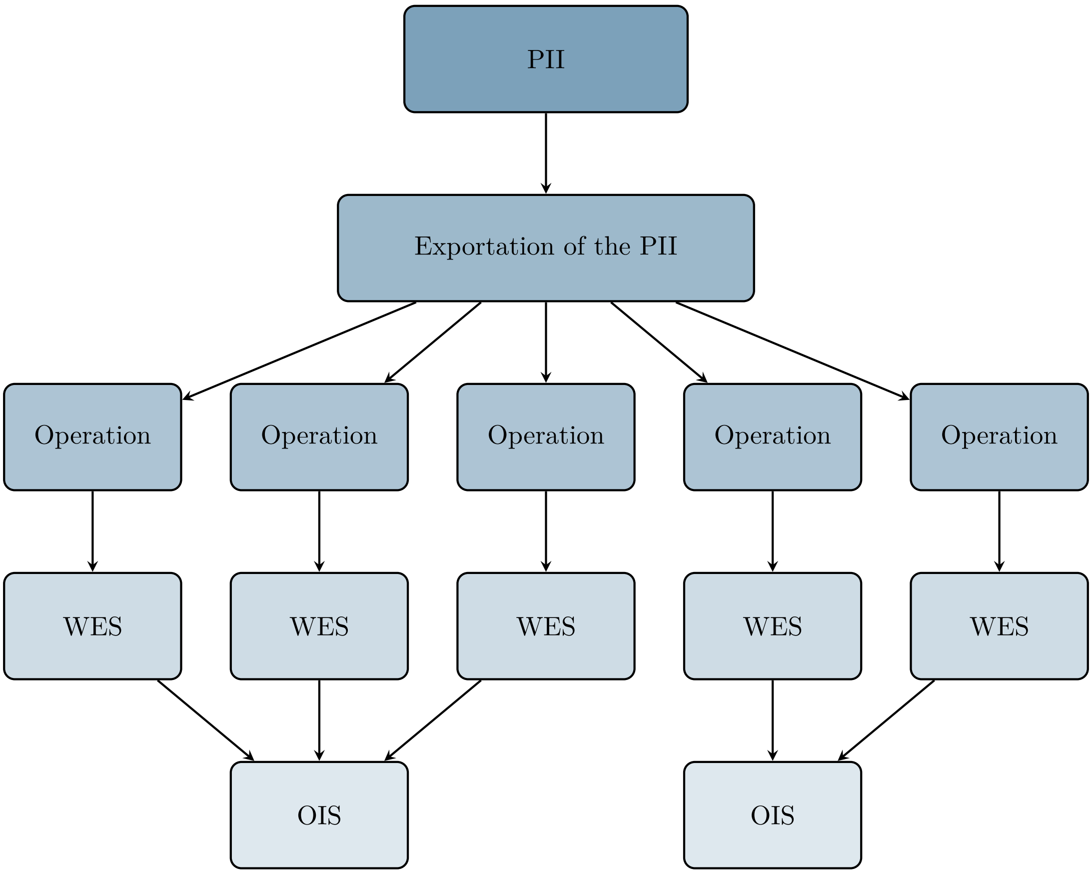

Figure 1.4: Relations between PII, OIS and WES

1.4.3 The use phase

The first stage in the use phase is where the new WES's and OIS's are implemented in the running production. The production manager informs the team managers and the operators of the changes and ensures that they understand the new WES's and OIS's. The WES and OIS are tested during a period and later verified. If the operators have any opinion regarding the assemblage, they report to the team manager who later reports to the production manager. If the WES's operations require a rework, the product is recalled and improved. When the testing and implementation stage is finished, the second stage is entered.

The second stage in the use phase includes the practice of the operations in the WES's and OIS's. The operators assemble according to the WES's and OIS's until additional changes of the WES's or OIS's are implemented. When a WES or OIS is changed, the existing one enters the final stage and is thereby phased out.

1.5 Aim

The thesis aims to reveal and analyze issues connected to the PII's, OIS's, and WES's. The PII's will be studied from the development phase at ME, to the creation and usage of OIS's and WES's in the plant. The main focus will be on the usage of the instructions within Line X, and thereby human factors, cognitive ergonomics, and behavior are important factors.

The outcome will be a list of identified issues, their root causes, and recommendations on how to manage them.

1.6 Research questions

The research questions constitute the thesis' objectives and will help with addressing the investigated problem and reach a conclusion.

- What are the main issues connected to the PII's, OIS's, and WES's?
- How can these issues be handled?

2 Theoretical Framework

The following chapter covers the theory relevant and necessary to enable and understand the project. The theories are gathered from existing literature.

2.1 Organizational management

The purpose of an organization is to coordinate the different resources, e.g. personnel, material, and money, to achieve a certain goal. The leader within the organization has five different responsibilities; planning, delegating tasks, allocating responsibilities, information sharing, and controlling. [2]

A well-functioning organization should not only see to the humans' physical needs, e.g. safety but also enhance self-realization. Sigvard Rubenowitz [2] mentions five factors to consider when forming an organization. Firstly, the workers are more happy and productive if they can control their work [2], [3]. To achieve this, an adapted leadership structure is necessary. The leadership should allow for the workers to have more control over their tasks and safety programs[2]. This is linked to *Taylorism*, meaning that the best procedure possible should be emphasized [3]. Secondly, the worker needs to be recognized and given some sort of meaningful role within their work [2]. Thirdly, the personal development of the worker is important, otherwise, the worker might not feel stimulated and lack the motivation to perform. Fourth, social interaction with co-workers, and the freedom to move around and meet others. Lastly, variation and reasonable challenges within their work are important. The worker needs to feel that their knowledge is used and that they can take initiatives.

2.1.1 Communication

Communication can be defined as a process or an activity. It is a process in the form of an information exchange, where a commonly used set of signs, behaviors or symbols are used. In terms of activity, the communication needs and expectations are defined, i.e. setting a timeline or plan. [4]

The communication process contains a sender, a receiver and a message. How the message is received and interpreted depends on the relationship between the sender and the receiver. The credibility of the sender will affect how the message is received. Credibility can be based on earlier events, or the receivers apprehension of the sender, i.e. the receiver believes the sender to be non-trustworthy on the matter. Further, the relationship between the two needs to be considered by the sender if the message should be treated in the desired manner, especially if the parties disagree on the subject. [5]

Lack of communication will affect the sharing of knowledge on all levels. The sender might assume that the receiver has enough knowledge on the subject, and therefore communicates very briefly and believes that the receiver will understand. Since the sender believes that their message is clear and understandable, it could give the sender the impression that communication is well established, when the communication might not be working at all. [5]

Successful communication builds on feedback, monitoring of performance, and trust. The parties monitor each other's work and help each other when needed, feedback is given in order to improve performance. Trust builds on earlier experiences and the willingness to trust others. If trust has been broken it is difficult to redeem. [5]

There are two types of communication within an organization; external and internal. The internal dimension is the communication within the organization, i.e. between manager and employee or employee to employee. The internal communication is important for controlling the employees' behaviors. Further, it is important for ensuring that employees receive the information necessary for their work tasks. The external dimension is the communication between the organization and external parties, e.g. unions or clients. [4]

A failed communication within an organization will impact the performance of the organization [4]. According to Geoffrey Boothroyd et.al. [6], communication between manufacturing and design is essential to achieve a product suitable to assemble. All parties within the process of producing a product should agree and communicate their terms and requirements to achieve a product designed for high manufacturability.

2.1.2 Culture

Culture is a dynamic phenomenon constantly present in human lives, and the definition is highly debated [7]. It emerges when people interact, and is partly formed by leadership characteristics as well as structures, routines, rules, and norms, affecting and limiting the behavior. The establishment of shared rules, norms and policies is based on communication [8]. As these aspects are communicated, they turn into collective competence and thereby become parts of the culture.

The characteristics of the culture are depending on the length of existence, along with the stability of the membership and the emotion connected to the shared experiences [7]. Within organizational groups, the culture constrains, stabilizes, and gives meaning, as well as structure, to the individuals within the group. The forces originating from culture are powerful and it is important to understand how to operate them. As the power of the cultural forces is strong, the culture must include a supportive climate [5]. This climate should not only allow for agreement, but also disagreement. Additionally, the allowance for diverse ideas is crucial. The opposite, a negative climate, is closed and enables blaming, discourage and punishing.

Schein [7] defines the culture within a group as " *a pattern of shared basic assumptions that was learned by a group as it solved its problems of external adaption and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way of perceiving, think, and feel in relation to those problems.*".

The culture is shared by a group of individuals where the size of the group is not delimited to a defined number of members. Within larger organizations, the culture varies a lot between different sub-groups where the tension between subcultures might lead to the failure of an entire organization. Further, the cultures might differ between different occupations. If one occupation involves a period of education, these individuals will share learning attitudes, norms, or values, all of which eventually turning into assumptions. These assumptions will likely remain even if the individual works within another group. [7]

As the culture is shaped by the leadership, it sets high demand on the leader's creation and management of culture. The leader's values will partly be the basis for the group's culture. As the culture gets established, the leadership gets defined and thereby becomes a part of the culture. At this stage, leadership is defined by the culture and this will continue up until a difficulty emerges and requires evolutionary changes and updated leadership. One of the greatest challenges within leadership is finding a balance between understanding the individual culture and to adaptively evolve the culture. [7]

If the leadership is excessively strict, or unclear and confusing, it increases the risk for dissatisfaction among the employees. When the manager is strict, the employees have no power in their work. Thereby the employees might feel neglected and exchangeable. On the other hand, having diffuse leadership might undermine the authority of the leader. This might lead to the distrust of the leader's ability to lead and support the group, and thereby lead to dissatisfaction among the employees. Another aspect of culture might be the expression of dissatisfaction to increase the feeling of belonging. This aspect might lead to individuals expressing discontent solely due to the fear of being excluded from the group. [9]

When managers try to change employees' behavior, the resistance to change is sometimes remarkably high. Frequently, departments in organizations seem to be more interested in fighting each other than performing their job. Within such organizations, unreasonable communication issues and misunderstandings are common between group members. Further, when trying to explain to people that these issues exist, these people tend to continue with their senseless behavior. When trying to change an organization, e.g. becoming more effective due to severe environmental pressure, individuals often tend to undermine the change by continuing behaving in ineffectively. This ignorance might threaten the survival of the organization. [7]

2.1.3 Work-as-imagined versus work-as-done

To improve the work within an organization, it is necessary to understand the difference between "work-as-imagined", i.e. the theoretical construct, versus "work-as-done", i.e. the reality [10]. Work-as-imagined is the ideal way of performing the work, where the author refers to Hollnagel's description. According to Hollnagel, work-as-imagined is the way managers or other authoritarian people believe the work is performed or should be performed. Therefore, these ways become the basis for designing, training and controlling the work. The opposite, work-as-done, is the actual way of working and how the work is performed in reality.

Work-as-imagined provides a conceptual image of the work and its process, offering several hypothetical constructs of the work. Additionally, work-as-imagined can potentially be used to develop general guidelines and theoretical concepts, applicable to the work. Further, defining work-as-imagined creates the opportunity to examine the gap between work-as-imagined and work-as-done. Examining the gap makes it possible to review the work from different perspectives, such as "work-as-documented" and "work-as-observed".

Work-as-documented is limited by the person executing the documentation process as well as the condition for documenting, e.g. time or environment. Reading documents to understand work-as-done might also lead to misunderstandings.

Work-as-observed is the observed reality, revealing how the work is executed in its environment. As the term reveals, this is the observed way of performing the work. The participants know they are being observed, which leads to the commonly known Hawthorne effect, i.e. the observed individuals modifying their actions when being aware of the observation. Consequently, this may lead to an inaccurate representation of the work situation.

2.1.4 Knowledge Management

There are two types of knowledge; *tacit* and *explicit*.

Tacit knowledge is an individual's internal knowledge and cannot be found in written form. Generally, this kind of knowledge is intuitive and is only to be found within the mind of the individual, e.g. how to bicycle. One of the main difficulties within knowledge management is to enable the accessibility and availability of tacit knowledge. [11]

Explicit knowledge, on the other hand, is possible to explain. It can, therefore, be described through documents or other forms of documentation, making it available to an entire organization [11]. Examples of explicit knowledge are work instructions and regulatory documents.

Knowledge work is information-based, i.e. the spreading of knowledge, as opposed to manual work which is materials-based. Manual work consists of material handling and reshaping and is, therefore, quite hands-on. Knowledge work is, on the other hand, intangible since it converts information. [11]

There are two main knowledge management strategies for capturing, sharing and using knowledge. The first type is the codification strategy, where the knowledge is stored in computers and accessibility through a database. This enables the reuse of already existing information. The second type is the personalization strategy. In this strategy, the knowledge is tied to the developer and is personally communicated. A company's choice of strategy is complex and depends on several factors, such as the clients, economies and individual preferences. Choosing the incorrect strategy might rapidly undermine an entire business. [11]

All humans have individual experiences and different types of knowledge. When handed a set of instructions, every individual will interpret the instructions differently due to their tacit assumptions [11].

2.1.5 Assembly work design

Work design could, in a simplified matter, be defined as the proper selection and planning of work. Having effective decision-making processes is crucial to achieving change within an organization. [12]

To achieve a better workplace design, it is important to consider the learning curves of the user, e.g. employee. To do so, the work has to be measured before it can be improved. This shows the importance of work measurement within the industry. [12]

Work measurements are used to set standard times required to perform operations. By taking measurements, it is possible to set time standards. The time standard is decided based on the time required to perform a task, performed by an average skilled operator working at a regular pace. An average skilled operator is defined as the normal case, i.e. not the best and not the worst. The regular pace is the pace enabling for an entire working day. When the operator performs the task, the standard time for the task is set. [13]

Work standards enable scheduling, staffing, balancing, planning of material, simulating systems, wage payment, calculating cost and evaluating employees. Within a plant, work standards can be used to measure operator performance, control incentive systems and provide employees with output goals. Traditionally, there are three major ways for developing the standards: estimation, direct observation and measurement, and standard data systems. [14]

The first one is *estimation*, i.e. a knowledgeable person examines the work or the use of historical data. [14]

The second way is direct observation and measurement, with the three most common ways, are *time study*, *work sampling* and *physiological work measurement*. Time study is defined as the study of an operator to identify the elements required to perform the work, the sequence of these elements and the required time. Work sampling is defined as several randomly gathered observations where the condition or state of the operator is noted. The state is labeled according to predetermined categories of work situations. Finally, physiological work measurement is defined by studying the operator's physiological factors, i.e. oxygen consumption, heart rate, and body temperature. [14]

Finally, the third way of setting a work standard is by using *standard data systems*. Standards data systems are defined as the gathering of all the elements required to perform a task, where the standard data is used for deciding on similar work standards. There are two types of standard data; *macroscopic standard data* and *microscopic standard data*, also called *predetermined time systems*.

Microscopic standard data is defined as the data of an element used in several, different scenarios, e.g. walking. When analyzing different activities, e.g. handling or material or assembly operations, the element walking is measured several times. Having a set standard for walking would ease the work of the analytic work.

Microscopic standard data, or predetermined time systems, includes predetermined time-limited for each motion. The motions are gathered by carefully studying the method required to perform the task.

When implementing work standards it is important that the employees are aware of the progress and that the pace of the progress is at a reasonable level. Further, the standard should be implemented in an area directly after the previous one. By doing so, the operators feel prioritized by the management. [15]

2.2 Human Behavior

Humans have an individual biological heritage and diversifying personal experiences. Due to the significant variation in genetics and experiences, all humans are unique [16]. Generally, psychologists focus on two main explanations for behavior; the biological needs and drive, and the motivational one, i.e. extrinsic drives [17]. To understand the factors affecting human behavior, it is important to consider past events connected to the individual. The attitudes and personality traits are evaluated to reveal the affecting factors. Identifying the factors is important to understand the reasons behind a certain behavior [16].

2.2.1 Disposition

Within psychology, it is common to refer to *dispositions* to explain human behavior [16]. The term disposition is used for describing a person based on their actions, e.g. if a person is lying, they are referred to as dishonest. If they lack in performance, they are referred to as unmotivated. The disposition explanation has commonly been used throughout the history of both social and personality psychology. Within social psychology, the term *attitude* is used to describe human behavior. In a similar matter, personality psychology explains human behavior by the concept of *trait*.

The terms attitude and trait are quite similar, both being hypothetical constructs with widely varied, observable responses. Though their similarities, there are differences necessary to consider. Attitudes consist of evaluative responses directed towards a given object or target. Personality traits are not always evaluative. Instead, the traits describe the response tendencies within a given area, i.e. behaving in a certain way; to be sociable or self-confident. Attitudes are easier to affect and change, as opposed to personality traits.

Attitude and personality traits are important factors when evaluating a human's behavior. The dispositions are important pieces when trying to understand why someone acts in a specific way.

Attitude

Attitude is the individual's response to an object, person, institution or event [16]. The response can be positive or negative and is evaluative, e.g. favorably vs. unfavorably or pro vs. con. Attitude is a construct that cannot be directly observed. Instead, measurable responses are necessary to enable understanding.

The most applied classification system for attitude behavior is the categorization of three responses: *cognition*, *affect* and *conation*. Each of these categories can be divided into verbal and nonverbal responses. The reason for dividing these is that people's statements do not always correspond to their actions [16]. Also, verbal and nonverbal responses vary. The nonverbal responses might differ depending on how someone speaks. Furthermore, the nonverbal response is affected by the nature of the voice giving the instructions, e.g. if the voice is synthetic or real [18].

Cognitive responses are the opinions on or perceptions of the attitude object. The verbal nature of the cognitive responses consists of beliefs, i.e. the attitude towards a person's ability to perform their task. This attitude can be favorable or unfavorable [16], e.g. an operator believing that the engineers want to ease their work, or not. Cognitive responses in a nonverbal nature are perceptual reactions and therefore more difficult to analyze. Taking an operator as a further example, they could have different levels of threshold for different types of stimuli. If the operator's attitude is favorable, they will have a relatively low threshold for positive stimuli from the engineers. Conversely, if the attitude is unfavorable, the threshold is relatively low for negative stimuli. An example could be an engineer making small mistakes frequently. An operator with a favorable attitude would allow for several mistakes before reacting, while one with an unfavorable attitude would burst out in anger directly.

Conative responses are the intentions, inclinations, commitments, and actions connected to the attitude object. The verbal nature of the conative responses consists of what individuals say they do, plan on doing or would do depending on the circumstances [16]. An operator with an unfavorable attitude might state that they will never do what the engineers say since the engineers know nothing about the real work. Conversely, an operator with a favorable attitude might communicate that they will perform any task the engineer suggests. The nonverbal nature indicates unfavorable or favorable attitudes. An operator with a favorable attitude towards engineering might personally engage in the development of their work station as well as reading books, research papers and other literature covering the relevant topics. An operator with an unfavorable attitude might disregard the helping tools and send letters to newspapers complaining about their work.

2.2.2 Habits

Habits can be defined as a frequently occurring action, where the person has reached a state of acting automatically. The person possessing the habit can either be aware or unaware of it.[19]

A person's habits can be described in terms of two *systems*; the executive system and the operational system. The executive system is the conceptualization of choices and issues. Further, the operating system is the reaction to the context in relation to the need states. These systems, along with the physical and social environments, are the main influences on behavior changes. [20]

In some cases, human habits do not correlate to their best interest, e.g. smoking, unhealthy eating habits or lack of exercise. Furthermore, when trying to change unfavorable or even dangerous habits, people rarely succeed and often fall back [20]. To understand the mechanisms behind the difficulties in changing, it is important to understand how habits are changed.

The majority of behavior change is quite simple. Humans' environment, and their responses to it, are constantly changing. The response is affected by the individual knowledge and will change as the humans acquire additional knowledge or adapt to a new situation. [20]

2.3 Cognitive Ergonomics

Humans are complex beings, difficult to control and making mistakes, but also flexible and adaptable. Robots, on the other hand, can be controlled and their behavior is predictable. Due to their flexibility, humans are frequently used as assemblers in production. Therefore, human complexity must be considered.[21][3]

Cognition is a term used for describing the processing of information. The information is processed by the five senses; hearing, vision, touch, smell, and taste. Cognitive ergonomics focuses on improving the ergonomics for the mind and senses when processing information. Neither the mind or the senses should be overloaded with information, and the information given should be delivered suitably. For example, sounds chosen for the delivery of information should not be dangerously loud or of an unpleasant pitch. Further, color choice for visual information should be adapted with respect to color blindness.[21]

Poor cognitive ergonomics in production can lead to several consequences, e.g. mistakes requiring rework and thus additional cost, stress, and work-overload. A highly discussed factor related to cognitive ergonomics is *fatigue*. Fatigue is used for describing the state where the brain gets overburdened. [21]

2.3.1 Memory and input-stimuli

The memory is where past experiences, rules, and information get stored. The memory is divided into *long-term-* and *short-term memories*. The short-term memory is also called the working memory, where the human can store 7 ± 2 items to understand the situation. The short-term memory can also cooperate with the long-term memory to identify patterns from past experiences. Recent events can be stored in the short-term memory for 30 seconds, if not repeated. When a task has been performed several times, the information is stored in the long term memory. If the human has a lot of relevant experience, i.e. information stored in the long-term memory, the human can perform several tasks simultaneously due to that the short-term memory is not overloaded. [22]

Mental model

Humans use mental models to recognize patterns, predict behavior, and interpret their surroundings. The mental model builds on memories, where humans store information about experiences to easier handle similar situations. The model is the human's expectation on how a specific process or product works, which can lead to complications if reality does not correspond to the human's mental model.[22]

2.3.2 Perception to action

Christopher D. Wickens's model explains the human's information process. Humans receive stimuli from outside, which sends a signal to one or several of the three *senses*; Vision, Hearing or Touch. Next, the *perception* interprets the stimuli and gives the stimuli relevance. The *attention* controls if the brain should focus on the new stimuli or not. This control is affected by aspects such as expectations, needs, memories or feelings. [23]

Depending on what the human wants or needs at that moment, the attention will filter relevant stimuli from the perception. The output from the perception and attention are the inputs to the *decision*, where the human decides on the action to the given inputs. The output from the decision is transferred to the *response*, where the human performs the predetermined action. The output from the response will later be the feedback, i.e. input to the senses, enabling the human to reflect on the outcome of the action. [23]

During the entire process, the long-term and short-term memories are connected. During the perception, the long-term memory will help recognize patterns. The memory will connect the perception to earlier experiences, which later supports the decision making. The short-term memory is involved during both the attention- and decision-phases. As mentioned earlier, the long- and short-term memories work to compensate for each other. The short-term memory helps with interpreting and processing the information from attention and decision. Later, this is one of the inputs to the decision.[23]

Decision

When a human makes a decision, there is a lot of information evaluated to produce a single action. The decisions can be simple; *go or no go* choices, or complex multi-choice tasks.[23] Jens Rasmussen [24] has developed *the SRK-model* to explain the different levels of the human decision-making process.

The uncertainty of the consequences is significant for the decision-making process. Depending on how predictable the surroundings and other subsystems are, the uncertainty in the decision will change. The uncertainty might also contain risks that affect human decisions. The more predictive the consequences are, the easier the choice of decision for the human. [23]

According to Jens Rasmussen [24] the human makes decisions on three different bases; *Skill-based*, *rule-based* and *knowledge-based*.

The skill-based decisions are actions performed without thinking, i.e. routine. Typical skill-based action is sensory and meteoric responses. In some scenarios, the skill-based behavior has little feedback control involved, which means that the action is not fully automated.

Rule-based knowledge is built on rules and past experiences. Performance is goal-oriented, which means that the human chooses a "rule" to use depending on the goal. The rule-based behavior is not automated since the human needs to recognize the stimuli input and know what to do with it based on experiences and the goal. If the human experiences a new situation, the third level of knowledge is active to make a decision; the knowledge-based one. Those situations require the human to act problem-solving. The knowledge gathered from situations like this can later be stored in the rule-based knowledge.[24]

2.3.3 Environment

Humans rarely behave uniformly in similar situations. Not only attitude and personality trait affect the behavior of an individual, but also thoughts, feelings, and actions which might affect an individual to act differently in similar scenarios [16].

Another important aspect is the psychosocial environment, i.e. how humans are affected by their organizational surroundings. Further, humans interact with their surroundings and can control and influence it up to a certain level. When working, several factors are affecting the human; the social aspect, the cultural aspect and the personal lifestyle. [21]

2.3.4 Motivation

The term *motivation* is generally defined as the mental state of meaningfulness a human reaches when performing a task. This state of mind increases the possibility of a positive approach when completing tasks or reaching goals [21]. Motivation can be divided into two types; *intrinsic motivation* and *extrinsic motivation*.

Intrinsic motivation

Intrinsic motivation is defined as a mental state where the human feels internal satisfaction from performing a task [17]. This type of motivation was recognized when researchers observed humans and animals behaving in ways not applicable to their biological needs or any extrinsic consequences, i.e. reward or avoidance of punishment. This was explained with some sort of internal satisfaction or interest, today referred to as intrinsic motivation. Generally, intrinsic motivation arises when the task itself is meaningful to the individual [21].

Intrinsic motivation is important for the feature of human behavior due to its significance in development, quality, performance, and well-being. Intrinsic motivation will be undermined if extrinsic rewards are present. Consequently, the natural processes will be disturbed, leading to negative effects on an individual's learning, development, and expansion. [17]

Extrinsic motivation

Extrinsic motivation is defined as the type of motivation required for a human to perform a task, e.g. rewards or punishments [17]. These extrinsic consequences are not originating from the individual but an external source, e.g. employers, enactors or parents. Extrinsic motivation is necessary when the task itself cannot motivate the individual [21].

If a human is presented with extrinsic motivational awards, it will lead to the undermining of intrinsic motivation [17]. This was shown by studying people with an interest, i.e. intrinsic motivation, in a matter. When an extrinsic award was introduced and later removed, the test subjects had lost their interest as well. Humans also tend to accept certain discomfort if they achieve some sort of extrinsic award [21].

The effect of extrinsic rewards varies depending on the individual's interpretation of the reward. An important factor affecting the interpretation is the type of reward. If the reward is verbal or tangible, the verbal one is perceived as informational, i.e. positive feedback. When having tangible rewards, it might be mistaken for supervision, i.e. controlling. Further, it is important to separate expected from unexpected rewards when discussing tangible awards. Expected rewards for performed tasks are undermining while an unexpected one is not. [17]

2.3.5 Human error

Complex systems include several interconnections, meaning that everything that happens affects something else. Due to those interconnections, an error might be caused by several procedures inside the system.[3]

Below are the different types of human errors that can occur, describes by Christopher D. Wickens [23] and James Reason [25]. Further, the stress factor will be accounted for as stress can result in errors, but it can also be the other way around. Lastly, the mental workload will be presented, since too high workload has shown to have a great effect on human performance.[23][25]

According to Christopher D. Wickens [23] human error has been identified as the main cause of major accidents. Though, the reasons for human errors are often bad system design, or organization, rather than irresponsible actions by the human. Wickens explains that human error resulting in a major fault or accident, often is caused by a chain reaction leading up to the human, i.e. the system or organizational flaws will show through the human error.[23]

Errors of commission, (*performing an incorrect action*), are divided into three types of errors; slip, lapse and mistake. The human could also perform errors by omission; (*not acting when the action was needed*).[23]

Mistakes take place before the action is executed, either during the perception where the human interprets the situation or during the decision on how to act. James Reason [25] has categorized mistakes into two sorts; *knowledge-based mistakes* and *rule-based mistakes*, which are connected to the SRK-model by Jens Rasmussen [24]. The knowledge-based mistakes occur during the interpretation of the situation. This means that the human understands the situation incorrectly, hence deciding on the wrong action. Knowledge-based mistakes might originate from the lack of knowledge and expertise on the subject. A reason behind those mistakes could be a poor presentation of the information, resulting in that the human does not understand.[23][25]

The rule-based mistakes occur when the human believes to know and decides to act, unaware that the action is incorrect. Humans create rules that are adapted to certain situations; "if this happens, then that should happen". This means that if the human uses a predefined rule in a situation not suited for the rule, i.e. the "if" that triggers the rule is not relevant in the situation, the human will make a rule-based mistake. A common belief in situations where rule-based mistakes occur is "this has worked before, why should it not work again?". Humans tend to use rules that have been successful multiple times in the past. Due to their high trust in the rules, they might use the rules incorrectly. [23][25]

Violation is when a human deliberately chooses to act incorrectly. Routine violation is when the human constantly chooses not to follow the rules since it has become a custom to do so. Situation violation means that the human believes to know better than the set rules or instructions, and therefore act on their intentions. [26]

2.3.6 Design for cognitive ergonomics

Humans might adapt to the systems in a different way than anticipated, leading to that the systems are used incorrectly. This states that the anticipated human behavior within the system rarely correlates with reality. Also, the process designed for humans might not be fully suitable for them. Designers have a different view of which design is the most appropriate, which could lead to a design that is too complicated for the end-user. John D Lee et al. [3] talk about *learned intuition*, which is what the designer takes for granted. Although basic for the designer, it might not be something that the end-users understand. For example, a very complicated computer, used by an inexperienced end-user.

Location capability

To decrease the mental-workload, *location* and *movement* are crucial aspects to consider. They both need to be logical to the human, i.e. fit the mental model. Also, the coding needs to be easy to understand. *Co-location principle* means that related components are placed next to each other, or close by. The co-location is perceived as logical to humans, which means that co-location will prohibit confusion and incorrect usage. Although, in some cases, co-location is difficult or impossible to achieve. Instead, *congruence* and *rules* need to be used to promote correct usage.[23]

Rules signify a steady behavior of the system, and that its processes follow a specific pattern. If the system deviates from the rule, the human will get confused and might use the system incorrectly. Notable with using rules is that the applied rule might not correspond to the humans mental model, or seem logical to the human, hence the human might need to learn the rule.[23]

Minimizing human error

Many of the factors resulting in human errors are organizational or due to the environment where the human is performing the task. Listed below are, according to Christopher D. Wickens [23], relevant factors to address to minimize the risk of human error.

Task design. The human memory is limited, therefore the task should not require the human to store a heavy load of information, especially not during stressful situations. [23]

Equipment Design. Christopher D. Wickens [23] listed 5 different design factors that can be used to minimize human error.

- *Perceptual confusion.* Elements that should not be confused also need to have a design that separates them, i.e. shape, color, etc. Those design attributes will then help the human in choosing correctly.[23][22]

- *Visible action and result/response.* The human needs to see the consequences of their actions to notice an error and learn. The feedback given to the human also needs to be as direct as possible. If the feedback arrives to the human after a few minutes, the human might have forgotten the process and thereby not be able to learn from the feedback. Delayed feedback could also be harmful, the human might perform the same procedure twice during the absence of feedback, which could affect the results negatively. Another factor is that human tends to not learn from feedback and revise the process if the information does not surprise them. [23]
- *Constraints to prevent error.* The constraints can be that a procedure must be done in a certain order for the human to proceed, where the system will stop the human when the procedure is not followed correctly. An example is that humans are not able to lock the car from inside, which will eliminate the risk of having the key locked inside the car. Another example is to have "checks", the system will then ask the human if it wants to proceed, and the human then need to actively override the system, e.g the warnings computers give when the human tries to delete a file. The system needs to be designed in such a way that it promotes the human to perform the right procedure, even if the procedure is poorly executed and results in a fault. If the human perform the wrong procedure and the result is correct, the system has invited the human, i.e. not "stopped" the human to perform the incorrect process. [23]
- *Multimode systems.* The same action should not, if possible, be connected to different actions or context. If the situation cannot be avoided, the modes need to be distinguished as much as possible to not confuse the human. Another important design factor is keeping the number of modes as low as possible. [23]

Training. To enhance knowledge and understanding of the work process, training is essential, especially for repetitive work. Also, periodical training is necessary to uphold a good skill level for humans performing repetitive tasks. [3]

Lack of knowledge will increase the risk of errors. Another important aspect of training is to perform errors. For the human to learn how to handle certain errors, the human needs to have experience from them. Training will also strengthen or build up the humans mental model of a system.[23] John D Lee et al [3] talks about interconnections in a system, where complex systems include several of interconnections. The human operating the system has to learn at the same rate as the system gets updated.

Assist and rules. Assistance can be used as memory aids, e.g check-lists, procedures or schedules. To avoid safety issues rules are commonly used, those rules then need to be logical, well thought through, enforced and explained to be properly used by the humans. [23]

Error-tolerant systems. In some cases, the error might be desired. As the human makes a mistake, there is a possibility for improvement of the system. If the human does not make mistakes, the designers will not find the flaws in the system. Also, if the human wants to create a good mental model for the system, the human needs to test the limits, which includes making errors. When the found errors are collected and applied to improve the design the system will be more tolerant of error.

3 Method

This part of the report presents the methodology applied to the thesis's data collection. The chapter is initiated by the project procedure, where the chronological order of method execution is presented. Thereafter, the methods are presented in sections categorized accordingly; literature study, including a document review, observations, surveys, interviews, and lastly the analysis methods.

3.1 Procedure

The procedure presents the methods in the order they were performed, since the remaining part of this chapter will not be presented in chronological order of occurrence. This is visualized in Figure 3.1, showing a simplified flow of the work procedure.

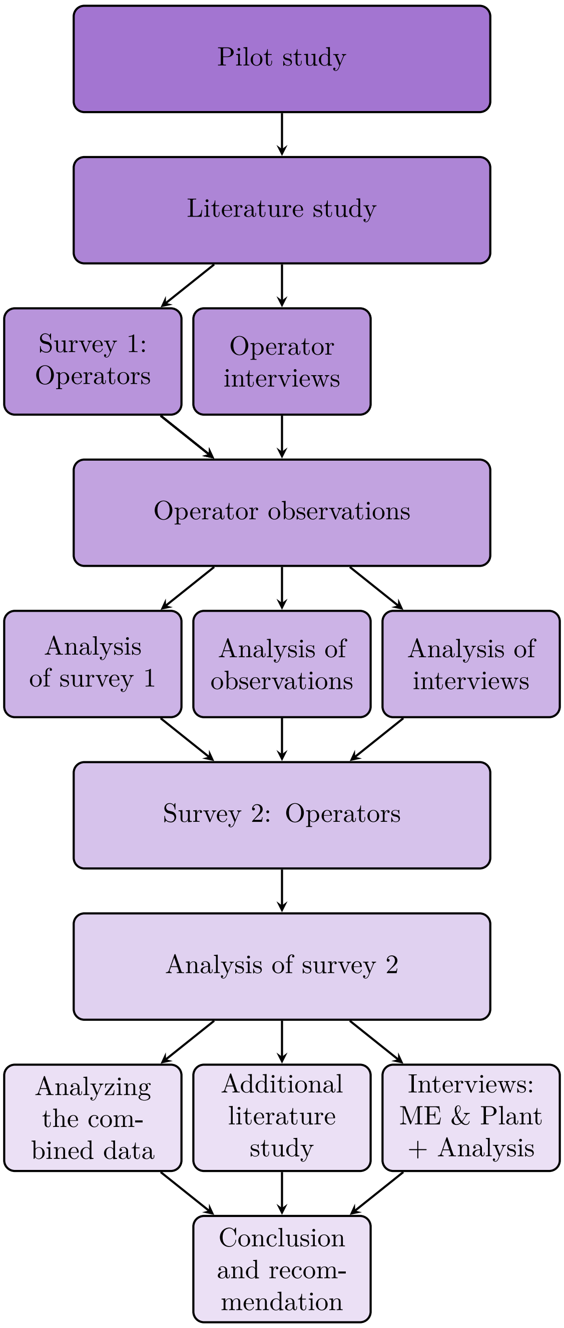

Figure 3.1: Procedure for the data collection and analysis.

3.2 Triangulation

Triangulation is a term used to describe a study combining several methods or data sources. The term originates from a military strategy where it is used for locating the position of an object by pinpointing several reference points. The advantage of applying the triangulation method is the increased validity in the results. Further, the findings and understandings will be more reliable. [27]

In this study, the triangulation method was applied by combining different sorts of data collection methods; interviews, observations, surveys, and literature, as well as the combination of different sources of information; operators, team managers, production managers, process technicians, and manufacturing engineers. Mixing different research types is the most common approach today, which is why this thesis applies several research types [27].

3.3 Literature study

The main reason for reviewing existing literature is to prevent the reinvention of existing results and models [27]. Further, having several sources stating similar thoughts increases the credibility in the findings and conclusion. Additionally, the literature might bring out unanswered research questions, enabling the possibility to rewrite or add questions to the project.

The literature study included books, research papers, articles, and internal company documents. The data from external sources, i.e. not the company, was gathered from Chalmers Library, GU Library, ScienceDirect, Scopus, Springer, and Springerlink. The internal data was gathered from Volvo Cars' intranet and databases. To ensure reliable and credible sources, the literature's date of publication and the author were considered when reviewing the external sources. For the author, the profession, education, previous work, and other relevant experiences were taken into consideration. Further, the literature's number of citations was reviewed.

Keywords used to find relevant literature from external sources:

- Human behavior
  - Habits
- Cognitive ergonomics
  - Human senses
  - Motivation
  - Incentives
- Organization
  - Knowledge management
  - Communication
  - Work culture
  - Work method

Critically analyzing the literature's conclusion, e.g. by reviewing the type of theory influencing the result, and findings are important for ensuring credible sources. Further, it is important to take good notes when reviewing literature [27].

Initially, the literature was summarized, critically approached and coded. In the summation, the title, author, publication year and keywords relevant for each article are noted. The summations were gathered in a document on Google Drive. Further, the literature was shortly described in an additional document, where short descriptions of all gathered literature are available. The document is, as the summations, located in the Google Drive folder.

During the project, new literature was reviewed when the need for additional sources occurred. Continuously reviewing existing literature is important to ensure that all relevant information is gathered. Thereby, the initial literature review can be seen as temporary [27].

The literature study was mainly performed at the initial stage of the project, and all literature gathered from external sources is presented in Theoretical Framework, Chapter 2. The internal sources, i.e. Volvo Cars' confidential documents, were gathered in forms of a document review and are presented in Result, Section 4.2.

3.3.1 Document review

In case-study research, organizational documents, inaccessible for external parties, are often used to describe the investigated organization [27]. For this study, several internal documents were used.

Volvo Cars' internal databases and intranet were used to access Line X's PII's, OIS's, and WES's. These PII's, OIS's, and WES's were downloaded and reviewed to enable comparison to the interviews and surveys, as well as the observations. Also, they were used for creating fictional examples, see Appendix A. Further, information concerning the process and its optimal state was gathered from documents accessed through Volvo Cars' intranet.

To enable comparison between the instructions, i.e. WES's and OIS's, and the collected data, i.e. the surveys and observations, the OIS's connected to the chosen work stations within Line X were examined. The corresponding WES's and PII's were reviewed as well. A total of seven PII's were examined and evaluated. The Swedish translation and the spelling in the original PII texts were reviewed.

3.4 Observations

Observing is the most commonly used method for observing human behavior [28], using predetermined categories for systematization [27]. Observations are performed with the purpose to understand the actual situation [29]. Observations can be *controlled* or *uncontrolled*, i.e. observed in a laboratory, or observed in a natural environment [28]. For this study, the observations were uncontrolled and the operators were observed during regular work hours and normal conditions. The uncontrolled type is most suitable for this study due to the exploratory character of this project. The main disadvantages with uncontrolled observations are the risk for interpretation and the risk that the observer overrates their knowledge about the observed phenomena.

The observations were *unstructured*, or sometimes called *systematic* [30], which is preferred when the study is exploratory [28]. The observations aimed at being *disguised observations*, i.e. the observed people are unaware of the observers. Though, the observations were of the *non-participant* sort, i.e. the observer observing without attempting to participate. The *participant* type of observation, i.e. the observer experiencing what the observed, is preferred due to the likelihood of more solid results.

Further, the observations were based on formulated rules where the observer records certain behavior [27]. Alan [27] and Kothari [28] mentions several advantages with using observations as a method. If performed correctly, the main advantage is that observations reduce the risk of subjective bias. Another advantage of using the observation technique is that the behavior is directly observed, i.e. observing what is currently happening. Additionally, it eliminates the risk associated with surveys, e.g. bias or false statements, if performed correctly.

Observations were performed within Line X, after the first survey and the operator interviews, but before sending the second survey. Due to the complexity of the observed situation, the operators were video recorded while assembling, using a GoPro attached to their head. Later, the videos were used for observing the performed work and comparing it to the instructions. Three operators at three separate work stations were recorded for 20 - 40 minutes each. Due to the high time consumption of observing, three work sequences with identical product types were chosen for observation from each work station. One work sequence consists of the assemblage of one product. The observed sequences were randomly chosen and the time of occurrence can be seen in table 3.1.

Table 3.1: Observed work stations with chosen sequences and their occurrence in the video.

Work station 1	**Work station 2**	**Work station 3**
Sequence 1 at 07:21	Sequence 1 at 05:45	Sequence 1 at 02:21
Sequence 2 at 15:24	Sequence 2 at 07:17	Sequence 2 at 09:12
Sequence 3 at 30:00	Sequence 3 at 15:25	Sequence 3 at 14:43

3.5 Surveys

A survey is a sort of structured interview with the goal of relatively quickly collect quantitative data from a high number of people. Additionally, it enables data collection from people with limited time resources and availability [29]. Further, it is important to ensure that the collected data is comparable [27], e.g. by having multiple-choice questions.

When formulating survey questions, it is important to ensure that the participants can understand them, e.g. by not using difficult terms or words. The questions can be of *closed* or *open* character, where the closed questions are multiple-choice and the open ones allow for individual answers. To ensure that the formulated questions are understandable, it is preferable to test the survey on one participant before dispatched. [27]

Surveys might be difficult for gathering data concerning human behavior. This is due to the quite high risk of individuals reporting inaccurate behavior, either in purpose or by accident. Sometimes, people are not aware of their behavior, with attitudes and personality traits deviating from what they believe. [27]

Surveys were sent to operators within Line X. By sending surveys, it was possible to achieve an extensive amount of data concerning the knowledge and emotions regarding specific objects or situations, e.g. the knowledge of and feelings toward the WES's and OIS's.

3.5.1 Survey 1

The first survey's questions were mainly of closed character, but a few questions were open, see Figure D.1 in Appendix D. The questions mainly aimed at revealing the extensiveness of the operators' knowledge of the instructions, but also the frequency of usage. The survey was printed on paper and handed to the operators during the interviews. For operators who were not interviewed, the surveys were handed out by the production managers. There were 50 copies of the first survey, where the copies not answered during the interviews were handed to the production managers.

3.5.2 Survey 2

An additional, second survey was sent after the analysis of the interviews and Survey 1 since new questions arose during the analysis. The second survey aimed at collecting both quantitative and qualitative data and therefore had a higher number of open questions. The aim was to reveal how the operators use and prioritize the instructions and their work methods. The survey was sent to the production managers within Line X. For further information regarding the content of the second survey, see Figure D.2 in Appendix D.

Question 2 in survey 2; *What do you do differently? For example: take the tool with you, do things in another order. Please give examples om exactly what you do, and on which work stations.* has been translated into quantitative data, see Table E.2. The citations have been translated from Swedish to English, and some fragments have been removed or renamed due to confidentiality reasons.

3.6 Interviews

Interviewing aims at accentuating the spoken word, instead of numbers or quantity [27], and is used as a source of data when addressing the research questions. In contrast to surveys, interviews aim at revealing what people think and believe, i.e. self-reports [30]. Further, interviews help with understanding and revealing information and experiences as well as values, concerns, and additional feelings [31].

The outcome included personal opinions and will thereby reveal the thoughts and feelings among the participants. Thereby, the result from a qualitative study reflects the individual perceptions and experiences among the participants.

Interviews can be structured, semi-structured or unstructured [30]. For the interviews in this study, the choice of interview type was semi-structured i.e. interviews with predefined questions but allowance for discussion and attendant questions [29]. According to Denscombe [30], there are three ways of interviewing; one-to-one interviews, group interviews, and focus groups.

There are six main steps in qualitative research, which were followed during this study, visualized in Figure 3.2

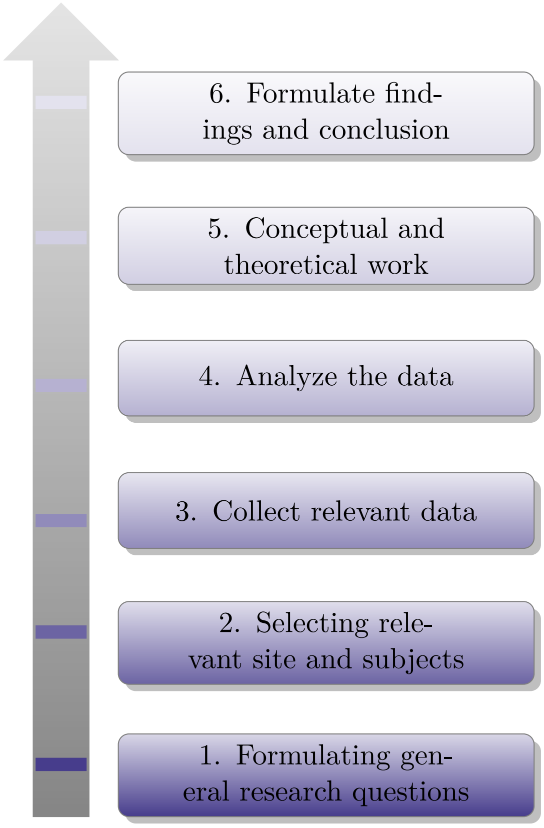

Figure 3.2: Main steps of qualitative research [27]

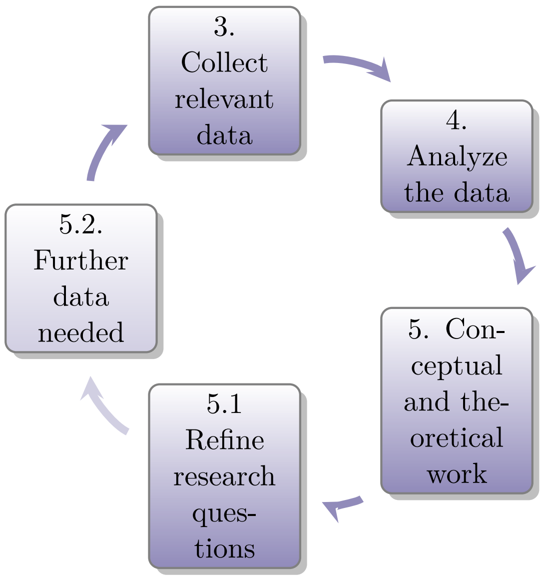

Figure 3.3: Iterative process between Step 3, Step 4 and Step 5 [27]

Additionally, Step 5 includes tighter specifications of the formulated research questions, which might require further data collection [27]. The additional data collection could include further interviews, either with additional or previous interviewees. Subsequently, the newly gathered data must be analyzed, which corresponds to Step 4. An iterative process between Step 4 and Step 5 will continue until Step 5 is sufficient. The iterative process will continue until the data is sufficient. This is visualized in Figure 3.3.

During this project, the insufficiency was occasionally obvious during Step 4 in 3.3 and 3.2, e.g. when an interviewee could not answer the predefined questions and refer to a colleague. When this occurred, Step 5 and its sub-steps in the iterative process were excluded and the data collection was initiated immediately, e.g. by contacting additional interviewees.

All interviewees were chosen within Line X, Plant C and ME. During the data collection, interviews were held with people who develop, manage or use the PII's, OIS's and WES's. The data concerning the development and content of the PII were gathered from interviews with people working at ME. For data concerning the reception and implementation of the PII and the development of the OIS and the WES, people from Plant C, primarily within Line X, were interviewed. Further, the data concerning the usage of, perception of and feelings toward the WES's, interviews were held with team leaders and operators within Line X. The interviewees are presented in table 3.2.

Table 3.2: Interviewees for the qualitative study

Work title	Number of interviewees	Recorded interview	Transcribed interview	Organization
Technical leader	1	X	X	ME
Process manager	1	X		ME
Process technician	2	X		Plant C
Production manager	2	X		Plant C, Line X
Team leader	2	X	X	Plant C, Line X
Operator	12	X	X	Plant C, Line X
Process technician	1			Plant C, Line X
Process technician	1			Plant C
Process engineer	1			Plant C
Group manager	1			ME

The initial interviews were held with two engineers at ME; one technical leader and one process manager. The main aim of these interviews was collecting information for the Pilot Study, but information directly connected to the actual project emerged as well. Information regarding ME's point of view on the formation of the PII and its translation to the plants was gathered. Further, the supervisors for the thesis are both working within ME and therefore constituted as sources of information throughout the project.

The interviews performed for the study within Line X began by interviewing two production managers. Due to their responsibility for formulating the OIS's and WES's, they could explain the content and its visualizations. After interviewing the production managers, 12 operators and 2 team leaders were interviewed with the purpose to investigate the OIS's and WES's. For the interview questions asked during the operators' interviews, see Appendix B.1.

Although the searched information was predefined, the main focus was on the interviewees' knowledge. The majority of the interviews held during this study were one-to-one interviews since they are easier to arrange compared to group interviews [30]. Further, some interviewees had specialization areas, making it difficult to combine interviewees.

The operators perform equal tasks due to their similar type of employment and were, therefore, asked equal questions during separate interviews. The operator interviews were held consecutively and went on for three to ten minutes each. All interviewees were working within Line X.

The interviews were audio-recorded, and notes were taken during the interviews, to enable summation or transcription. The recorded operator interviews were transcribed to enable a *KJ analysis*. After finishing the summation or transcription, the audio files were deleted.

Transcription can sometimes be difficult due to poor quality in the audio file [31].To prevent confusion followed by incomprehensible recordings, notes were taken during the interviews. These notes could further supply information important for the study and therefore it is important to take notes although the interview is recorded [30].

After interviewing the production managers, team leaders and operators within Line X, the process technician responsible for Line X was interviewed. The process technician interview aimed at understanding the process of translating a PII to WES's and OIS. During this interview, the need for additional information regarding the communication between ME and the plant emerged. Further, the terms *global ME* and *local ME* emerged. To understand ME's point of view, as well as the organizational division, a group manager at ME, was interviewed.

In the final stage of the project, a process technician and a process engineer were interviewed due to a project they work on. The interview was unstructured, containing questions regarding their project, its aim, and issues related to it.

3.7 Analysis methods

The methods used for analyzing the collected data are presented in this section. Further, the application of the method is described, connecting the analysis method to the relevant data collection method or methods.

3.7.1 Coding

Coding is an analytic method used for categorizing data, aiming at making the data comprehensible [32]. During this thesis, coding was used for analyzing the literature and the interviews not analyzed using the KJ Analysis, see 3.7.2. For the literature study, coding was used for categorizing the gathered literature in the Theoretical Framework, see 2. The interviews with the process technicians, process engineer, production managers, manager at ME, technical leader, and process manager were analyzed by coding their statements.

3.7.2 KJ Analysis

The KJ analysis is a method used for analyzing interviews and is a type of coding. The *KJ analysis* is performed by categorizing the interviewees' statements and thus receive a holistic view of the issues [33]. To enable a KJ analysis, the interviews must be transcribed since the analysis requires written citations. By using the tool, it is possible to identify the main issues connected to the interview topics.

The KJ analysis was divided into three main categories depending on the interviewee's answers. Subcategories were then connected to each category and interviewee quotations were connected to those. All subcategories were formulated based on the quotations and are therefore entirely dependent on the interviewees.

3.7.3 Visualization

The numerical data collected from the surveys and observations were compiled in forms of tables and charts. These tools give a comprehensible overview by visualizing a large amount of numerical data [33]. By visualizing the numerical data, it is possible to get a holistic view of the current situation and identify issues connected to the gathered data.

3.7.4 Criterion for evaluating qualitative data

The evaluations of the interviews are based on Guba and Lincoln's criteria for qualitative research, described by Alan Bryman and Emma Bell [27]. To evaluate qualitative data, Guba and Lincoln suggest two main criteria for assessing the data; *trustworthiness* and *authenticity*. For this study, trustworthiness is used for analyzing the interviews.

Trustworthiness can be divided into four criteria; *credibility*, *transferability*, *dependability* and *confirmability*. In short terms, credibility is the internal validity while transferability is the external one. Further, dependability is the reliability while confirmability is the objectivity.

Credibility corresponds to the internal validity of the research, including the data and its sources. To ensure credible results, the participants in a study should review the results to enable confirmation of the findings. Further, the methods used for data collection should be generally accepted. The methods should be the standards for their type of research or producing superior results compared to alternative methods. Another technique used for increasing credibility is triangulation.

Transferability corresponds to the external validity of the research, i.e. if the findings are possible to apply to another context or the same context in the future. For example, if the data is gathered from a small group of individuals, sharing certain characteristics, it might decrease the transferability.

Dependability corresponds to the reliability of the research, where all phases of a project should be recorded, e.g. selection of interviewees and transcription of interviews.

Confirmability corresponds to the objectivity of the research, ensuring that the researcher is working aside from personal values or bias. It is impossible to be fully objective while researching, but the researcher should be working in good faith.

4 Results

This chapter presents the result, initiating with presenting the main findings. This is followed by presenting the results from the document review, the observations, and the surveys. Thereafter, the interviews are presented in the following order; operators, production managers, production engineer and production technicians, and lastly, the engineers at ME. Lastly, an ongoing project, aiming at simplifying the OIS's and WES's, is presented.

4.1 Issues

An overview of the identified issues are shown in Table 4.1. The reasons for each issue will be explained later in the chapter. The issues originating from the highest number of sources are; *Shop-floor culture*, *Instruction layout*, and *Poor ergonomics*. Although, three main issues were decided based on the results; *Communication*, *Culture*, and *Instruction layout*. The main issues were found to be the sources of all issues listed in Table 4.1.

Table 4.1: Main issues found, data sources mentioning them, and sections in the result were they can be found.

Issues	Interviews	Observations	Surveys	Documentation	Section
Communication ME/plant	X				4.7, 4.8
Communication Production manager/Operator	X		X		4.5
Culture ME/Plant	X				4.7,4.8
Shop-floor culture	X	X	X		4.5
Translation of PII to WES/OIS	X			X	4.2, 4.7
Difficult formulation/structure of PII	X			X	4.2, 4.6, 4.7
Training of operators	X		X		4.3, 4.4, 4.5
Change management in production	X		X		4.4, 4.5
Instruction layout and content	X		X	X	4.3, 4.4, 4.5, 4.7

Table 4.2 shows the findings from the interviews, related to the main issues. The text in the table is compilations of what the interviewees stated and no citations.

Table 4.2: Main issues and qualitative findings

Interviewees	Communication	Culture	Instruction lay-out
Manufacturing engineers	Most manufacturing engineers rarely have contact with the process technicians.	The manufacturing engineers are not responsible for the usage of the PII in running production	The manufacturing engineers are uninformed of what a OIS's and WES's are. They use incorrect grammar in the PII's.
Process technicians	The production technicians do not communicate with ME. Also, the production technician at Line X mentioned that the communication between the different plants are insufficient.	They claim that there is a "we" and "them" culture between them and ME, where ME are unaware of the errors following the PII.	There are miss-spellings, incorrect order or words leading to another meaning, and information missing in the PII's. The OIS and WES are too complex and contain too much information.
Production managers	Production managers lack in their communication when changes are made.	Information shared by the production managers regarding the operators training period, did not correlate with the operators' experiences.	The production managers mentioned that the WES's are confusing. Also, they mentioned that important information could sometimes be missing in the PII's.
Operators	When changes are made, the operators feel that they are not correctly or sufficiently informed by their production manager and team leader. Further, the operators receive different information on how to work a work station depending on who trained them.	The culture at Line X allows the operators to deviate from the instructions.	The operators mentioned that the instructions are difficult to read, and too complex compared to the operations performed in reality.

4.2 Document review

Volvo Cars' intranet and internal databases enabled the formation of fictional examples of a PII, an OIS and a WES, see Figures A.2, A.3 and A.4.

The PII review revealed incorrect formulations of the operation texts. The grammar is frequently incorrect, e.g. Swenglish formulations and several texts include incorrect language semantics where the meaning of a sequence of words changes when put in another order. An example is the word sequence ”*Tighten one component screw according to specification*” based on a real PII text. The word sequence implies that the screw is a *component screw*. When reviewing the pictures and the WES including the operation, the correct formulation of this specific PII operation text should be ”*Tighten one screw to the component according to specification.*”.

Further, if the manufacturing engineer wants to comment on something in the PII, they add a note in the database used at ME. When reviewing the databases, the note is only accessed through ME's database and not through the production's database.

Out of seven reviewed PII's, three have incorrect grammar. Also, different types of words are used for describing the same thing, e.g. ”instructions” and ”specification”. In the examined OIS's and their associated WES's, the Swedish translations are incorrect for 6/7 PII's. As an example, one PII used the term *fitting* to describe assembling a component. Another example is the usage of ”*inner structure*” to describe a hole. Additionally, the word ”*bow*” is used to describe an arc. Further, inconsistency in setting key symbols for equal WES's, i.e identical operations, was identified.

4.3 Observations

The data gathered from observations are presented in graphs. One graph for each work station, see Appendix A.1, and one for all work stations combined, see Figure 4.1 and 4.2. The data is divided into two different focus areas; the execution order of the operations, and the correctness of each performed operation. Further, the operations have been divided into; operation, and critical operation. Were a *critical operation* means that a key-symbol is connected to the operation.

The order in which the operations have been executed can be correct or incorrect. For example, for a sequence A B C D E, performed A E B C D, one operation is incorrect and four are correct.

The correctness of each performed operation has been categorized by three outcomes; correct, skipped, or incorrect. Skipped implies that the operator skipped an operation, and wrong is when the operator's performance of the operation differs from the instructions. Notable is that the two focus areas are not related to each other, i.e. an operator could perform an operation correctly, but in an incorrect order.

The OIS's and WES's connected to the observed work stations, and thus used for comparison to the work performed by the operators, cannot be shown due to confidentiality.

The result from the observations showed that the deviation most frequently made by the operators is to switch the order of the operations. It could also be seen that some steps were skipped, those skipped operations were often preparatory work, e.g. greasing a component to easier attach it to the product. The operations which were performed wrong were most often related to the usage of a helping-tool. Further, almost all of the critical operations were done in the correct way, and order.

4.3.1 Observed operation order

The result from each work station is shown in Figure A.5, A.6, and A.7.

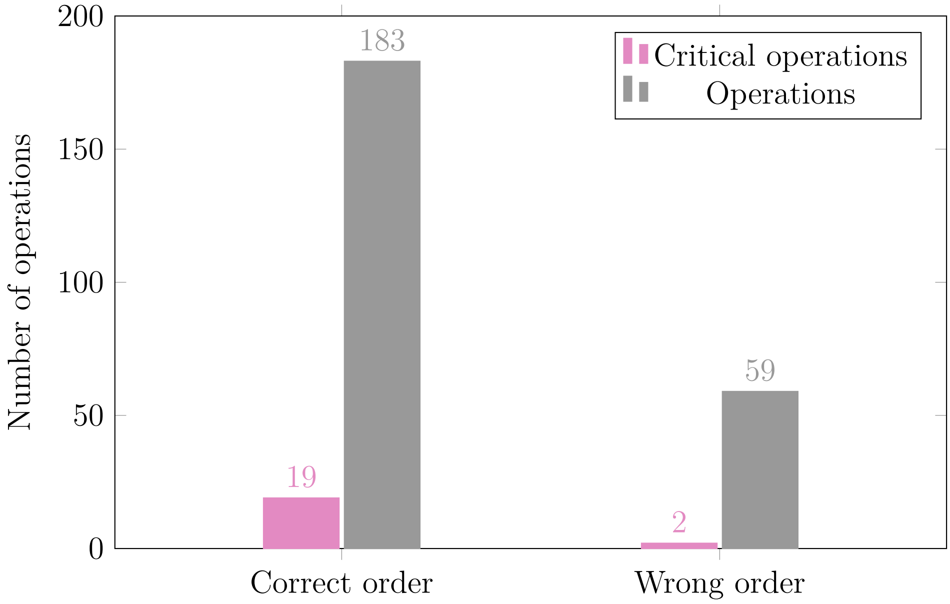

Figure 4.1: Observed order from observations, all three work stations combined. Correct order means that the operation was done in correct series according to the instructions.

4.3.2 Observed performance of the operations

The result from each work station is shown in Figure A.8, A.9, and A.10.

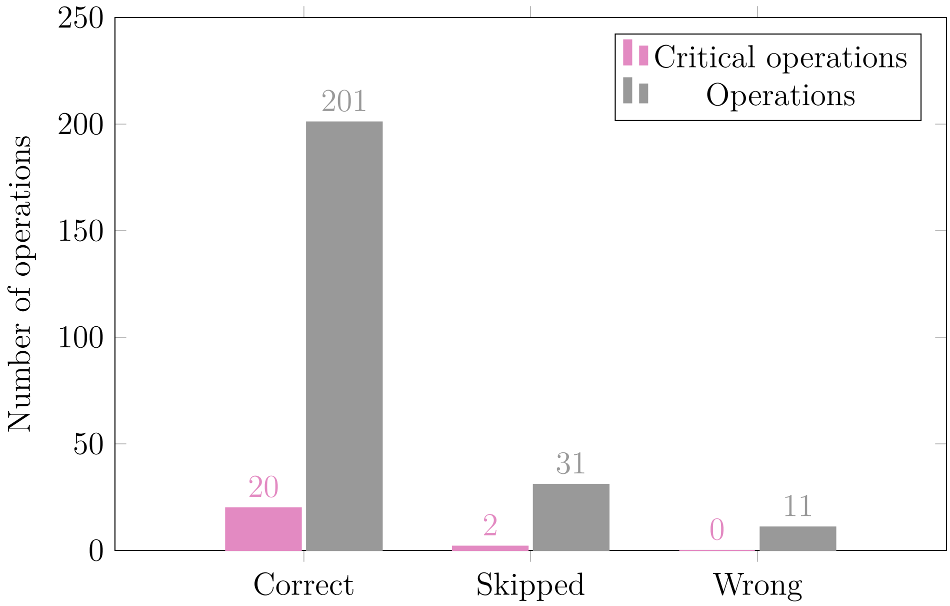

Figure 4.2: Observed operational performance from observations, all three work stations combined. Skipped implies that the operator skipped one of the steps in the instructions, and wrong means that the operation was executed incorrectly.

4.4 Surveys

The results from the surveys are presented in tables and figures. It was possible to follow what each of the operators answered in the surveys and thereby patterns were found. Patterns found from the answers in Survey 1 and 2 are presented in text, related to each survey. Although, patterns between Survey 1 and 2 were not possible to identify.

The result from the surveys showed that the operators to a very little extent use the instructions. A lot of them did not know what they were called and many of them were not motivated to read them at all. Although, it was also recognized that most of the operators believe that they follow the instruction almost perfectly, and all of them prioritize quality over time. When asking the operators what they value the most they ranked *Following the instructions* the lowest together with *Not stopping the line*, the operators value *Ergonomics* the most.

There was discontinuity when the operators were introduced to the instructions during their training period, see A.12, and the training period could influence the operators' general usage of the instructions after the training period. Change management relates to how often the operators read the instructions, and if they are encouraged to read the instructions, both factors have shown to have defects. The shop-floor culture relates to the survey-results as the operators seem to have a collective attitude towards the instructions; they do not read them, they prioritize them the lowest, and a majority of the operators answering Survey 2 claim to deviate from the instructions. Further, this could also be connected to the layout of the instructions, as it might affect the poor usage of them.

4.4.1 Survey 1

Out of the 50 copies, there were 29 responses. Survey 1 includes quantitative data and therefore the data from Survey 1 will be presented in figures. The questions asked in the survey were divided into two categories, and the answers are shown in Figures 4.3, 4.4, A.11, 4.5, A.12, 4.6, 4.7, 4.8, where the figure texts show the questions asked in the survey. For survey figures not presented in result, see Appendix A.2.

General knowledge of the instructions

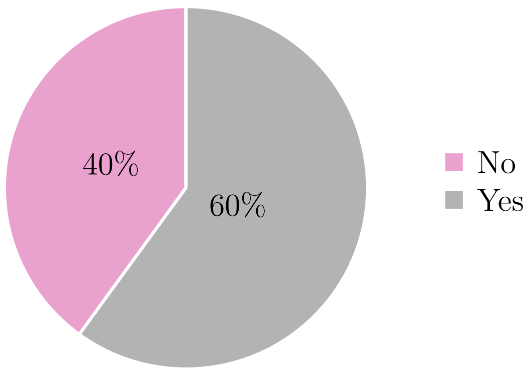

Figure 4.3: *"Do you know what a OIS is?"*

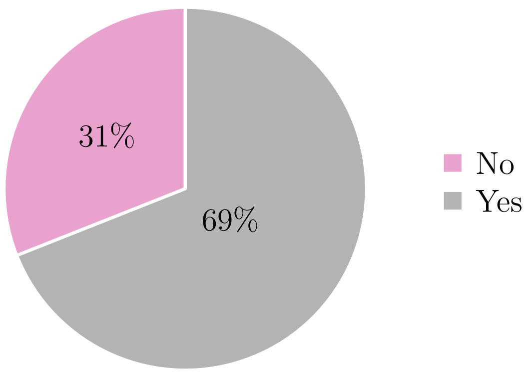

Figure 4.4: *"Do you know what a WES is?*

Some patterns regarding the general knowledge of the instructions and number of years worked in the factory can be made. The operators employed for more than 5 years have a greater knowledge of the OIS's and WES's; 80% (12/15) know what an

OIS is, and 86% (13/15) know what a WES is. Out of the 15 operators employed for less than 5 years, 40%, know what an OIS is, and 46% know what an OIS is.

Usage of the instructions

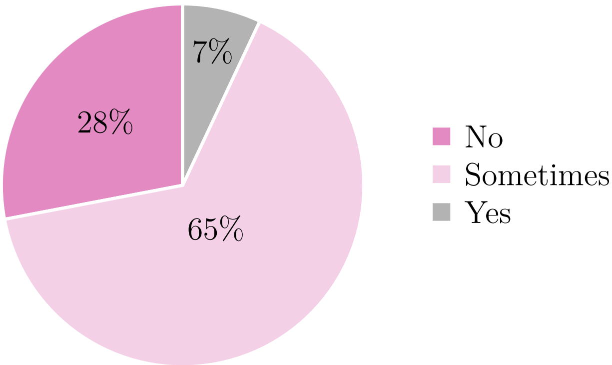

Figure 4.5: *"Do you have time to read the instructions?"*

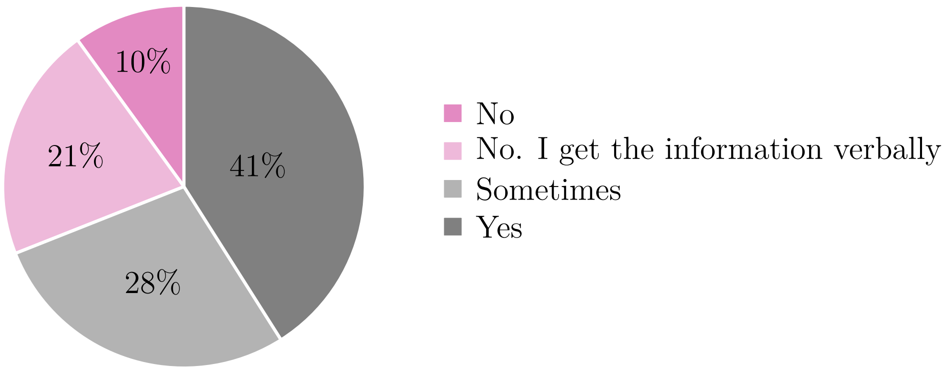

Figure 4.6: *"Are you encouraged to read the instruction?"*

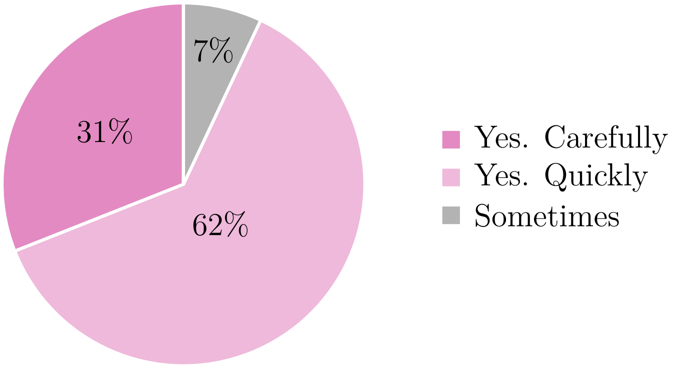

Figure 4.7: *"Do you read the instructions when you are told to?"*

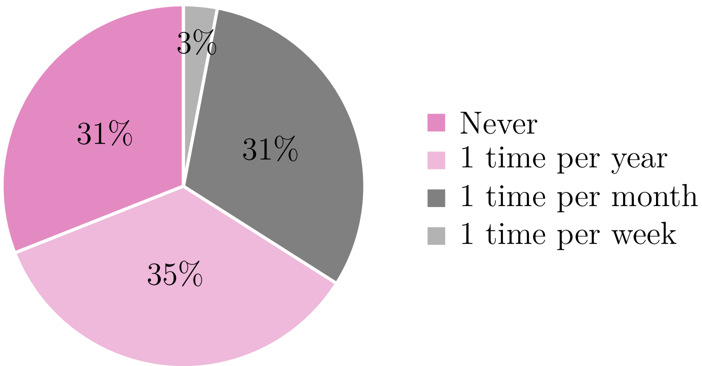

Figure 4.8: *"How often do you read the instructions?"*

Some patterns concerning the habits of reading the instructions were investigated. Firstly, 31% (9/29) never read the instructions. Out of those, five operators claim to never be encouraged to read the instructions, constituting 17%. There are no patterns between the frequency of reading the instructions and the time of employment. Secondly, out of the 35% (10/29) who read the instructions once a year, four operators read them carefully, the rest reads them quickly. Out of those, nine operators feel that they have, or sometimes have, time to read the instructions.

4.4.2 Survey 2

The second survey was sent to the production managers within Line X and resulted in 25 responses. The quantitative data from Survey 2 is presented here.

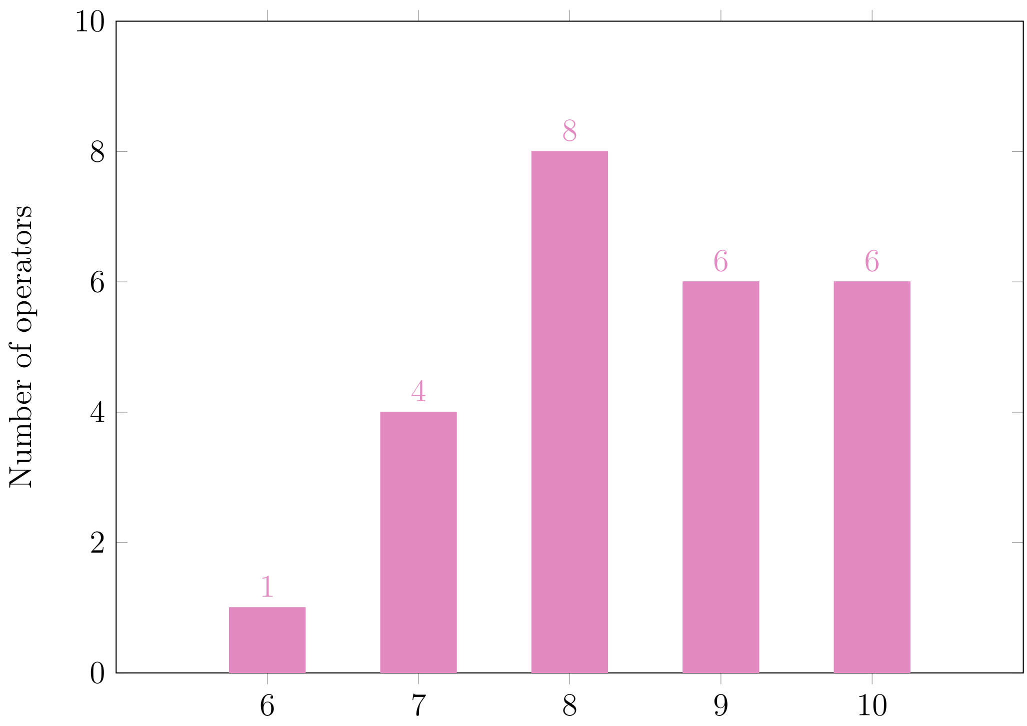

Figure 4.9: *"To what degree do you follow the instructions?"* Scale from 1-10, were 10 means that the operator thinks he/she follows the instructions completely

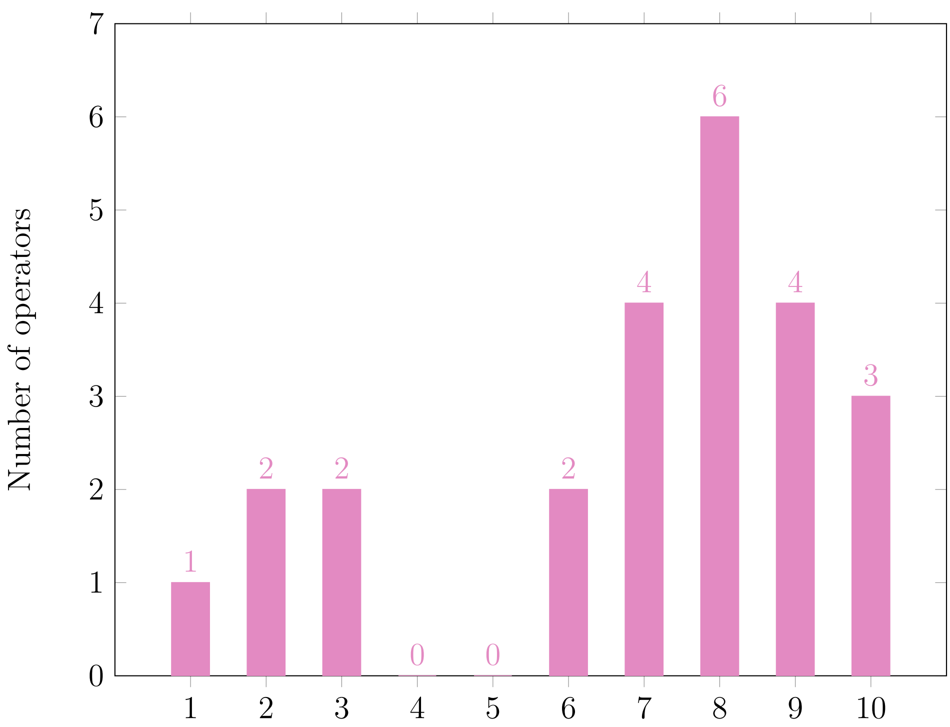

Figure 4.10: *"How do you prioritize time on a scale from 1-10?"*

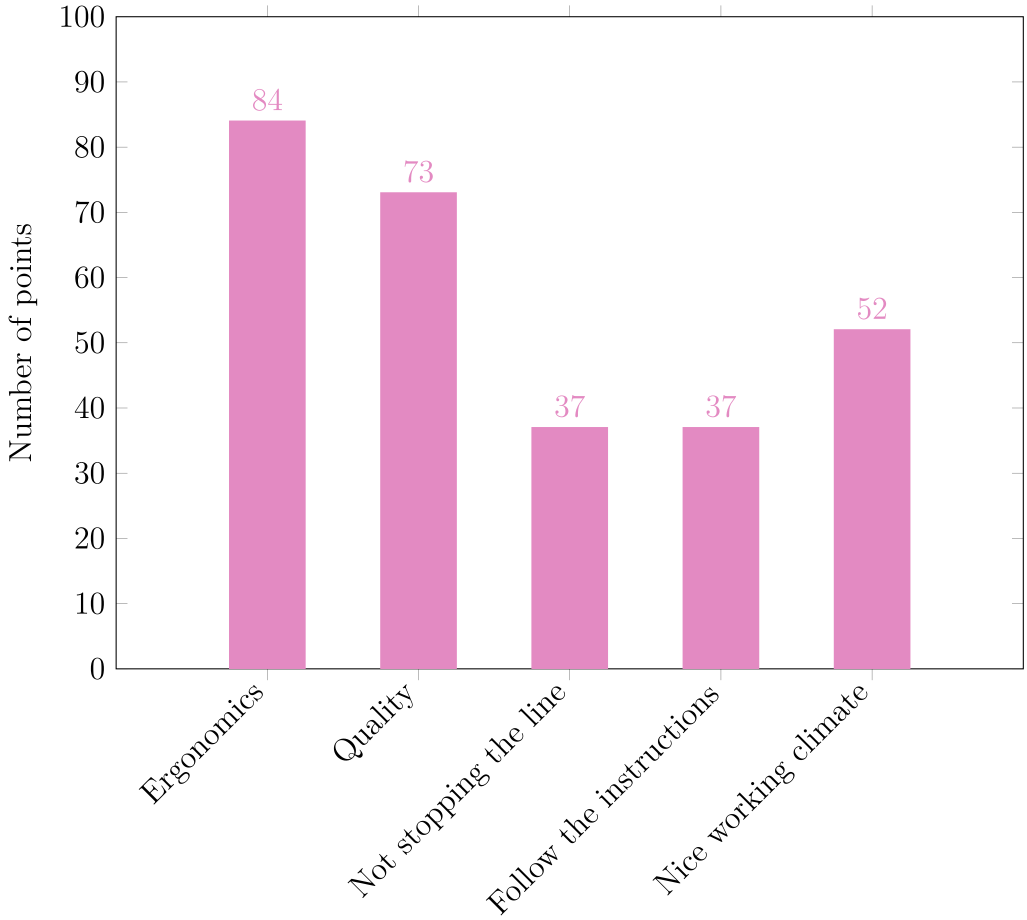

Figure 4.11: *"What do you think is most important? Score 1-5. Give 5 points to the think you value most, and 1 to the thing you value least."*

The answers from the qualitative questions in survey 2, see D.2, have been translated into quantitative data, see Figure 4.12. The categorization of citations can be found in Table E.2.

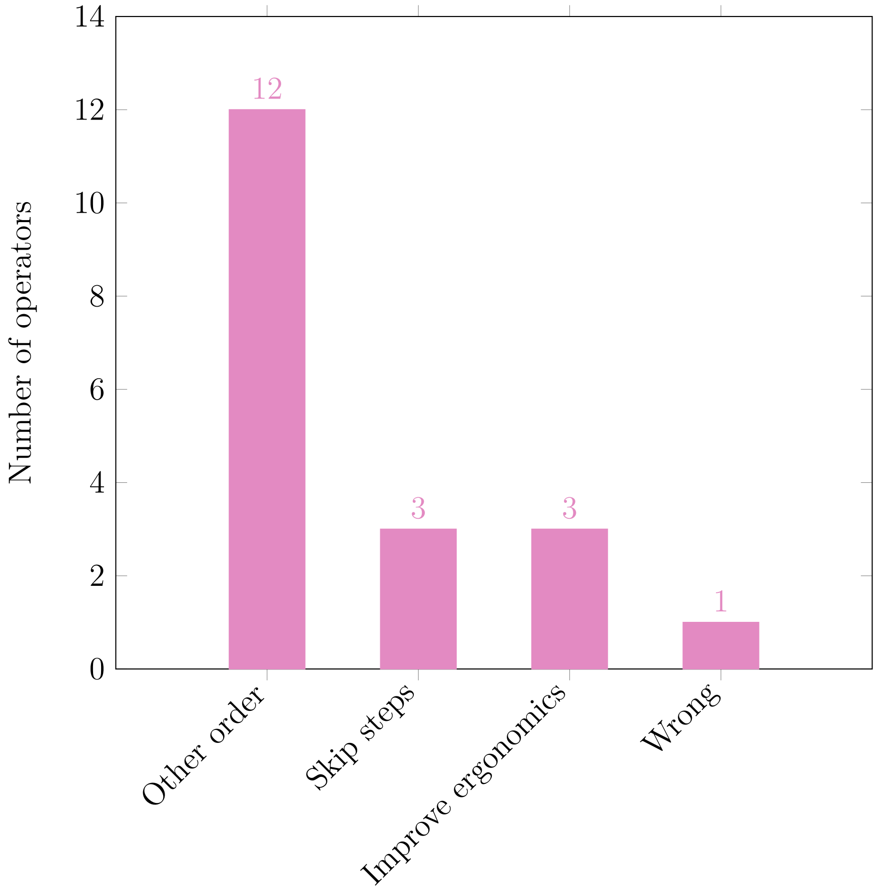

Figure 4.12: Deviations from instructions mentioned by operators, Survey 2

4.5 Operator interviews

Based on the answers from the interviews, three main problem areas were discovered; Human attributes, Instructions, and Work culture and organization. Those areas were categorized based on the interviews and used to perform the KJ-analysis.

The collected answers from the interviews showed that the culture within Line X allows the operators to deviate from the instructions. There are several reasons for deviating from the instructions; avoiding falling behind, or due to injuries, or other. The operators also mentioned that they rarely read the instructions and that the instructions are useless if you are correctly taught from the beginning. Though, the ”correct way” might be unclear, as operators mentioned that everyone has their own way of working. Also, the operators stated that the method differs depending on who your supervisor during the training period.

The general opinion regarding the instructions is that they are too long, too complex and that they do not reflect the reality. Some operators stated that the instructions are impossible to follow and that the structure has to improve to make them understandable. Another problem mentioned by the operators was the current change management. A majority stated that the information regarding new or updated instructions never reaches the operator until the very end, where they have little or no time to learn the new working method, i.e. read the instructions.

The operator interviews are available in Appendix B.1, and the transcriptions of the interviews are available in Appendix C.5.

4.5.1 KJ analysis

In total, 69 citations have been extracted from the interviews, and they are all connected to the unsuccessful usage of the instructions. The category *Human attributes* contains 17 citations, *Instructions* contains 21 and *Work culture/organization* contains 31. Citations used to conduct the KJ-analysis can be found in Table E.1.

Human attributes

Human attributes includes all citations where the interviewees refer to their behaviors, or to their personal experiences. Each citation is given a number, corresponding to the number in Table E.1. The subcategories are; Motivation, Injuries, Training period, Habits and Falling behind.

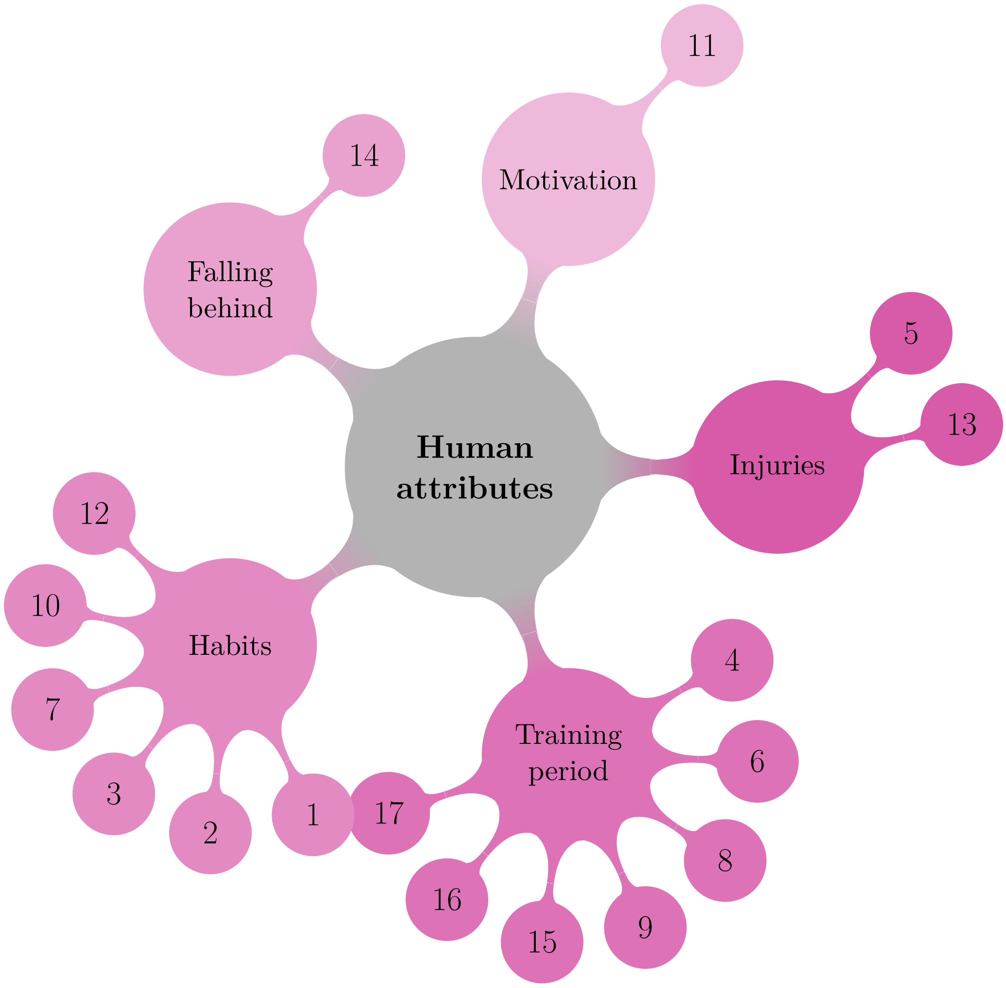

Figure 4.13: KJ-analysis, Human attributes. For citations see E.1

Both *Motivation* and *Falling behind* had one citation each. The citation connected to *Motivations* states that the operator is not motivated to read the instructions since the folder is too large. For *Falling behind* on operator said that operators tend to mix the order of the operations when they are falling behind to gain time.

"Sometimes when you are falling behind you tend to do the operations in another order to catch time."

Next is *Injuries*, including two citations. Both citations contain information where the operators need to adapt to their work due to injury. Both mention that they had to find their own way of working to ease their workload.

"I have back pain and I, therefore, have my own way of doing things. My way is easier."

The third category is *Habits*, including six citations. All citations include aspects connected to habits, where the operator deviates from the instructions. Habits mentioned were; bring tool when you are not supposed to, skip steps in the instructions, having own working methods, and other deviations to make the work easier.

"Sometimes I skip some steps in the instructions when they're not needed."

"Some work stations are hectic and therefore I bring the tool with me."

The subcategory with the highest number of citations was *Training period*, including seven citations. Those citations contain a series of conflicting statements regarding the *Training period*, and they all state quite different things. Four of the operators mention that they were introduced to the instructions after their training period when they were ready to work independently. The other citations contain statements where operators had to be trained by several different operators, due to staff situations.

"I've learned different work methods depending on the supervisor, everyone works differently."

Instructions

Instructions includes citations where the interviewees mentioned insufficient features of the physical instructions. The subcategories explain what part of the instruction that the operator believes to be insufficient or in need of improvement. Subcategories are; Incomprehensible, Pictures, Complexity, Structure, and Text.

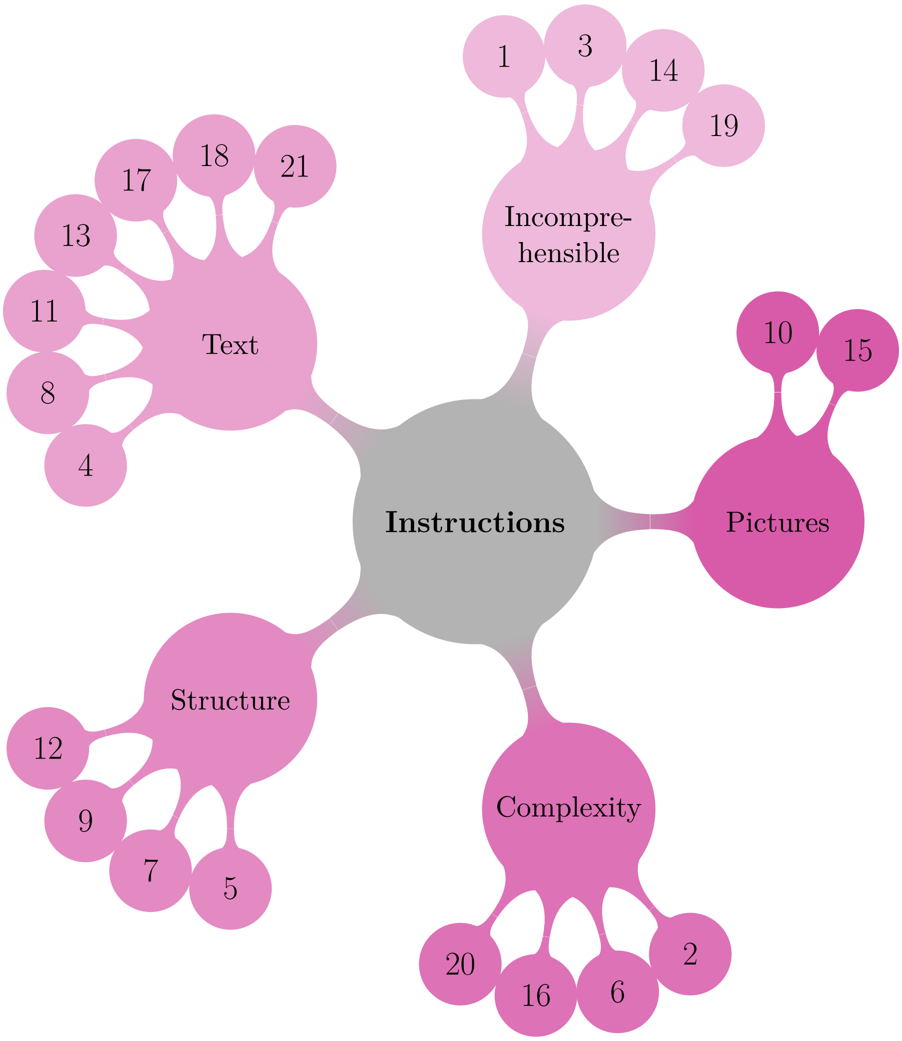

Figure 4.14: KJ-analysis, Instructions. For citations see E.1

The subcategory *Text* has the highest number of citations; seven. Most of the citations include criticism regarding that time intervals are incorrect, two operators mentioned that the intervals are impossible to work after and that the instructions do not correspond to reality. Two other operators mentioned that the texts in the instructions are very hard to read, especially for new operators. Finally, two citations were regarding specific features missing in the instructions; ergonomics and resting.

”You read the instructions in the folder but they’re not correct, the folder is too big, it’s not applicable to the reality when you assemble”

Structure got a total of four citations. Two out of those were comments regarding the mixture of car-models, where one OIS might include two car models. If the operations differ between the models, each car model should have an OIS, instead of mixing them. Further, different OIS’s and WES’s might have identical operations. In those cases, the WES’s and OIS’s could be merged into one shared instruction, instead of having several identical ones. Another citation was regarding the mixture of language, the PII text in the instructions are in English, and the text added by process technicians and production managers are in Swedish. One operator thought it could be easier to understand if the languages were not mixed. The final citation regarding *Structure* was that the overall structure in the instructions needs to be better in order to fully understand them.

”The instructions should have a better structure to make it easier to read and understand.”

Incomprehensible also got four citations connected to it. All citations state that the instructions are hard to understand and read. One operator said that the instructions at Volvo Cars are more difficult than at competitors. Another operator mentioned that the instructions might be easy to understand for those who wrote them, but not for the operators who use them.

”Volvo’s instructions are actually very difficult to understand, especially when comparing them with a legible instruction.”

The citations connected to *Complexity* contained statements where operators thought the instructions were too complex compared to the work they perform at the work stations. One operator mentioned that it was impossible to work according to the instructions, due to their complexity. Another said that it was hard to know what to focus on, that they contain too much information on a small space, see Figure A.4 and A.3 for examples of a WES and an OIS.

”I could never be able to learn to work according to the instructions. Not a chance in the world. They are too difficult and complex.”

”There is a lot of information in a small space.”

Lastly the subcategory *Pictures* got two citations. One of the operators said that some of the pictures used in the instructions are not updated, and another mentioned that there should be more pictures and less text.

Work culture and organization

The citations placed in category *Work culture and organization* were regarding deficiency in the behavior, leadership or work organization. The subcategories chosen are; Injuries, Shop-floor culture, Training period, and Change management.

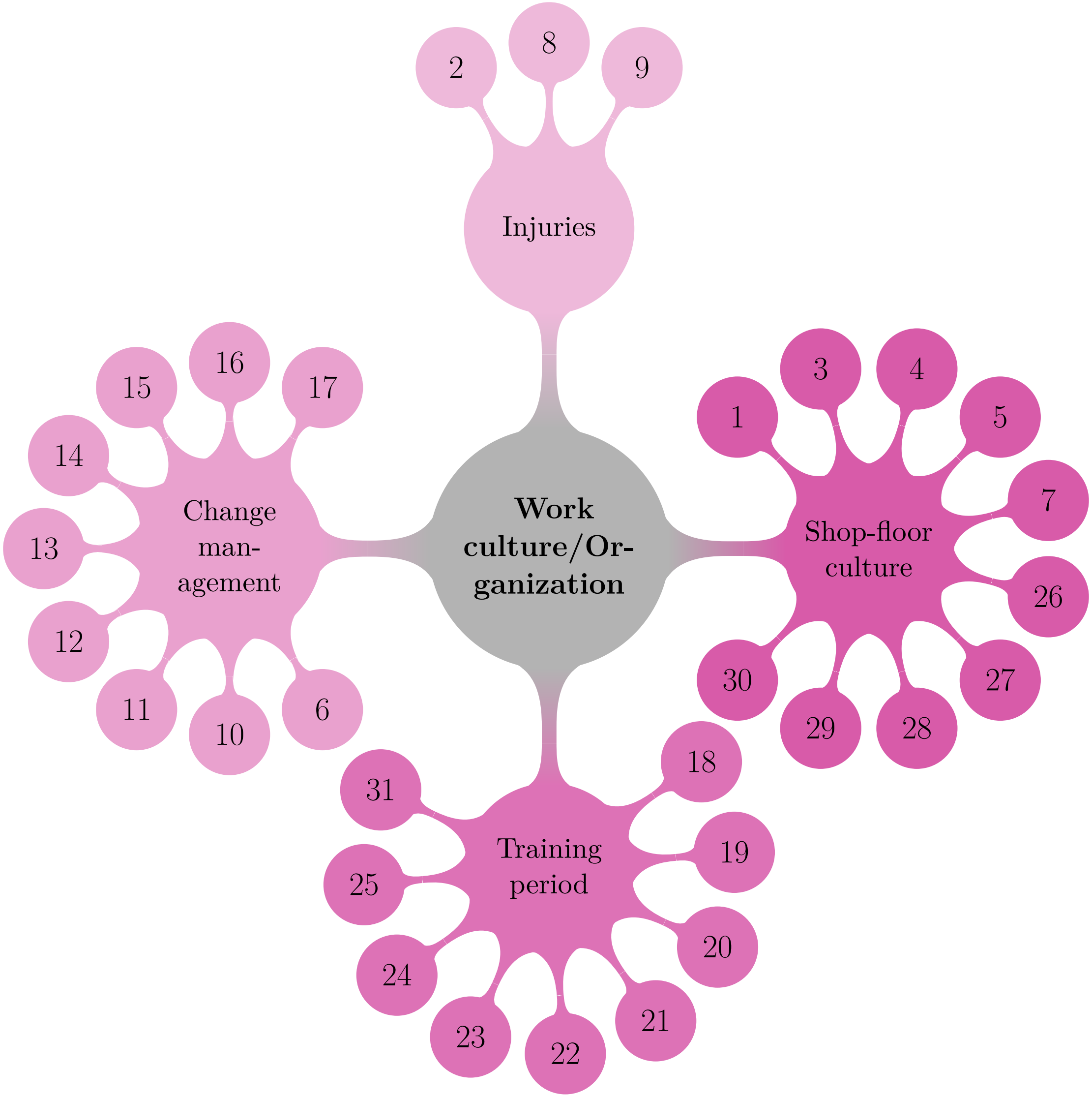

Figure 4.15: KJ-analysis, Work culture and organization. For citations see E.1

The subcategory with the highest number of citations was *Shop-floor culture*, having ten citations. Some citations were regarding falling behind and how the operators handle that situation. They mention that they might need to improvise and that you as an operator do not want to fall behind.

> **"There are several occasions where we have to improvise. I'm not supposed to say it, but if you fall behind, you'll have to fix it during the given amount of time."**

Other citations contained information were the operators mentioned that they deviate from the instructions. Two operators stated that everyone has their own way of working, and a third said that you need to work according to the standard when your boss is watching. A fourth operator mentioned that operators have their own way of working, but there is no systematic deviation from the instruction at Line X. One operator also argued that the instructions are unnecessary as long as you are taught the correct method.

> **"As long as you're taught the correct method, the instructions in the folders are unnecessary."**

Second is *Training period*, with a total of nine citations. The citations were mainly regarding the training period process and the introduction of the instructions. Several operators mentioned that they were forced to work alone during their training period due to a lack of staff. One operator mentioned that they were allocated to one work station for a long period of time since the operator only knew that the work station and there was no possibility of training. Another operator also mentioned that there should be more time allocated for beginners to learn. Also, one operator stated that they had learned different methods depending on whom they had as a supervisor.

> **"I've learned different work methods depending on the supervisor, everyone works differently."**

The citations regarding the introduction of instructions all state that they were introduced after the training period, or when the operator was ready to work independently. One operator mentioned that they were told to focus on the key symbols when reading the instructions.

Change management also got a total of nine citations. Several citations concerned the time operators get to read the instructions after a change. All three operators stated that they did not get any information about the re-balancing and that they had little, or not time to read the instructions before they had to work accordingly.

> **"Sometimes changes are implemented overnight without informing the operators, so when we start working we are expected to learn the changes within a second."**

The other citations were regarding the update of the instructions. One operator mentioned that the instructions are not always updated after re-balancing, and another mentioned that the verbal information given to the operators can differ depending on whom you get the information from. Lastly, one operator said that it is difficult for changes to happen.

> **"It takes a lot for a change to happen around here."**

Lastly *Injuries* got three citations. They all include a statement regarding the difficulty to be transferred to another place, adapted to the person's injury. The operators mentioned that some persons get transferred, it depends on the staff situation. Another operator mentioned they talk to their co-workers to switch the work station, instead of their boss.

4.6 Production manager interviews

During the pilot study, two production managers responsible for Line X were interviewed. The purpose of the interview was to get an understanding of the WES's and OIS's, and their work tasks.

The answers from the interview have been summarized and put into relevant categories. To view the summarized interview, see C.4.

4.6.1 Responsibilities

Each production manager is responsible for one line, including several work stations and teams of operators. The production managers each have an office connected to their line. The production manager's main responsibility is ensuring that the lines can run continuously and that there is enough staff during the shift. They are also responsible for the new operators' training period, some of the text in the WES's and the introduction of new instructions to their lines.

In the WES, the production manager is responsible for two sections of the text. The first sections include a simplified explanation of the operation, and the second includes the reasons for executing the operation, see A.4. The production manager formulates these texts according to their preferences and interpretation of the operation.

4.6.2 Change management

The team leaders, managing one team of operators, are responsible for informing the operators when new WES's, OIS's or other changes are implemented on their line. When new WES's and OIS's are introduced, it is highly important that the operators are properly informed. To ensure that the operators have understood the changes, the production manager prints an "information-sheet" where the operators sign-off that they understand. Occasionally, the production manager gives verbal information instead and thereby skips the information-sheet.

Further, the production manager is responsible for the training of new operators. According to the production managers, the training period begins with the operator reading the instructions, i.e. the WES's and OIS's. If the operator has any questions, they ask their team leader, and the team leader can extend the question to the production manager if necessary. The next step includes the practice of the operations performed at the work stations during running production, with a skilled operator as a supervisor. When the new operator is able to work independently, the operator and the production manager sign a paper, stating that the operator is approved for working on the work station alone.

4.6.3 Issues regarding the PII's

The production managers state that the PII's are often difficult to understand. They mention that important numbers are frequently missing in the PII. These numbers include; the article number on tools needed for a certain operation and the ”drawing-number”. In many cases, pictures are missing as well, making it difficult to understand the operations. Further, the WES's are often confusing, and difficult to understand. When unable to understand a PII, the production manager contacts their process technician, and the process technician contacts the responsible manufacturing engineer, if needed.

4.7 PcE and PcT interviews

PcE is short for process engineer and PcT is short for process technician. This section includes the interviews with two process technicians from the pilot study, the process technician responsible for Line X and the process technician and process engineer executing a project aiming at improving the WES's and OIS's.

4.7.1 Responsibilities

The process technician works as a link between ME and production. They search the PII operations for errors and make sure that they are adaptable to production. The OIS is developed by the process technicians, where WES's and non-value adding operations, such as walking, are added. The WES's are mainly written in Swedish and the process technician is responsible for translating the PII's operation texts into Swedish. For the translation, the technician is not allowed to use Google Translate or other helping tools to translate the entire text, though it is acceptable for single words. Ergo, the translation of the PII will reflect the process technician's individual interpretation, mentioned by the process technician at Line X. The process engineer stated the opposite and claimed that the translations have to be literal, to protect the process technician from the responsibility of any issues. The technician might also receive feedback on their translation and change it if necessary. If the technician believes that equal operations for different car models are identical, they will copy-paste the written text.

Further, the process technician is responsible for balancing the operations in the PII. When balancing, they must secure quality and evaluate the need for purchasing additional tools. The balancing of operations is concurrently decided by the process technician, production manager, and safety officer, where the responsibility is equally divided. If the technician wants to re-balance work stations, they must communicate with the safety officer and the production manager and concurrently decide on the re-balancing of operations.

4.7.2 Issues regarding the PII's

All interviewed process technicians and the process engineer mentioned that the PII's are difficult to understand. Frequently, information is missing in the PII's; *"Best case scenario, the PII includes all necessary information plus pictures, but they are generally incomplete"*. The process technician for Line X also mentioned that the estimated time set for identical operations can vary. The process technician argued that the manufacturing engineers have poor internal communication; *"There are different owners of different PII's, and they do not talk to each other. Even if the operations are identical, they have different time estimations."* In some cases, the estimated time is incorrect. When this occurs, the technician has to contact the manufacturing engineer. If the manufacturing engineer agrees on the need for change, the manufacturing engineer then contacts the time setter. The time setter then has to validate the time in production, and thereafter the technician can rewrite the OIS. Further, it is possible for the manufacturing engineer to change the time without informing the process technician or sending any sort of notification. It is therefore quite common that time estimations are changed without anyone knowing about it. The process technician mentioned that this sort of thing happens every week, where process technicians find changes in the time estimations without being informed.

Further, the process engineer and one process technician mentioned that the PII's are frequently designed in a way that makes them impossible to adapt to production. According to them, it is obvious that the manufacturing engineers are unaware of what a WES is and how production applies to their PII's. Occasionally, the PII's operations are completely impossible to balance and thereby the increased complexity of the work stations requires additional workforce. When this occurs, the company has to hire operators.

"If there are errors from the initiating state, the errors are likely to follow. It is quite difficult for us to identify all errors when reviewing the PII's. Especially if the quantity of PII's is high, for example when a new car is introduced. It is a higher risk that the errors follow then. All steps are like pillars to a house; if one falls, the entire house collapses."

An additional issue is the communication when problems emerge. When the process technician detects an error they will, as mentioned, contact the manufacturing engineer. The process engineer mentioned that manufacturing engineers frequently refuse to correct the errors due to the complexity and time consumption required to make the change. *"It doesn't work, ME is like; the drawings are locked, they can't be changed, you should have mentioned it earlier"*. The main problem with this statement, according to the process engineer, is that several errors are difficult, or near impossible, to detect before implemented in running production. Further, several errors might pass due to the high workload on the process technicians.

Another factor mentioned by the process technician at Line X is the note in the PII, which is written by the manufacturing engineer if they have any comments related to the PII. To view the note, the technician has to open the PII in the database for ME. Also, if the manufacturing engineer decides to change the note or something else, for example, the time settings, the technician does not get notified.

To find any changes in the PII's, the process technician has to review all the PII's every day.

Further, the process technician talked about the key symbols, indicating if extra precaution must be taken for a WES. The key symbols are decided by the team leaders and are placed in the OIS and the WES. Occasionally, identical operations for equal work stations have had different key symbols. According to the process technician at Line X, this might be due to the lack of communication between team leaders. According to the process technician at Line X, the team leaders should concurrently decide on which operations should have key symbols.

There is a project going on in production where they are trying to change the structure of the OIS to make it more readable, lead by the interviewed process engineer and one of the process technicians. In their study, they argue that the key symbols ergonomics, critical operation, and quality control should be decided by the manufacturing engineer and thereby follow the PII.

4.7.3 Organizational issues

A significant part of the issues mentioned by the technicians was connected to when changes are made in the PII's. The changes can be made with short notice, even the same day, due to mistakes made by the manufacturing engineer. The technicians also have problems allocating those changes; *"The technicians spend a lot of time trying to find where the changes have been made. They need to simultaneously review two documents, the old PII and the new PII, and compare them to identify the change. Earlier, it was even worse, but it is still not good"*. The process technicians state that it has improved since ME introduced the "buddy-check", meaning that the manufacturing engineers check each other's PII's.

If the process technician has questions, ideas of adjustments or remarks on the PII, they need to contact their local ME. If it concerns a small change, the process technician is not required to go through ME, but can instead contact the other plants, i.e. the plants in China, USA and the one in Gent. *"If I want to make a small change, I do not need to go through ME. Although, I need to reach an agreement with all the other plants regarding the change. This means that I need to find the technician for Line X in all of the plants, and we need to agree. This process is always very difficult, especially since China rarely responds."*

4.8 Engineers at ME, interviews

During the pilot study, and the initial interview with a technical leader at ME, issues connected to the PII emerged. The manufacturing engineer will ensure that the developed PII fits the Bill of process. When this is done, the PII is sent to the factory and the engineer does not need to contact the plant thereafter if the change made in the PII is minor, and the release time is correct. Before becoming a global company, with several plants located around the world, the contact between ME and the plant in Torslanda might have been more frequent. Today, due to the high number of plants, it would be inefficient and time consuming for the manufacturing engineer to contact each plant. Further, contacting one plant, e.g. Torslanda, would be unfair to the other plants in China, Belgium, and the USA. The technical leader also mentioned that there might be manufacturing engineers who are unaware of what an OIS and WES are, and what they look like, they are trained to solely learn what a PII is and their connections to OIS and WES.

At ME there is a ”buddy-check” between the manufacturing engineers, which means that the manufacturing engineers check each other’s PII before they are sent to production. The buddy-check includes several questions that are meant to guide the review of the PII, although this buddy-check might not be used by the manufacturing engineers, especially not when the PII needs to be done quickly.

According to the technical leader, the PII’s are global and should, therefore, be applied to all the plants. If one plant has opinions on the PII’s or wants to make an adjustment, they have to align with the rest of the plants and commonly decide on the changes. If the plants have agreed, the manufacturing engineer reviews the request evaluates its feasibility and thereafter changes the PII. Although, if an obvious fault is found, the single plant can request a correction of the PII.

The technical leader mentioned that there might be issues in production, regarding the usage of the instructions. Although ME is not responsible to secure that the PII method is followed by the operators, the PII method is the valid one.

At a later stage in the project, though still as a part of the pilot study, an interview with a process manager was performed. The main aim was to receive feedback on the life cycle of the PII, but additional information emerged. According to the process manager, the launch of new car models requires the manufacturing engineer to inform the plant about the changes six weeks before the implementation, while continuous changes and improvements require two weeks or seven working days. If the time regulations are infringed, the manufacturing engineer receives a remark. Further, if a process technician discovers any issues in the PII, they are supposed to contact the manufacturing engineer.

4.8.1 Local and Global ME

According to one of the managers at ME, the division of ME into global and local is in need of improvement and requires further work. Firstly, allocating tasks to global and local ME is quite difficult and there is frequently disputation on the division of responsibilities. When trying to discuss the allocation of tasks, the feeling of having a second rate team emerged and led to upset emotions. Further, the confusion on responsibilities has led to distrust in the other part.

4.9 Project: simplified OIS’s and WES’s

Within Plant C, a project regarding an update of the OIS’s and WES’s is currently being executed. The project is performed by a process engineer, Joakim Andersson, and a process technician, Nathalie Rasmusson, aiming at simplifying the OIS’s and WES’s.

The project suggests several changes to the layout and content of the WES's and OIS's. Initially, the PII text is removed and the language is solely in Swedish. Instead of having a translation of the PII text, the project aims at reformulating the text to a simplified and clearer description of the operation. Further, the TMU is removed and the only time setting available for the operators should be in seconds.

The improved versions of WES's and OIS's suggest a new system for setting key symbols, where the symbols are updated. They propose that ME sets the symbols relevant for the PII; ergonomics, critical operation, and quality control. The remaining key symbols are either set by the operators or removed. Further, they suggest adding new key symbols where the setting is decided by the operators. These new key symbols are not yet decided.

In the OIS, the current product type numbers are updated and instead of coded numbers, the car model is written. If there is any variance, it is written in the text instead of additional coded numbers.

In the WES, the *HOW* and *WHY* are the central parts. This is due to the fact that these sections constitute the main reasons for operators to read the WES's, according to the process engineer. Further, the descriptive pictures for the operations are uniform and the aim is to simplify the operator's understanding, in contrast to the available pictures in the current WES's.

5 Discussion

This chapter discusses and critically examines the thesis project, the process, and the findings. Throughout the discussion, sustainability aspects are considered. Initially, the project procedure is discussed, including trustworthiness and ethics. Further, the findings are discussed, categorized by the three main issues. Lastly, future work is discussed.

5.1 Project procedure

This section discusses the project procedure, including the methods, sources, and data. The project's trustworthiness is evaluated with the purpose to identify weaknesses and strengths connected to credibility, transferability, dependability, and confirmability.

Further, the sustainability of the project procedure is discussed, with the purpose to evaluate different parts and viewpoints of the thesis.

5.1.1 Trustworthiness

The section is divided into four subsections, according to Guba and Lincoln's criteria, cited by Bryman and Bell [27]: credibility, transferability, dependability, and confirmability.

Credibility

For this project, the methods applied were chosen based on a literature review. All methods are supported by literature gathered through Chalmers Library, Gothenburg University library or databases accessed through Chalmers; ScienceDirect and Springer. Thereby, standard methods for the chosen type of research were applied to the study and strengthened by the literature.

Further, the thesis applied the triangulation method. Having several methods for gathering data, i.e. observations, interviews, and surveys, as well as different types of sources, i.e. manufacturing engineers, production managers, process technicians, team leaders, and operators, enables triangulation. The chosen methods, as well as the sources, were triangulated throughout the project, increasing the credibility in the findings.

As the interviews were held in Swedish, they required translation into English. The translation of the interviews with the manufacturing engineers, process technicians, process engineers, and production managers was validated by having them confirm their statements. If a source did not modify their statements, they were interpreted as correct. Confirmation from the operators was not possible due to the anonymous recordings and transcriptions, and the absence of contact information. To enable the reader to validate the translations, the transcription of the operator interviews are available in Appendix C.5.

When addressing the surveys, the credibility and dependability of the collected data can be discussed. When the surveys were handed out, the process was partly or entirely handled by the production managers. For survey 1, 14 surveys were completed during the interviews, while the remaining surveys were distributed to the team leaders. The second survey was handled in an equal manner, where the production managers allocated the surveys to the different teams. The team leaders were responsible for ensuring that the operators on their team completed the given amount of surveys. While the operator performed the survey, the team leaders worked their work station. Since the operators completed the surveys during their working hours, knowing that the team leader and possibly the production manager could review their answers, there might be partly incorrect results from the surveys. Another aspect is the procedure of handling the surveys, where there is no way of confirming the actual course of the event, or who answered the survey. This is because the process was not monitored or in any way controlled.

A majority of the data sources are working within, or in connection to, Line X. The production managers, the team leaders, the operators and one of the process technicians are employed with the purpose to develop, improve or execute the daily work within Line X. Due to this, the combination of these sources should be considered the expertise knowledge of Line X.

Transferability

The surveys were only sent to Line X and were only answered by the operators working at there. Also, all operators and team leaders interviewed during the project, all work within Line X. The observations were also solely done at Line X. Due to the physical limitation, the collected data only reflect the situation within Line X, which decreases the transferability.

Since they all work within the same line, they perform equal tasks, experience the same type of leadership and see equal issues during their workdays. To get a more transferable result, it is necessary to study several lines within the plant. Also, to get a more holistic view of the company situation, the plants located outside of Sweden should be studied as well.

Dependability

Interviews were held with interviewees from ME and production. Interviewing was the initial method used for collecting qualitative data. Since it was performed before, or simultaneously with, the surveys and observations, some interview questions were missing. This was due to the initially broad and an explorative purpose with the thesis, where several aspects were evaluated as interesting. Therefore, some questions were not necessary and additional questions would have benefited the result. The lack of certain information was compensated by a second survey, though having additional interviews would have been preferred, especially from people working at ME. Though additional interviews would have been beneficial for the project, it was not possible due to the limited time frame.

The interviewees chosen for the pilot study were solely based on recommendations from the supervisor at Volvo Cars. Subsequently, the limitation of Line X was based on the interviewees from the pilot study, where the process technicians helped with choosing a suitable line. Within Line X, the interviews with the operators were randomly chosen by the production managers. The choice of recruiting Line X's process technician for an interview was based on the fact that they formulate the WES's and OIS's at that line. Finally, the interviews held with the process technician and the process engineer designing the new OIS and WES, was held on recommendations from the process technician at Line X. The choice of interviewees was based on recommendations from Volvo Cars employees, or on the interviewee's connection to Line X.

Table 3.2 shows that only a few of the interviews were audio-recorded and transcribed. During all of the interviews, notes were taken, which means that the interviews not recorded are an interpretation of what the interviewee said. The transcribed interviews are written in the original language (Swedish), and the rest of the interviews were summarized in English.

The interviews held with engineers at ME (the technical leader, process manager, and group manager) could have been more structured. Also, the purpose with most of them was to formulate the pilot study, and not address problems related to the instructions or their relation to the engineers working at Plant C. Additional interviews with manufacturing engineers, who write the PII's, would have been beneficial to get a answer or validation to the statements made in production. Therefore it is possible that the study only reflects one side of the problem.

Additionally, an important aspect when discussing the interviews is the feeling of belonging within a group. Within groups, members might express the feeling of dissatisfaction solely to increase the feeling of belonging [9]. This is important to keep in mind when reviewing all the interviews since all interviewees belong to different groups. This was prevented by interviewing the interviewees separately, thereby decreasing the risk of agreeing with colleagues.

In this project, the observations were video recorded due to the high complexity of the work methods. The complexity includes a high variation of product types, each consisting of several variants, high speed and the operator performing several operations simultaneously. Further, the authors have no previous knowledge of Line X and its operations, layout or work stations, which increases the complexity further. Therefore, the observations solely relied on the videos, where the operators might have been affected by the GoPro attached to their heads. Further, some parts of the work methods were difficult or impossible to observe due to a limited picture range. Therefore, the result from the observations might be incorrect due to the inability to observe the entire sequence of operations. As mentioned, the operators might perform two or several operations simultaneously. Due to this matter, and executed operation might thereby be missed and marked as skipped in the results.

Another issue connected to the observations is the fact that the observations were non-participant. Though there are risks with uncontrolled observations, it would not be possible to perform controlled observations since the aim is to reveal the actual usage of the OIS's and WES's.

Confirmability

The thesis was partly based on the working experience of one author. This fact might increase the risk of adding personal values to the research, due to past experiences and personal opinion on the matter. Though, having supervisors at Volvo Cars and Chalmers should prevent the risk of biased research.

An issue connected to the KJ Analysis was the difficulties in placing citations. Some citations could be connected to more than one category or subcategory and were therefore evaluated and placed in the most reasonable one. The evaluation was based on the interview context and the interpretation of the citation. The evaluation might, therefore, be affected by the authors' values, although based on the statements from the interviewees.

Further, the thesis was performed on behalf of ME, where the supervisors are employed within the organization. This might affect the standpoint in some aspects, but should be mitigated by the fact that the thesis is supervised by Chalmers. Further, the supervisors at ME were the initial sources of information and were the ones recommending further sources. Therefore, the choice of data sources is based on recommendations rather than the sources themselves.

5.1.2 Ethics

In this project, there are several aspects possible to ethically examine. Firstly, the fundamental issue of the project, i.e. the instructions, can be ethically evaluated. On one hand, the instructions are helping tools, developed to enable the optimal work outcome, including aspects such as standardized work methods and beneficial ergonomics. On the other hand, these instructions might be redundant, and thereby only generate a waste of resources.

Due to problem formulation, the findings might be controversial since it aims at elevating flaws in the organization. Extensive resources are invested in the instructions and a significant task at ME is the development of the PII's. Questioning the PII's contribution, and thus their existence might raise upset emotions.

Another aspect connected to the controversially of the thesis, and the identification of vulnerabilities, is that these issues might be connected to an individual or a group of individuals. To prevent this, the researched area, along with the interviewees, are anonymous. Further, it is important to point towards a general problem, speaking in general terms, when discussing the identified issues. Therefore, it has been important to critically examine the formulations to ensure that the issues are discussed generally, instead of specifically.

5.2 Findings

This section discusses the main findings from the project with a focus on the identified issues, see Section 4.1. The discussion on the findings is divided by the three identified issues; communication, culture, and instruction layout.

5.2.1 Communication

When reviewing the collected data, one of the identified improvement potentials was communication. Issues connected to communication constitute the source of several problems and misunderstandings, as well as additional, unnecessary work. Poor communication might lead to several unsustainable situations, from economical, social and environmental aspects.

The relationship between the sender and the receiver will affect the quality of the communication [5], and this relationship has been recognized as having several issues. Problems in communication can lead to errors in the organization [4]. Also, since Volvo Cars is a company manufacturing product, *Design for assembly* is important to have in mind, which includes all stages of the development process. If the communication in the final steps fails, so might also the manufacturability [6].

ME and plant

The communication between the manufacturing engineers at ME and the process technicians in the plant are in need of improvement. This was mainly revealed during the interviews with the process technicians, and the process engineer, and it is therefore important to consider the bias in their statements. Although the issues connected to the communication mainly originate from the interviews with the process technicians and process engineers, the technical leader stated that the manufacturing engineers do not need to contact the plants with the purpose to discuss the PII's.

According to the process technicians, there are deficiencies regarding the communication connected to the PII. Communication between two parties is complex and goes two ways. The responsibility in establishing a functioning communication is commonly shared and if communication is lacking, it is likely not due to one party.[5] The interviews with the engineers at ME did not show the same problems with the communication between ME and production, as the interviews with the people working in production. Since the problem only shows from the receiver's perspective, it could be a knowledge clash between the sender and receiver, i.e. ME and production. The knowledge clash appears since the engineers at ME have difficulties in interpreting the PII-text, the manufacturing engineer assumes that the information given is sufficient enough, and therefore believes that the communication is working properly[5]. Poor communication could also originate from the relationship between the manufacturing engineer and the people in production. If one party believes that the other lacks credibility, e.g. the manufacturing engineer might not listen to the process technicians' feedback on the PII, the communication between the two will fail. Although, there are no data collected implying that this is might be an issue.

Poor communication could lead to misunderstandings and incorrect prioritization of work tasks. For example, if the process technician dedicates time for unnecessary work, it will decrease the time dedicated to the more important tasks, i.e. value-adding tasks such as improvement work. The unnecessary work could include the investigation of differing time estimations for equal operations or trying to understand operation texts. In the long run, it leads to inefficiency in the process development. Inefficiency will negatively affect the cost and thus lead to an economically unsustainable situation. Another example is the manufacturing engineer spending time trying to understand production and how to adapt their PII. Instead of spending time trying to figure it out by themselves, they could contact the process technician and discuss the formation of the PII. This is resource-efficient, since the explicit knowledge of the process technician is transferred to the manufacturing engineer, potentially saving a lot of time. Also, and highly significant, this could strengthen the relationship between ME and production.

The defects in the communication could also result in knowledge-based mistakes [24] made by the process technician. If information is presented in a non-sufficient way, the process technician might interpret the information incorrectly and make a knowledge-based mistake. Further both the manufacturing engineers and process technicians set "rules", e.g. *"this has worked before, why should it not work again?"*, could lead to misinterpretation and a rule-based mistake[24]. A rule-based mistake could originate from when the manufacturing engineer set the time-estimation on very loose grounds, the engineer make a guess on earlier experience, without further investigation. The process technician at Line X mentioned that they copy-paste operation text between car models, where they think that the operation is the same, those situations could result in a rule-based mistake. The process technicians, just as the manufacturing engineer, acts on experience, probably to save time. Imagine then if the process technician misinterpreted the PII-text, and a chain-reaction of errors has begun. Those mistakes could have both minor and severe consequences. A severe consequence could be that misinterpretations of the PII-text, or errors in the PII-text, are not recognized until it is too late, i.e. the error reaches production. Another factor that could have the process technicians make a knowledge-based mistake is their mental model of a PII [22]. One technician gets PII's from several manufacturing engineers, which means that the structure of the PII might vary, depending on who wrote it. If then the technician has a set model of the PII, and there is a PII which looks very different or contain very different information from what the technician expect, there might be problems. Having standardized ways of writing PII's is crucial for the correct interpretation when converting the PII into OIS's and WES's.

During the interviews with the process technicians and the process engineer, an issue connected to the communication of changes in the PII emerged. When a process technician identifies an error or find the PII confusing, they should contact their local ME. Thereafter, they contact global ME, making the process of improvement or question asking quite resource consuming. Instead, there could be systems for handling these issues. If there is an error, global ME should be contacted directly, to enable quick adjustments, since an error could stop production. The issue concerning questions could be managed by having a clearer structure of communicating the PII's from ME to production, decreasing the level of confusion. When questions arise, local ME should be sufficiently informed to answer questions connected to the PII.

Another issue, mentioned by the process technicians, are the e-mails sent when a PII is changed. The formulations of the e-mails are perceived as cryptic, making it difficult to understand the implication of the change and its effect on production. When the process technician receives an e-mail, including the cryptic message supposedly explaining the change, they must allocate the change in the PII. Due to the need for reviewing two documents, the updated and the outdated PII's, simultaneously, a lot of time is spent on identifying changes. This is an issue due to the fact that time is wasted on performing a task that is unnecessary. This can be handled by having the manufacturing engineers adding a comment to the e-mail, shortly explaining the changes as well as its effect on the PII. Another example is that the structure of the automated e-mail is redone to enable a more thorough explanation of the PII. Further, the risk of a process technician missing a change will decrease if the e-mails are improved.

Most human errors show through organizational flaws[23], meaning if the communication tools are not adequate to fulfill the quality of information needed, there might be errors done by the human. The lack of systematic feedback to the technician when a change has been made in the PII is a clear organizational flaw, that might lead to human error. If the system would allow feedback to the technician, the risk for missed information will decrease. Further, as mentioned regarding the communication of feedback from the technician and the manufacturing engineer need to be improved The technician often needs a change to be made within the same day, if not within hours, this hectic work pace does not correspond with the manufacturing engineers working at global ME. For a quick change to be made, the engineers working at local ME need to have the permission to make changes in the PII's.

The communication issues between ME and the plant would require an additional study, due to the fact that this study mainly builds on interviews from process technicians, production managers, and a process engineer. To receive a broader understand and point of view, interviews with manufacturing engineers who write the PII's are necessary. Though the data is limited, the communication issue is still existent and in need of improvement due to the importance of having good communication [4][6]. Although the issue is quite easily identified and elevated, it is difficult to change. It is easy to state that communication is important, but harder to find concrete tools to improve communication. Therefore, it is important to further investigate this issue and will be discussed at the end of this chapter, in Section 5.3.

Production manager and operator

During the operator interviews and surveys, it was clear that the communication within production has to improve. The operators seem to receive diversifying information, or no information at all, leading to confusion or in worst-case scenario; incorrect work. Communication is the base of information spreading [4][5], and is therefore in need of improvement within Line X.

If the communication fails, the spreading of information might be insufficient. This might lead to several serious consequences, where some were mentioned during the interviews. One scenario, mentioned by an operator during an interview, took place during a Monday morning. The operator arrived at their work station, and the day seemed to be just like any other. A few minutes into the shift, after assembling an equal amount of cars, the operator found out that a change had been made during the weekend. The operator had not been informed about the change and had a short amount of time to relearn. The human short-term memory can only hold about 7 items at the time, and they will be forgotten within seconds if not repeated[22]. Which means that non-repeatable information, e.i. verbal information might be forgotten fast. Having no, or little time, to read new instructions is a serious issue if it occurs frequently within the plants, since it might lead to the need of rework on the concerned products. This leads to increased cost and might require the line to stop depending on the amount of rework. Further, the components might not be reusable and will thereby increase the scrap rate, which is environmentally unsustainable.

If the communication is insufficient, parts of the necessary information might never reach the operators. The human might also understand the information differently since they have different tacit knowledge, e.i. experiences [11]. Therefor clear communication is needed and ensuring that the operator has understood correctly. Being un- or miss-informed might lead to an increased risk of poor ergonomic situations for the operator. If the operators are unaware of changes, e.g. if a work station is reevaluated with a bad ergonomic score and helping tools are added, the unawareness of the helping tools will increase the risk of injuries. The operator will then make a knowledge-based mistake since the operator does not have sufficient knowledge to make the right decision [24]. Further, the operators might not understand the reasons for using the helping tools and thus ignore them. In some cases, the reason for having helping tools might not be obvious. The aim might be preventing injuries caused during a long period of time and by the frequent occurrence of operation or movement. Therefore, the lack of communication could increase the risk of the operators' health is therefore socially unsustainable.

Different from the communication between the manufacturing engineer and the process technician, the communication between production managers and its operators has a strict structure to follow, i.e. the information-sheets. It is mandatory for all operators to sign the information sheet, and the production managers are supposed to use those as a communication tool between them and their operators. Although, as seen in the interviews the in formations-sheets are sometimes not used, and the communication thereafter is not held at a sufficient level. When communicating verbally the operator might not have the time to process the information, due to the hectic pace in their work. Therefore the production manager might explain the changes very briefly, assuming that the operator understands, and the operator tries to understand to the best of its abilities. Similar to the knowledge clash mentioned between the manufacturing engineer and the process technician, something that is obvious to the production manager, might not be for the operator, therefore the operators do not understand[5].

The fact that the production managers and the operators describe the training periods differently reveals a significant issue concerning their communication. As mentioned, they obviously do not communicate, no matter what the underlying reasons are, leading to an unsystematic execution of the training of operators. Additionally, it demonstrates insufficient leadership due to the fact that the operators are able to apply individually preferred methods while the production manager is unaware of it. This demonstrates the need for solid leadership, where the manager must establish compliant relationships with the operators. Further, the manager must develop a functioning communication system where these sorts of issues are revealed and properly managed.

5.2.2 Working culture

During the study, issues connected to the culture were revealed when reviewing the collected data. The culture issue was revealed at all the reviewed parts of the company, where the culture seemed to allow for internally formed rules and norms [7]. Humans are deeply affected by their surroundings, including the culture within their group [21]. Further, individuals tend to act differently in similar situations [16]. The issues connected to culture can be divided into two sections; the relationship between ME and production, and a shop floor culture allowing for undesired behavior within Line X.

An important aspect to discuss is the idea that cultures are partly based on communication, i.e. the rules, norms, and policies are established when communicated [8]. Due to this, it is necessary to establish a well-functioning communication system to enable the desired culture. If communication is insufficient, it might lead to misunderstandings and thereby increase the risk of rules or behavior conflicting with the company goal. One example of this is the training period, where communication is not sufficient enough to ensure standardized rules for training. Another example is the practice of individual work methods, where lack of communication might be the cause of undesired rules and norms. An additional example is the communication between the manufacturing engineers and the process technicians, where the insufficient communication might be the cause of the unawareness of each other work situations.

Differing goals and prioritization

During the study, a cultural issue connected to goals and prioritization emerged. ME's and production's goals and prioritization differ, resulting in a negative effect on the relationship. Within production, the pace is significantly higher and small, seemingly insignificant errors might cause severe effects. If emerging issues stop the line, there is no time for discussion, the problem needs to be fixed right away. Instead, the focus is on fixing the error and continue the running production. At ME, the pace is slower and there is generally enough time to discuss issues before handling them. Further, the engineers at ME are separate from the running production, working in projects with launch dates far in the future. Therefore, errors in their work will have no immediate consequences, such as stopping the line. The difference in prioritization is the source of an unfavorable attitude towards each other and is negatively affecting the relationship between manufacturing engineers and process technicians. When problems occur, ME and the plant should work collectively to reach a solution, instead of blaming the other part. Having differing cultures, including differing goals and prioritization, might lead to tension between subgroups. This tension is damaging and could lead to the failure of an entire organization [7].

The unfavorable attitude will lead to the distrust in the other party's ability to perform their work, and will also lead to a lowered threshold for negative stimuli, as stated by the literature [16]. In other words, the unfavorable attitude might lead to distrust in the work performed by the other party, and low allowance for small mistakes. The consequences of parties not trusting each other might further increase the gap, leading to a negative loop of distrust and widening of the gap. Further, the difference between goals might lead to an unfavorable attitude in the conative responses, meaning that the process technician might believe that the manufacturing engineer is unaware of the real work within production [16]. This might further increase the gap between the organizations and a malfunctioning relationship.

During the interviews with the process engineer and one of the process technician, the issue concerning the formation of the PII's emerged. According to the process engineer and the process technician, the manufacturing engineers are unaware of what WES's are, which reflects in the PII's. Due to their lack of familiarity, several PII operations are difficult or impossible to properly adapt to production. This can be explained by the differentiating working cultures, where the manufacturing engineer is unaware of how the PII is managed by production. If production and ME were aware of their differences and would communicate and try to ease each other's work by adapting as much as possible, the relationship between ME and production could improve significantly.

When discussing culture and errors caused by humans, it is important to remark that the human errors rarely are caused by the individual. Instead, deficiencies in the system or organization are the main factors leading to human errors such as accidents or major faults [23]. The accidents and faults often origin from the issues connected to the organization or the system, causing a chain reaction leading to the human. Therefore, it is necessary to establish well-functioning systems and organizations to prevent human errors from occurring.

Shop floor culture

Another issue was the culture among the operators. As the data was analyzed, it was obvious that the shop floor culture allowed for unwanted behavior within Line X, e.g. working according to personal preferences without any consequences. In the interviews, the vast majority of the operators stated that they have their individual work methods when assembling. This was due to reasons such as ergonomics, speed or ease. Further, the operators revealed that they are rarely encouraged to read the instructions. Also, they disregard reading the instructions even if they have the time.

The culture within Line X allows for undesired habits, such as bringing tools, skipping operations or assembling in another order. During the interviews, several operators mentioned that they apply individual methods since they believe their ways are easier, faster and have better ergonomics. This can be linked to the conative response, where the operators might an unfavorable attitude towards the engineers, believing that the engineers are unaware of the real work [16]. Further, the operator's individual working experience has provided them with tacit knowledge[11], e.g. what it feels like to tighten a screw with a certain torque. This tacit knowledge is very difficult, or impossible to describe in the instructions. Further, tacit knowledge is significant for an efficient and correct assembly. The tacit knowledge is an additional factor decreasing the need for written instructions since the written instructions cannot teach the operator how it feels when the screw is correctly tightened.

According to Borland [20], it is quite easy to change a habit since habits are changed every time a human acquires new knowledge. Therefore, the identified issues connected to the habitual part of the culture issue, i.e. bringing tools, skipping operations or assembling in another order, could be changed by educating the operators. The operators should know the reasons behind assembling according to the WES's and OIS's and it is therefore important that they understand the potential consequences of using non-standardized methods.

Another aspect of the culture issue is the motivation among the operators. Lack of motivation might contribute to the unfavorable culture within Line X. It is difficult to affect the intrinsic motivation since it is quite individual. Further, the task itself, assembling hundreds of equal products a day, is not rewarding enough for the majority of people and therefore extrinsic motivation is necessary [21]. One way of extrinsically motivating people is by having positive feedback [17]. Today, the operators within Line X have extrinsic motivation in form of positive feedback, where they receive weekly feedback on their level of quality. This feedback is solely positive if they actually perform their work and generate a high-quality level. In other words, the feedback will reflect their performance. Apparently, this feedback is not enough to motivate the operators to work according to the WES's and OIS's. Another factor that could motivate the operators is being more involved in their work, [3]. If the operators could participate in the development of their workplace, and particularly the instructions, chances are that they would be more motivated in using them.

An additional issue connected to the practicing of individual working methods is the operators' personal experiences and memories. Human's have individual mental models, reflecting past experiences and events, and used to identify patterns, predict behavior, and understand their surroundings [22]. This might affect the operator's reception of new information since they have a mental model describing how to act. For example, when a work station is re-balanced, the operator might believe they know how to assemble a component due to past experiences. Therefore, they skip reading the updated instructions. In reality, the component might be updated and changed, requiring a new method for assembling.

Another interesting aspect to discuss is the different experiences stated by the production managers versus the operators. To set an example, the training period can be discussed. During the interviews, the operators described their training periods and the variation was high. Several operators were introduced to the instructions quite a while after finishing their training period while others were introduced during the training period. Only a few stated that the instructions were introduced before the training period, which, according to the production managers, is the established way of being trained. The production managers stated that the operator should read the folder containing the WES's and OIS's before entering the line and beginning the practical training. In reality, the majority of newly hired operators have practical training as the initial stage of their training period, which contradicts the statements from the production managers. This is a clear example of Hollnagel's [10] concept of work-as-imagined versus work-as-done, where the production managers' idea of the training period differs from the operators' experiences.

The issue of having a difference between work-as-done and work-as-imagined might have several reasons. One reason might be the lack of information shared with the operators, where they are unaware of the decision method for the training period. Another reason could be that the operators value the method as insufficient, and thereby apply an adapted version without communicating their discontent to the manager. Regardless of the reason, this is obviously an issue and requires further attention.

Although the operators apply individually preferred working methods, accidents or major faults within production cannot be blamed on the operators. According to Wickens [23], accidents and major faults are often caused by system errors or organizational issues, causing a chain reaction leading to the human. This is applicable to the operators using individual work methods. If accidents or faults occur, it is not due to disregarding the instruction, but instead the possibility to do so. This shows the need for a solid system and a well-functioning organization since these aspects will lead to fewer human errors.

If discussing the combination of the training period and the human errors, the literature states the importance of sufficient training [3], [23]. Therefore, the diffusion connected to the training period, as well as the fact that human errors can be based on organizational- or system issues, strengthens the idea of having a standardized, well-structured training period. This is further stated by the operators who believe that the need for instructions will decrease if the training period is sufficient. By ensuring a high quality of the training, it is possible to achieve higher performance and decreasing the risk of human errors.

5.2.3 Instruction layout and content

The final issue revealed during the study was the instruction layout and content, i.e. the physical appearance and structure, of the PII's, OIS's and WES's. Additionally, this issue includes the text formulation within the PII operations, WES's and OIS's as well as the pictures in the WES's. Handling this issue is significant due to the extensive resources invested in the development of the PII's, as well as the potential consequences that follow by not using standardized work methods [14]. If the instructions are difficult to process, it will increase the risk of individual work methods and thus a high variety of aspects such as ergonomics or product quality.

PII

One of the purposes of having PII's is simplifying the work in production. Today, according to the sources, this is not the case. The PII's are difficult to understand and the process technicians spend several working hours scanning for errors, fixing errors and understanding the PII's. This is an issue mainly due to the extensive resources invested, but also due to the potential of the PII, enabling standardized work methods [14]. According to the process engineer, process technicians, and production managers, the PII's are quite complex and lack intuitiveness. The designer, i.e. the manufacturing engineer, and the user, i.e. the people in production might not have the same comprehension of what is a high level of complexity [3]. The manufacturing engineer might think that the PII-text is straight forward, although the user might have difficulty understanding it. Since all users of the PII said that the PII's are too complex the layout and content of the PII need to be revised.

One identified problem is the formulation of the operations in the PII. The operation texts frequently include incorrect language semantics, where the meaning of a sequence of words changes when put in another order. Further, the grammar was occasionally incorrect. Implementing more error-tolerant systems would prohibit incorrect grammar and spelling in the PII [23], e.g. automatic spelling and grammar checks. Several process technicians translate the operation texts literally, to prevent being held responsible for errors, which will lead to incorrectly formulated operation texts in the WES's and OIS's. This is problematic due to the consequences of having incorrect formulations while coincidentally requiring the operators to follow them.

The "buddy-check" performed by the manufacturing engineers could also help to prevent bad English grammar in the PII's. By checking the readability and spelling in colleague's PII's, the risk for confusion in production could decrease. Having standardized ways of writing the PII's, i.e. using the same word for the same thing, could further help. An alternative to the standard could be having predetermined "functions" for regular operations. Thereby, the manufacturing engineer can apply the function connected to the operation, instead of manually writing each operation. An example of a function could be the tightening of a screw. Following standards when writing PII's would also prohibit the manufacturing engineer from adding their personal touch to the PII text, which would support the process technicians' mental model of a PII[22]. Although, having pre-written operations could decrease the readability of the PII-text, and the flow in the text might disappear. Although having the PII-text divided into functions, instead of a long coherent text, will ease the conversion to an OIS for the process technicians. Another way of decreasing the risk of incorrect translations of the PII text is by having the manufacturing engineer translate the texts. This might be difficult since ME is a global organization with no demand for knowledge of the Swedish language.

WES and OIS

The WES's and OIS's are commonly developed by process technicians and production managers, which are based on PII's developed by manufacturing engineers. The operators, performing the work based on these instructions, are not involved in the development processes and have little, or no, possibility to affect the layout. Additionally, the operators are the ones responsible for educating and training the future operators and are thereby responsible for ensuring that they learn the correct work methods. If the operators have a negative attitude towards the WES's and OIS's, its content might not be practiced, and future operators will assemble based on experienced operators' own working methods. Therefore, it is highly important that the operators have a positive attitude towards the WES's and OIS's. One way of handling this issue is including the operators in the development. The literature stated that people are happier and productive if they can control their work [3] [5].Further good leadership should encourage the workers to evolve within their work, and the workers need to be challenged[5]. If those are lacking, the worker might feel less motivated to perform. Thereby, including the operators in the development of the WES's and OIS's might improve the work satisfaction and create a feeling of ownership, and thus increase the practice of the instructions.

The importance in adapting manual assemblage to the human and her senses is a shared standpoint among the reviewed literature [21], [3], [22], [23], [25]. If the work station is designed in an optimal way, the need for text-based instructions is decreased. Different principles that could be used to design a intuitive work station are; *Co-location*, *congruence* and *rules* [23]. With those principles in mind, the order in which the different operations should be performed could be obvious. Other strategies are those who prevent human error from occurring, mentioned by Wickens [23] *Assist and rules* and *Error tolerant systems* could be used to design an error-proof work station. Error tolerant systems might be of the highest importance in this case, maybe not in the sense that errors are allowed to occur since those might be costly, but an error-tolerant system would allow the operator to give feedback instead of adapting. An error-tolerant system would listen to the expertise of the operators. Further, equipment design is of high importance. The equipment design is similar to the co-location and congruence used to guide the operator and to give correct stimuli to the operator [23]. Examples are that there should only be possible to perform an operation in one single way, and in one single order. The operator should receive visible or audible feedback when the correct operation has been executed, and the same action should if possible not lead to different outcomes, which means that the human will connect one action to one outcome. With those design principles in mind the instruction in the folder might be unnecessary for the operator.

Another aspect interesting to discuss when regarding the instructions is the effect on quality and performance. According to the process technician at Line X, the quality and performance at Line X are significantly higher compared to other lines within Plant C. This is interesting since it questions whether or not the WES's and OIS's are necessary to achieve high quality and performance. According to the limited study performed within Line X, they might not be necessary. To get a more valid result, the culture among the operators must be further investigated. If the instructions in the WES's and OIS's are frequently ignored, but the quality and performance are high, the operators might not need access to them. Instead, they could solely be used for scheduling, staffing, balancing, planning of material, simulating systems, wage payment, calculating cost and evaluating employees, which are the main application areas for work standards [14].

A final argument for removing the folders including the WES's and OIS's is the environmental aspect. The folders are quite extensive, including the OIS's, WES's and additional texts for all variants of each product type. Due to this, each work station has several folders, and the plant holds several work stations. These folders are supposed to be updated when a change is made, which occurs frequently due to new products or changes on existing ones. In the end, this will lead to extremely high consumption of paper. If the folders are rarely read by the operators, all that paper will be used in vain, which is environmentally unsustainable. Instead, the WES's and OIS's could be available to the operators as PDF's, e.g. by the operators asking the team leader who has access to the internal database, and used when the need emerges.

5.3 Future work

In this chapter, the project has been discussed and evaluated. In several sections in the report, future work has been mentioned. In this section, the parts requiring future work are discussed.

- During the data collection, only one out of three shifts was investigated. For the future, the night- and evening shifts would be interesting to examine since they constitute approximately two-thirds of the production.

- At Volvo Cars, there are laterally reversed lines, such as Line X. During the data collection, an issue connected to these sorts of lines emerged. Although the lines are equal, but laterally reversed, their PII's, OIS's and WES's might be significantly different. If this issue would be reveled as common and widely spread throughout the plants, it would require resources for securing a standardized work method. There are several benefits with standardized work methods, and thereby it is beneficial to investigate, and potentially remove, deviations.

- This study has mentioned the term falling behind, i.e. not being able to finish the work within the given amount of time. Although the term has been used as a reason for not following the instructions, the reasons for falling behind have not been fully evaluated. Therefore, future work regarding the reasons for falling behind should be performed. The main reason is to identify the underlying causes for falling behind, to enable prevention. The outcome of such research has the potential to identify solutions or improvements, decreasing the risk of falling behind and thus improve aspects such as efficiency and employee health.

- The communication issue between ME and plant requires a more extensive investigation. In this study, the data is insufficient and it is therefore impossible to give solid recommendations on an action plan. Though the issue is not thoroughly investigated, it is highly important due to the negative effects of not communicating efficiently. If adding resources to investigating this issue, communication has the potential to improve and thus decrease the time spent on unnecessary tasks. Further, improved communication would likely strengthen the relationship between the organizations.

6 Conclusion

The final chapter of the report gives the conclusion. In this section, a summation of the findings and their recommendations is presented.

This thesis has investigated the development, implementation, and usage of the PII's, WES's, and OIS in Volvo Cars' final assembly plant. The focus was on the humans and their attributes. A study including several research methods; literature study, interviews, surveys, and observations, has been performed within ME, Plant C, and Line X. The conclusion is divided into the research questions, aiming at giving clear and structured answers to them.

- *What are the main issues connected to the PII's, OIS's, and WES's?*

The identified main issues are; communication, culture, and instruction layout and content. Within the communication issue, two problems have been detected: communication between manufacturing engineers and process technicians, and the communication between the production manager and the operators.

Further, the culture issue includes two main problems: the differing goals and prioritization between ME and the plant, and the shop floor culture allowing for undesired behavior.

Lastly, the issue concerning the instruction layout and content includes the PII's, WES's and OIS's, where the common denominator is excessive complexity.

- *How can these issues be handled?*

The problem concerning the communication between the manufacturing engineers and the process technicians is likely based on unawareness of the other party's work, and insufficient systems for communicating. Therefore, it is important to increase the understanding of the other party's work and create a clear structure for communicating. The communication problem within the plant is believed to be caused by deficient leadership skills. This can be handled by supporting the leadership, e.g. creating a clear procedure for information spreading. The differing goals and prioritization between ME and the plant are not reasonable to try to change. Instead, it is important to understand the other side, improve the relationship, and thereby adapt to the other party's work situation.

The culture within the plant, allowing for deviating from the work method, is partly caused by insufficient leadership. It is, therefore, necessary to establish clear leadership and involve the operators in their work. It is necessary to decrease the opportunity to apply personal work methods.

The issue connected to the instruction layout and content can be handled in several ways. The research revealed that the operators do not need access to the folders including the WES's and OIS's. Instead, the WES's and OIS's should be simplified, including less information and clearer formulations. Additionally, the need for detailed instructions will decrease if the work station supports the human and if the training period is sufficient.

6.1 Recommendations to ME

- Improve the system for creating PII's, including an automatic speller and standardized operations. The standardized operations should include several parameters, e.g. time estimation and necessary tools. Further, the system should include the setting of key symbols.
- Improve the buddy-check system within ME.
- The communication and culture between the manufacturing engineers and process technicians requires further attention. Additional resources should be allocated to identify improvement potentials in the communication.
- The communication and culture within the plant require improvement. The structure has to improve, decreasing the possibility to apply work methods according to personal preferences. The spreading of information has to improve between ME and the plant, as well as within the plant. This could be achieved by creating a system for information sharing.

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A
Figures

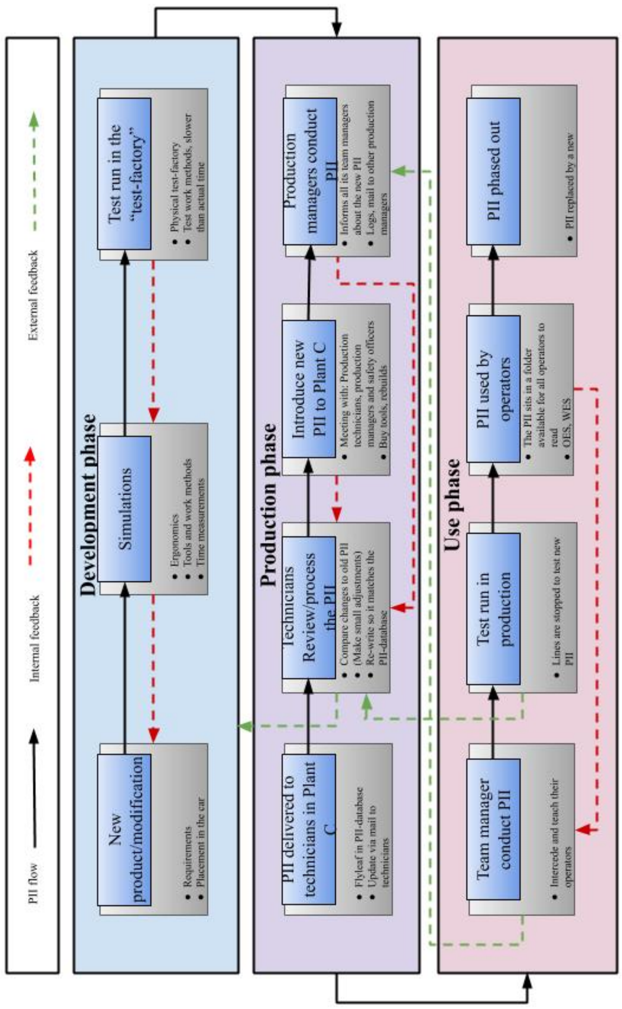


Figure A.1: Life Cycle of a PII

MANUFACTURING ENGINEERING — PROCESS-/INSPECTION INSTRUCTION — Page 1/ 2

OPERATION — VALID WEEK / WEEKS

Type	EL	No	Ref	CC	Operation Description	Stn No	Variant	TMU	Intro Week
M		111			Assemble the component to the product by screwing one (1) screw on top and two (2) screws on the bottom.			120	201611
S		...	A		...				
M		...			...				
S		...	B		...				
M		...			...				
S		...	C		...				

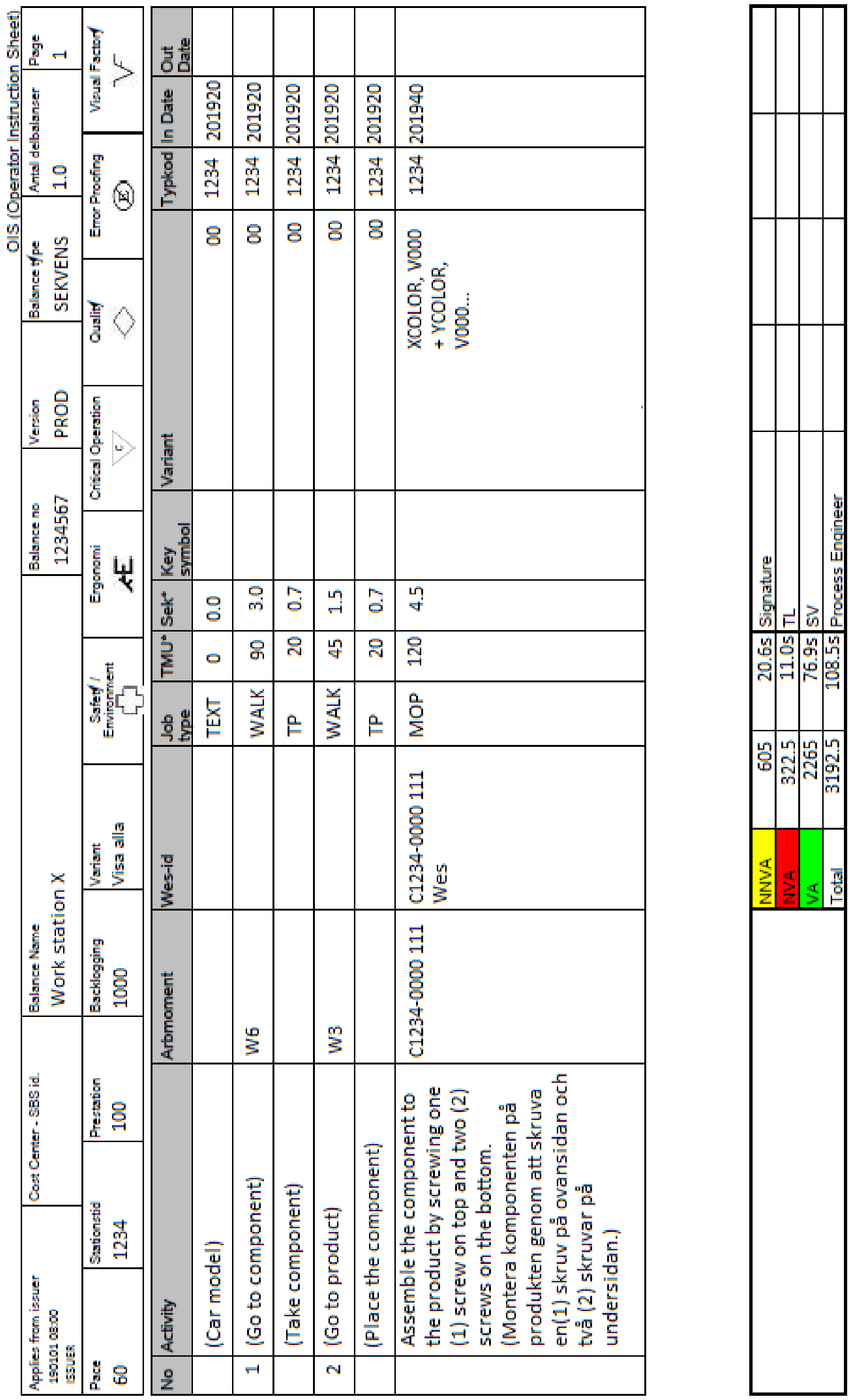
STRUCTURE

Ref	QTY	Part No	Part Name	Traceability	Variant	CO No	CO Iss	Intro Week
A	1	01234567	COMPONENT		00	A00112	1	201911
B	1	01234567	COMPONENT		00	A00112	1	201911
C	1	01234567	COMPONENT		00	A00112	1	201911

TOOL

General Variant	Title			
* 00	component to product			
Issuer	**Issued Date**	**Intro week**	**Type**	**PII No**
Issuersson, Issuer-IISSUER		201930	00	C1234-0000

Figure A.2: A fictional example of a PII page.



OIS (Operator Instruction Sheet)

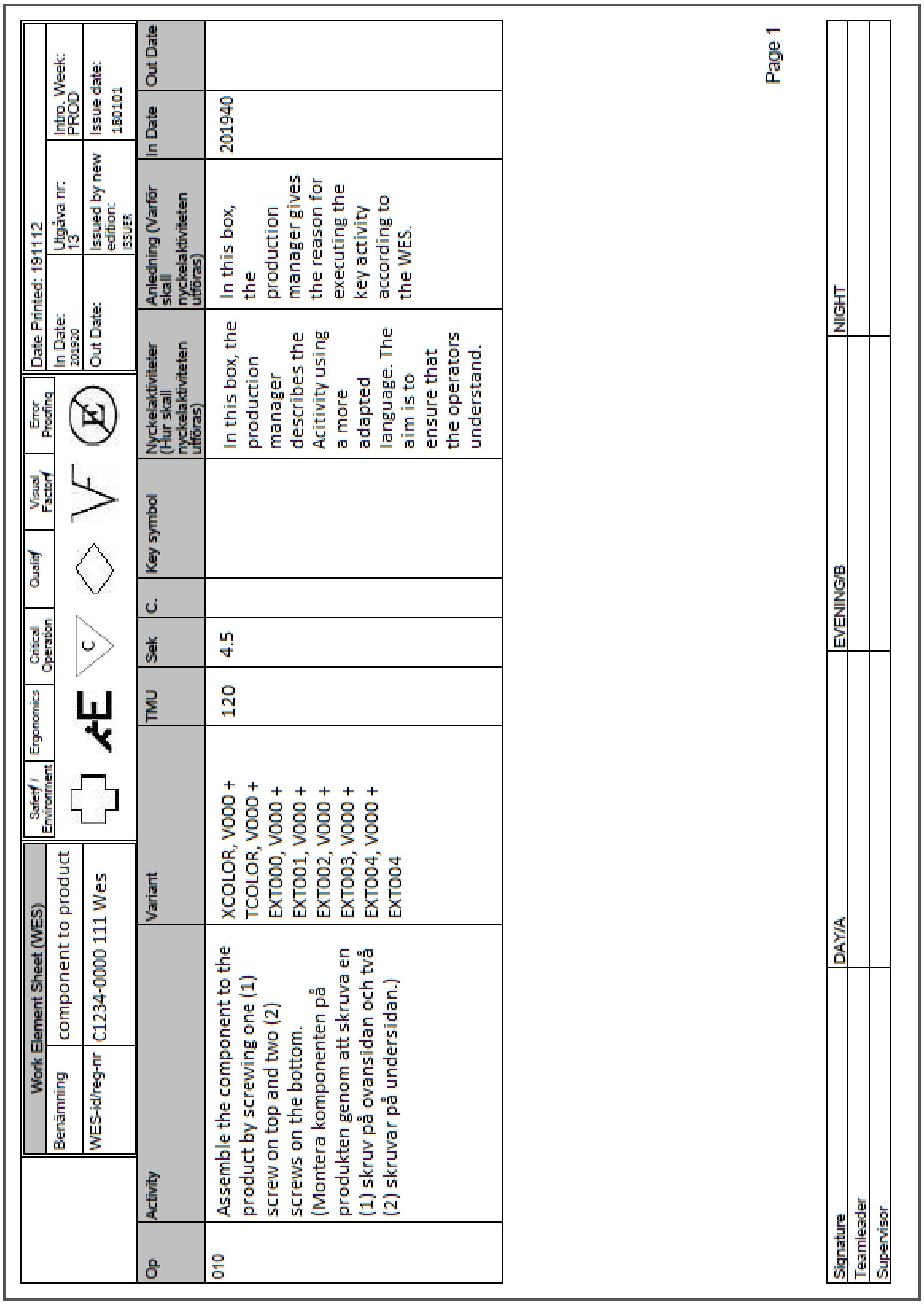
Applies from issuer 190101 08:00 ISSUER	Cost Center - SBS id.	Balance Name Work station X	Balance no 1234567	Version PROD	Balance type SEKVENS	Antal delbalanser 1.0	Page 1

Pace	Stationstid	Prestation	Backlogging	Variant	Safety / Environment	Ergonomi	Critical Operation	Quality	Error Proofing	Visual Factory
60	1234	100	1000	Visa alla						

No	Activity	Arbmoment	Wes-id	Job type	TMU*	Sek*	Key symbol	Variant	Typkod	In Date	Out Date
	(Car model)			TEXT	0	0.0		00	1234	201920	
1	(Go to component)	W6		WALK	90	3.0		00	1234	201920	
	(Take component)			TP	20	0.7		00	1234	201920	
2	(Go to product)	W3		WALK	45	1.5		00	1234	201920	
	(Place the component)			TP	20	0.7		00	1234	201920	
	Assemble the component to the product by screwing one (1) screw on top and two (2) screws on the bottom. (Montera komponenten på produkten genom att skruva en(1) skruv på ovansidan och två (2) skruvar på undersidan.)	C1234-0000 111	C1234-0000 111 Wes	MOP	120	4.5		XCOLOR, V000 + YCOLOR, V000...	1234	201940	

NNVA	605	20.6s	Signature
NVA	322.5	11.0s	TL
VA	2265	76.9s	SV
Total	3192.5	108.5s	Process Engineer

Figure A.3: A fictional example of an OIS page.



Work Element Sheet (WES)	
Benämning	component to product
WES-id/reg-nr	C1234-0000 111 Wes

Safety / Environment	Ergonomics	Critical Operation	Quality	Visual Factory	Error Proofing

Date Printed: 191112			
In Date: 201920	Utgåva nr: 13	Intro. Week: PROD	
Out Date:	Issued by new edition: ISSUER	Issue date: 180101	

Op	Activity	Variant	TMU	Sek	C.	Key symbol	Nyckelaktiviteter (Hur skall nyckelaktiviteten utföras)	Anledning (Varför skall nyckelaktiviteten utföras)	In Date	Out Date
010	Assemble the component to the product by screwing one (1) screw on top and two (2) screws on the bottom. (Montera komponenten på produkten genom att skruva en (1) skruv på ovansidan och två (2) skruvar på undersidan.)	XCOLOR, V000 + TCOLOR, V000 + EXT000, V000 + EXT001, V000 + EXT002, V000 + EXT003, V000 + EXT004, V000 + EXT004	120	4.5			In this box, the production manager describes the Acitivity using a more adapted language. The aim is to ensure that the operators understand.	In this box, the the production manager gives the reason for executing the key activity according to the WES.	201940	

Page 1

Signature	DAY/A	EVENING/B	NIGHT
Teamleader			
Supervisor			

Figure A.4: A fictional example of a WES page.

A.1 Observations

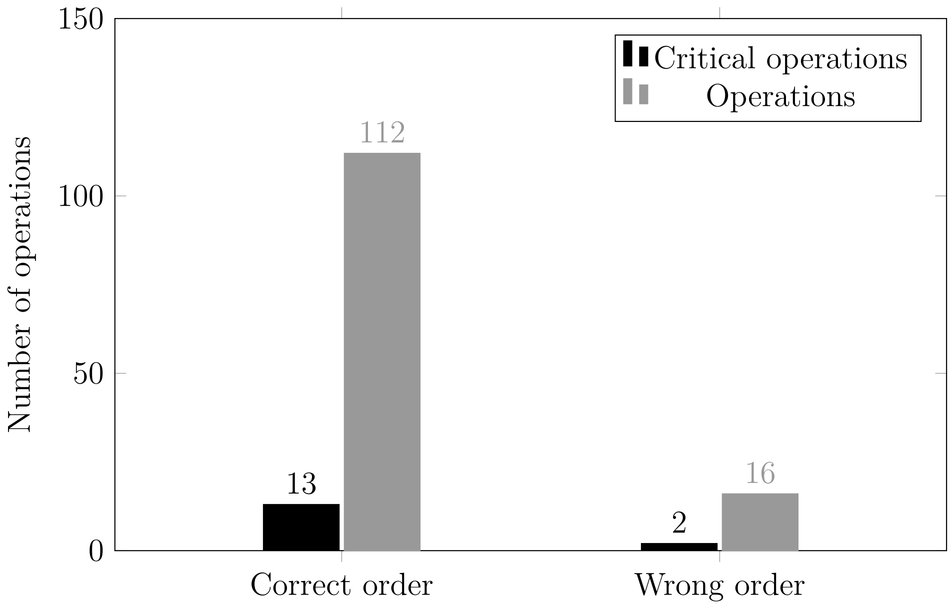


Figure A.5: Observed order from observations, work station 1

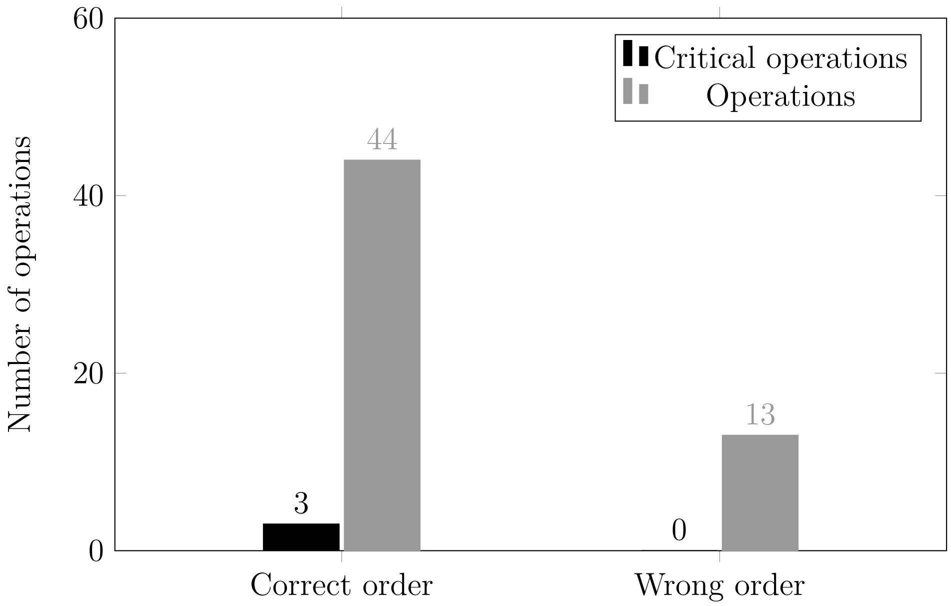


Figure A.6: Observed order from observations, work station 2

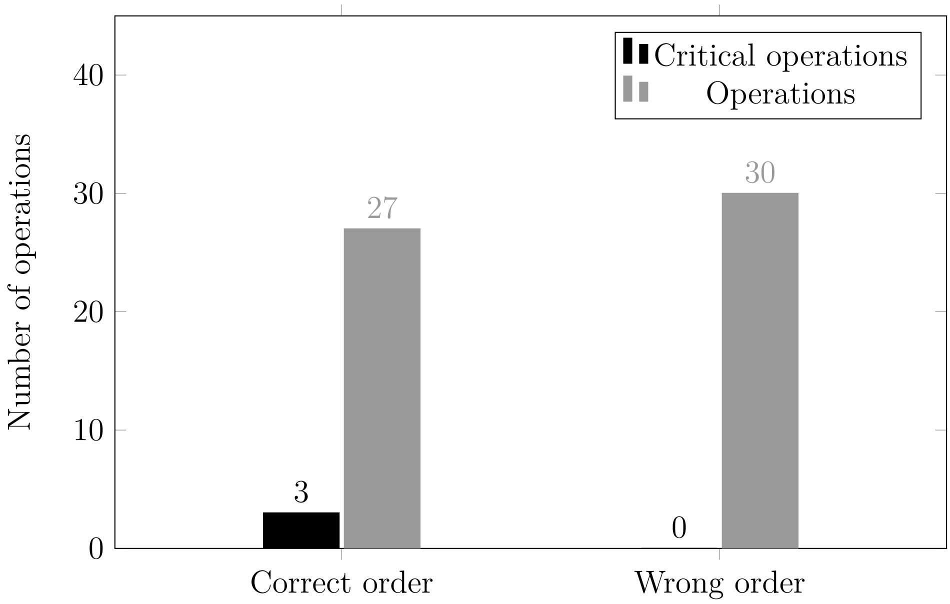


Figure A.7: Observed order from observations, work station 3

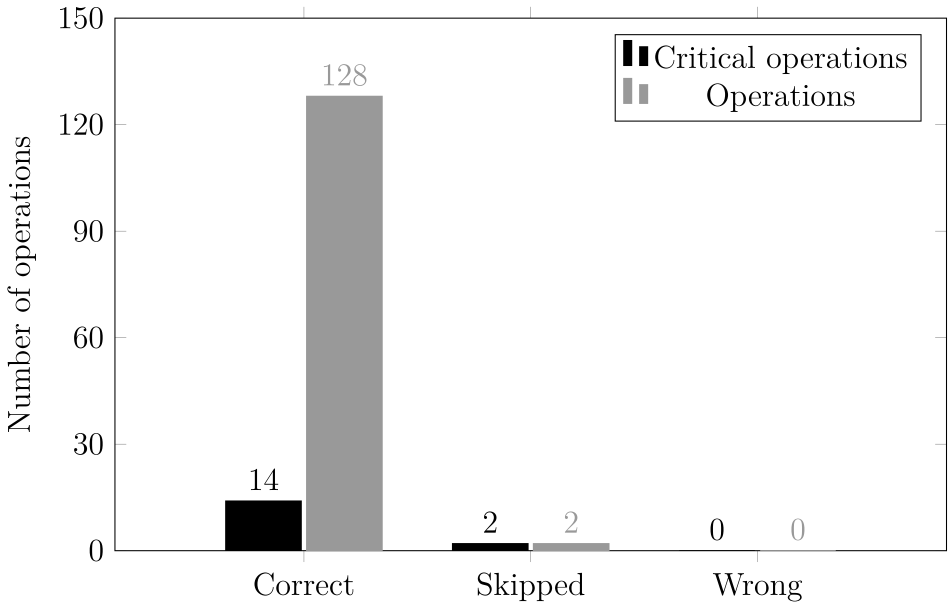


Figure A.8: Observed operational outcome, work station 1

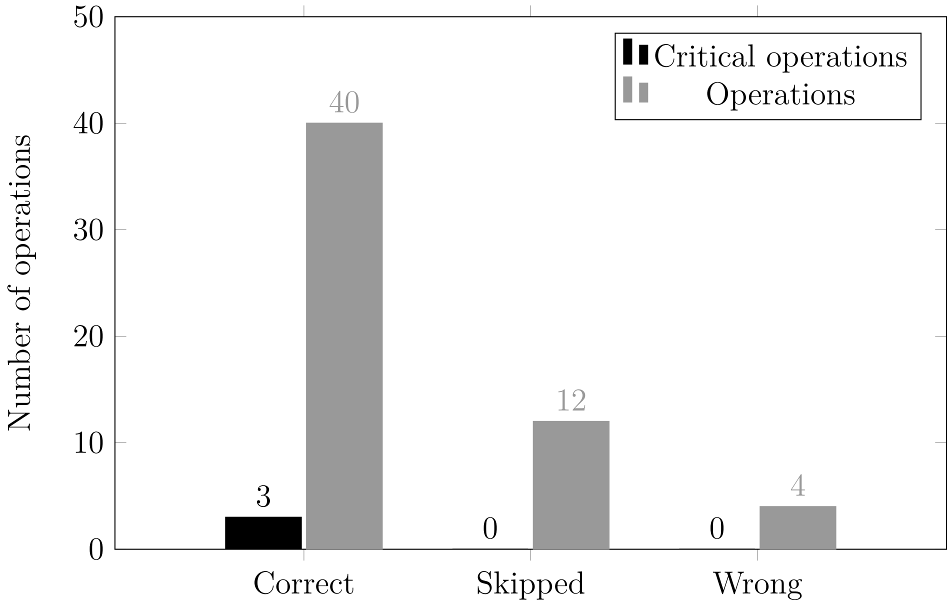


Figure A.9: Observed operational outcome, work station 2

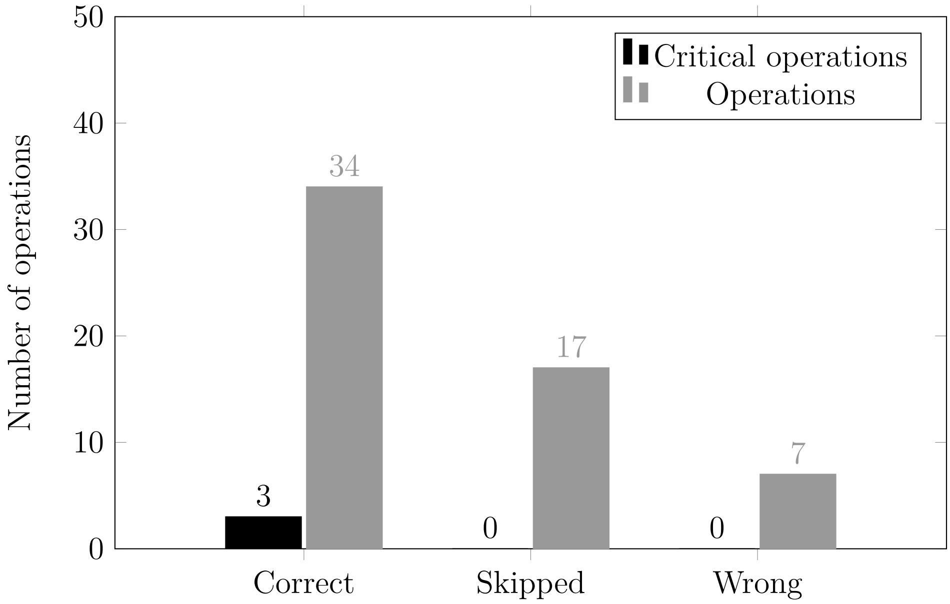


Figure A.10: Observed operational outcome, work station 3

A.2 Surveys

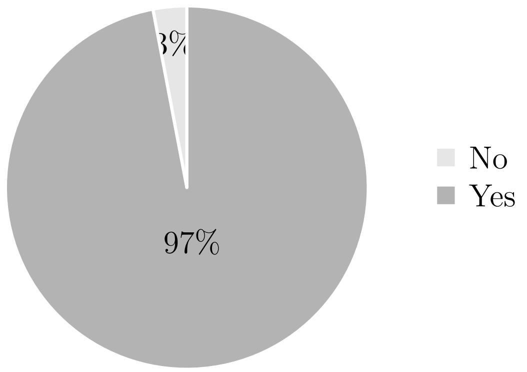


Figure A.11: *"Do you know were the instructions are?"*

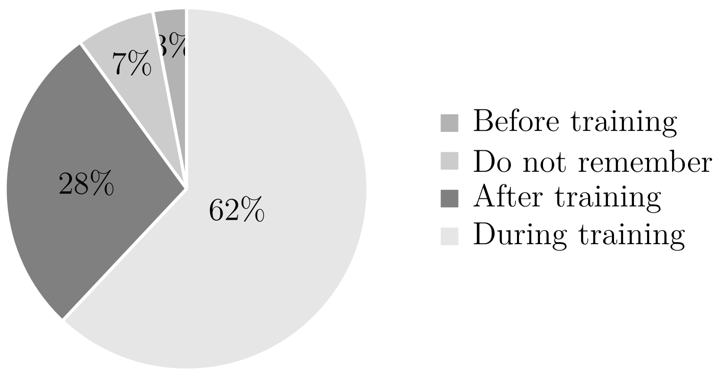


Figure A.12: *"When were you introduced to the instructions?"*

B Interview questions

B.1 Interview: Operator X

Introduktion:
Ta en kaka!

Hej, vi heter Jeanette och Fanny, pluggar på Chalmers och gör vårt examensarbete här på Volvo. Vi ska undersöka instruktionerna här på Line X för att hitta förbättringspotential i deras utformning, innehåll, användning osv. Därför vill vi jättegärna intervjua er som faktiskt använder dem, eftersom er input väger tyngst.

Först och främst vill vi säga att du kommer vara anonym, du är Montör X. Sedan undrar vi om vi kan få spela in intervjun? Efteråt kommer den att skrivas ner och filen kommer raderas.

Proceduren för den här intervjun är att du kommer få börja fylla i en enkät. Därefter kommer en kortare intervju äga rum där vi diskuterar instruktionerna, och du får jättegärna ställa frågor om du undrar något eller om vi är otydliga med något.

1. Hur gick din träningsperiod till? Från att du var ny tills dess att du fick gå själv?
   (a) Hade du tid att läsa instruktionerna?
2. Vilken uppfattning har du kring instruktionerna? Tycker du de är bra?
3. Finns det något konkret du tycker behöver förbättras i instruktionerna?
   (a) Har du någon egen metod för att förenkla din montering?
   (b) Är det något som försvårar ditt arbete? T.ex. synfel, dyslexi, fysiska begränsningar.
   (c) Tycker du att arbetet tar hänsyn till detta? Hjälpmedel?
4. Blir ni informerade när förändringar av instruktionerna sker? Hur?
5. Något annat att tillägga?

Och sluteligen skulle vi vilja fråga dig om du känner dig bekväm med att vi tittar på när du monterar? Vi kommer inte bara kolla på dig, utan alla som tycker det är okej. För att förtydliga så är vi inte här för att granska folk utan vi är här för att hitta sätt att förbättra instruktionerna.

B.2 Interview: Production managers

Bakgrund till ex-jobbet: Vi ska undersöka användningen av instruktionerna i produktion. ME har intresse av att undersöka om det finns några problem relaterade till PKI:erna eller instruktionerna (WES:ar, OIS:ar) i produktion. Detta för att avgöra om de fördelar sina resurser rätt eller om det behöver göras om på något sätt. Mha, observationerna ska vi kunna avgöra vad vi bör fokusera på.

Allmänna frågor:

1. Hur gick din träningsperiod till? Från att du var ny tills dess att du fick gå själv?
2. Facket?
3. Kläder?
4. Tillgång till PKI/WES/OIS? Helt enkelt; instruktionerna som används av montörerna.
5. Intervjuer med operatörer? Löpande intervju där de byter av varandra? Om möjligt. Under några timmar en förmiddag t.ex.
6. Enkät till operatörer? (QR-kod, fysiskt, mail)
7. Observera under alla skiften?
8. Får vi komma när vi vill? Vad måste vi förhålla oss till?
9. Kan vi får presentera oss för operatörerna? (fredags-möten?)
10. Personalomsättning? Montörer, lagledare, PL:s osv. Löpande, hög omsättning. 2,5 år längst av all 6.

För att göra detta har vi börjat med att kartlägga PKI:ernas livscykel. Vi har även mha input från produktionstekniker valt att göra våra observationer på Line X, vi skulle hemskt gärna (om möjligt) även vilja intervjua de operatörer som jobbar där samt skicka ut blanketter till dem. Får vi spela in? Vi kommer att transkribera och sedan radera intervjun. Ni är självklart anonyma.

Intervjufrågor:

1. Beskriv gärna processen från att ni får en PKI/WES till att den används i produktion?
    (a) Tar ni emot PKI:er eller WES:ar? Från vem, hur?
    (b) Skillnad mellan WES och OIS? Vem är det som "skapar" dem?
    (c) Vart någonstans förvaras PKI/WES/OIS? Fysiskt alltså. (pärm, lapp?)
2. Hur introduceras en bana när det kommer en ny montering?
    (a) Hur långt tid innan förändringen ska ske informeras dem?
    (b) Gör man test-körningar i fabriken? Hur funkar detta?
3. Byter monteringar plats, dvs flyttas runt mellan olika balanser?
    (a) Hur ofta sker detta?
4. Ser ni några problem med PKI:erna eller instruktionerna? Ur aspekter såsom: hantering, innehåll, formuleringar, visuellt, uppdatering, användning.

B.3 Interview: Process technician for Line X

1. Håller hen med gällande de nyckelsymboler vi har satt?
2. Skulle du kunna gå igenom hur dert går till när hen får ett nytt PKI?
   (a) Finns det någon standard att följa gällande översättningen?
   (b) Är det du eller Produktions ledaren, eller båda gemensamt, som balanserar ut operationerna? Ligger ansvaret hos en av er?
3. Gällande kvalité på Line X, ligger de i topp, mitten eller botten jämför med andra banor i fabriken?

B.4 Interview: Two process technicians

1. Hur många jobbar i C-fabriken?
   (a) Hur många av dem är montörer?
   (b) Hur många möntörer är det i varje lag?
2. Vad är en PKI och vad är en instruktion?
3. På vilket sätt jobbar ni med PKI:erna och instruktionerna?
   (a) Vilket ansvar har ni?
4. Hur ser flödet ut när nya PKI:er kommer till fabriken, vem gör vad?
   (a) Skulle ni säga att något av dessa steg är lite mer kritiskt än de andra, varför?
   (b) Skulle ni säga att något av dessa stegen är extra viktiga för att montörerna ska följa instruktionerna?
   (c) Hur fungerar det när montörerna ska lära sig nya instruktioner?
   (d) Hur ofta uppdateras instruktionerna?
   (e) Vem har ansvar för att montören gör rätt, montören eller lag ledaren?
   (f) Blir montörerna informerade om konsekvenserna av att inte följa instruktionerna? På vilket sätt och hur ofta?
   (g) Har ni någon tanke kring varför en montör skulle avstå från att följa instruktionerna?

C Interview transcriptions and summations

Additional questions are written in italic.

C.1 Interview 1: Technical Leader

B1 and B2 are the two interviewers, and A the technical leader.

B1: För det första så tänker vi transkribera intervjun och så fort vi har transkriberat klart den så raderar vi ljudfilen. Vill du veta lite om bakgrunden till vad vi gör?

A: Ja.

B1: Vi pluggar på Chalmers och gör vårt examensarbete här. Syftet är att ta reda på hur instruktionerna används i produktion och om de inte används vill vi ta reda på vilka orsaker som ligger bakom det.

B2: B1 har ju av egen erfarenhet sett att dem inte används och inte följs i rätt steg.

B1: Ja, jag har själv arbetat som montör så det är grunden till det här arbetet.

A: Och då är nog jag fel person för den delen, så den får ni ta med någon annan.

B2: ja precis, men vad det grundar sig ifrån. Från dig vill vi veta hur det går till när en ny instruktion kommer till och de olika stegen tills instruktionen hamnar i produktion och används av operatörerna (montörerna). B1: helt enkelt, “livscykeln” för instruktionerna. Från att det blir en idé och att man vill ha en ny instruktion, de olika stegen längs vägen, och tills de implementeras i produktion. Och att montörerna använder sig av metoden i instruktionerna. Alltså, vilka steg som finns då.

A: Då kan jag hjälpa till en bit. Jag kan lite om produktion och vad som händer i fabriken, men kanske inte i detalj, så där får ni tog ta någon som är där nere.

B1: Ja, vi tänkte väl mer övergripande, så vi kan visualisera stegen till produktion.

A: Yes, då är vi på rätt nivå tror jag.

B2: Ja, du får jättegärna berätta då, vilka stegen är. Hur börjar det?

A: Något nytt, något ska byggas, antingen en ny bil eller en ny förändring på en befintlig montering som du har, något nytt ska in i fabriken som ska monteras. De första bitarna som är, är att man börjar packa in den, alltså var får den plats i bilen, var ska vi montera den någonstans. Då är det mycket sådana pack-möten. Sen har vi våra krav som vi ställer på hur vi vill att monteringen ska kunna gå till. Det finns ju ett gäng med sådana krav. Krafter och sådana saker som ska uppfyllas. Montörsavstånd, alltså avstånd och sådant. Vi går ju på pack-möten, där man packar in och då sätts ju också metoden litegrann för hur den ska monteras. Ska den monteras med skruv, ska den monteras med clips eller behövs det ingenting kanske, vi kanske bara kan klicka fast den i någonting annat eller så. Där då så börjar man embryot till sin monteringsinstruktion, så tidigt så kör vi virtuella byggnationer där vi verifierar monteringarna och då blir ofta så att den här grunkan ska in och den ska sitta med två skruv eller två clips eller någonting och så beskriver man det. Sen förfinas det allteftersom tiden går. Sen vrider man kanske lite på den eller man kanske tar bort något clips eller man kan rationalisera eller man kanske tillochmed flyttar den någonstans. När det är klart så vet man hur den ska monteras och man får till sig om den ska skruvas fast. Det är ju konstruktion som ska tala om för oss hur hårt den ska skruvas fast och vilka skruvar det ska vara. Och där kan ju vi som beredare vara med och påverka, ifrågasätta, måste den sitta med fem skruvar eller räcker det kanske med tre skruv?

B2: Ja, för att då få in ergonomin och det där eller?

A: Ja, och monteringstid är ju också, det är en kostnad för bilen. Det förfinas ju hela vägen fram till vi bygger den inför första fysiska byggnationen, så ska vi ha ett färdigt PKI sen som ska beskriva hela monteringsbiten för den artikeln eller vad det nu är som ska monteras.

B1: en snabb fråga där, PKI, vad står det för?

A: process- och kontrollinstruktion.

B2: jaha, det är på svenska?

A: på engelska heter det PII.

B1: bra och veta, men sen då, så steg 1, då börjar det med produktutveckling då? en produkt då, och sen?

A: Vi är ju med i den loopen där det går in, så det är beredningsmöten och pack-möten och det är dialoger.

B2: och kraven där då?

A: ja krav, vi ställer krav tidigt då.

B2: sen det virtuella och sen implementeras det i fabriken?
A: i den första fysiska byggnationen som vi ofta kör här uppe så verifierar vi att monteringen fungerar, och förfinar, det kan vara att man missat något och vill lägga till något, justera någonting eller så.

B2: så ni har en separat liten fabrik där ni testar instruktionerna?

A: ja vi bygger oftast en första serie här uppe i, har ni inte varit nere i PVE (PVÖ?) och tittat?

B1B2: nej det har vi inte.

A: där har vi en liten fabrik där vi bygger stationsvis så man bygger i ett annat tempo.

B2: för att testa instruktionerna?

A: då kan man testa där då sen om det är några små-ändringar så kanske det inte byggs någon VP utan då kanske vi går direkt till produktion men är det stora bil-ändringar eller nya bilar som kommer in så bygger vi en förserie här nere.

B2: och sen då, om det går bra så? Då är det inne i C-fabriken?

A: sen bygger vi för-serierna i produktion och då är det lite mer kritiskt för då bygger vi på linen, i befintlig produktion bygger vi en förserie-bil, eller ett gäng förserie-bilar. Och då kan det inte, får inte lov att strula lika mycket när det är där för då stoppar vi ordinarie produktion.

B2: hur funkar det då med, jag tänker, instruktionen, kommer den i en pärm till C-fabriken; här har ni en ny, eller hur går det till?

A: vi bygger ju våra i team center; ett system där vi bygger PKIerna och där har vi modellerna och vi verifierar våra monteringsmetoder virtuellt i det systemet också. Sen släpper vi dem och så hamnar dem nere i fabrikssystemet som heter SP/SPS toolbox. Och då tar fabriken emot våra PKIer den vägen.

B2: så det är de olika production managerna som har kontroll eller som har ansvar att ta emot de här?

A: nej det är våra tekniker i fabrikerna som tar emot och får det här tankat i sitt system och då kommer dem ner med all information som vi har, våra PKI,i deras system. De plockar ut alla operationerna, de tar PKI:t på operations-nivå och sen balanserar ut dem, alltså lägger ut jobben på montörerna.

B1: så det är de som fixar det och vad som är på varje station?

A: precis, och då plockar de kanske några operationer från ett PKI och några från någon annanstans och så sätter de ihop det till att montören som gör jobbet ska vara så belagd som möjligt, med så lite onödigt tid som möjligt.

B2: så det är den här teknikern som ansvarar för att instruktionerna går ut till montörerna? Och att dem lär sig det nya?

A: ja eller att själva banavsnittet får till sig förändringarna.

B1: så de balanserar helt enkelt?

A: ja precis. Den biten är inte jag så involverad i utan vi gör ju här uppifrån och släpper ner. Sen vet jag ju lite om hur det fungerar.

B1: vad var det dem hette sa du? Tekniker bara?

A: IE kallar vi dem för, industria..., eller dem heter något annat nu.

B2: men de är inte samma som production managers/team ledarna?

A: nej

B2: vet du någon person spontant som vet hur det går till? Alltså hur teknikerna jobbar?

A: Dan Mattsson finns en person som ni kan ta kontakt med, sen kanske inte han kan det just nu men han har kunnat det i alla fall.

B2: finns det någon specifik metod som teknikerna ska använda när de väl får en ny instruktion eller en ny PKI?

A: de ska ju ta med sig den ner och så ska de beskriva för banavsnittet vad det är som ändrats på den här monteringen.

B1: vem är det de beskriver för?

A: jag vet inte. Om det är produktionsledaren eller, jag vet inte vem som tar emot dem.

B2: det frågar vi honom om då. Han jobbar här också?

A: nej, han bytte jobb tror jag, så det är inte säkert att han jobbar med det längre.

B1: men han kanske vet vem som efterträdde honom.

A: ja precis. Jag kan prata med honom om det så att ni...

B2: nästa fråga då, den här livscykeln vi har pratat om nu då, skulle du säga att något steg i den här är mer kritisk än dem andra för att instruktionerna ska följas på rätt sätt? Kanske konstig fråga, men...

B1: om det är någonstans där det ofta blir "fel", något ni har kunnat spåra tillbaka och se att det här steget, t.ex. kommunikationen mellan två personer, gör att det blir fel så att instruktionerna inte följs?

A: jag vet inte, det skulle vara, dels kan det vara att det är otydligt och så kan det vara så att fabrikerna själva gör saker som man inte borde egentligen för att de tycker att det är bättre. Sen kan vara så att montörerna gör någonting som, dels han kanske inte vet hur det ska göras eller tycker att det här sättet är bättre att göra det på än vad. det kan ju finnas olika anledningar till det. Men är det några anmärkningar på metoden så kan vi ju få till oss dem , att man kanske borde lägga upp det såhär istället.

B1: hur sker den kommunikationen? Vem är det som säger att "det här tycker inte vi är något bra", vi säger att en montör inte tycker något är bra, vem går den personen till och hur kommer det liksom..?

A: han måste gå till sin lagledare och sen går det till teknikern men sen ska ju alla fabrikerna aligna sig också med att, bara för att en fabrik vill ha det på ett sätt så kanske inte det funkar i en annan och vi gör ju PKIerna globalt för alla då. Så de måste enas om det totalt över alla fabrikerna innan vi går in och gör en ändring på PKIt. Sen måste vi vara överens om att ändringen är bra också, det kan finnas en anledning till att vi har gjort det på ett visst sätt.

B2: nästa fråga: hur ofta ändrar man instruktionerna, ungefär?

A: det är jättesvårt att säga.

B2: en gång i månaden?

A: vissa PKIer kanske du gör en gång och sen så lever den hela bilens livscykel och andra kanske du uppdaterar 10 gånger per år.

B1: jag tror vår fråga kanske var lite felformulerad för vi har nog missförstått vad PKIerna är, vår fråga är väl snarare; på en specifik station, hur ofta sker det förändringar där?

A: ojojoj, det får ni ta med dem som balanserar. För vi balanserar ju om flera gånger om året i fabriken. Höjer och sänker takter och nya produkter in och ut.

B2: instruktionerna bli uppdaterade ganska frekvent då?

A: nej inte själva monteringsinstruktionen men själva balanseringen, alltså det som montören ska utföra, han kanske monterar en sak den här veckan men nästa vecka så kanske han inte gör det utan gör någonting annat istället. Men hur ofta, det är lite svårt.

B1: det får vi kanske kolla på den specifika (stationen) vi kollar på, det är väl mest relevant. Det här kanske du inte heller vet då, men när det sker förändringar, montörerna, om de informeras om det.

A: det ska de ju göra men det får ni nog ta med nästa steg.

B2: vi ska välja ett “system” i C-fabriken, en avdelning, ett team, en lina, vi vet inte vad som blir för stort för oss eller vad som blir rimligt för vårt examensarbete så vi tänkte be dig om lite tips.

A: Ni vill titta på någon form av station, en montörs jobb eller vad?

B1: vi vill väl ha flera stationer, sen vet vi inte, tidsbrist gör att vi inte hinner med jättemånga men vi vill kunna se ett flertal, för att kunna observera och intervjua och så. Så kanske ett lag eller kanske en hel line med några lag, vi vet inte riktigt och har inte bestämt oss än. Men just om det finns någon specifik del i fabriken där det kan vara bra att titta, typ där det är enkelt att se utifrån och där det finns en person vi faktiskt kan komma i kontakt med.

A: jag skulle nästan vilja ta XX till hjälp där för jag tror att han är bättre på att hitta en sån.

B2: då får vi nästan ta de andra frågorna med honom också.

B1: jag tror det, mycket handlar nu om efter att det har blivit balanserat, till montörerna.

A: det ligger i fabriken. Att vi vet övergripande är en sak men inte ner på detalj.

B1: sen var det om det var något annat, nu när du har hört lite kort vad vi ska göra, om det är något du kommer att tänka på, något tips eller någon annan tanke?

A: inte på raka arm, men det ska bli spännande och se vad ni kommer fram till. Jag kollar med X nu.

C.2 Interview 2: Process manager

Steg 1: Ny produkt/modifiering
I nybildprogram kan det vara nya produkter. Kan vara nymounteda produkter, men ofta monterar vi dem på samma sätt. När det sker en förädring skapas det alltid nya artikel nummer, så ett nytt artiklen nummer kan innebära att det skett en liten förändring på en gamma produkt.

Steg 2: Simulering
Börjar forma PKI. Ett PKI består av artikelnummer och beskrivningen av artikeln, hur man monterar den, vilka verktyg som behövs för att montera, samt vilka krav produkten ska uppfylla. Beredare köper in vertyg om det finns. Preliminär tidssättning.
Virtual build event (VBE), bygger bil i simulering.

Beredaren skapar sina PKI:er i Teamcenter, det finns en databas i Sharecenter som heter BVP (bulid and varification plant). Då beredaren har släppt sitt PKI mot ett speciellt bilprogram så skapas det en bygglista i BVP vilket används i VBE. Beredaren går då in och kollar om de har någon ny monteringsmetod eller ny utrustning, byggsekvens eller nya artiklar. Plant engineering (Produktions tekniker?) kan vara involverade här om man hittat några problem, plant engineering är process ingenjörer. Om man ser problem i produktion så går man ledet tillbaka och hamnar så tillsist i BVP för att se över hur det skulle gå till och vad om behöver ändras.

Steg 3: Pilot plant
Där bygger de VP-serien (Varification prototype). Slow build är när de verifierar sina PKI:er. Alla nya PKI:er byggs av ansvarig berederare, för att kunna verifiera att det går att bygga enligt den instruktion de har skapat. Om det är mindre ändringar så byggs dem av Plant engineering, och launch folk, alltså personer i fabriken.

Steg 4: skickas till tekniker

PKI:erna blir exporterade från Teamcenter till SBS-toolbox. PKI:erna ligger i teamcenter. PKI:et slås isär när det exporteras till SBS-toolbox. Varje operation blir ett WES-skelett. Tekniker kontaktar beredare om något inte stämmer.

Team center → SBS-toolbox. Nybilsprogram ska man släppa 6 veckor innan, är det modellår eller löpande ändringar är det 2 veckor (7 arbetsdagar). Detta ska man hålla sig till annars får ME anmärkningar.

Steg 5: Adujustments
Om de gör förändringar är det i WES:en de ändrar, inte i PKI eller OIS. De tar operation för operation och balanserar ut dem.

Steg 6: Tekniker
Köper nya verktyg om det behövs, efter att man slagit isär operationerna.

Steg 7: PL
Beskriver hur och varför en viss aktivitet ska göras. Fytta OIS och WES, detta skapas tidigare.

Vanligen har man bara en WES när det gäller en nyckel-symbol. Annars står allt i OIS. Alla moment ska inte vara beskrivet i en WES, men väldigt många (typ alla) moment skrivs i WES:ar i Torslanda fabriken.

Plant engineering → plant launch. shop engineering är något annat. Kolla vad produktions teknikerna tillhör!

C.3 Interviewees 3: Two process technicians

Flera tusen som jobbar i fabriken. Montörer under dagsskift är ungefär 500 stycken.

Idealt är det 6 - 12 montörer per station men kan vara upp till 15.

En PKI är en beskrivning av en montering. Tex taket av en bil. Ta tak, placera tak, fäst tak. 3 operationer. Helt nya bilar blir ofta ut-balanserade på olika balanser. En operation kan vara att fästa taket.
En beredare (på ME) gör ett PKI och lägger det i en bana. Sen kanske det inte fungerar att allt görs där och då sprids PKIn ut över flera banor, vilket produktionsteknikierna gör.

ME gör en ändring, då får produktionsteknikerna ett mail med förändringen i form av ett försättsblad. Dessa försättsblad är ofta kryptiska och svåra att tolka för utomstående och från engelska till svenska av teknikerna för att bli förståeliga för PL och montörer. Försättsbladet består av ett införandedatum, PKI-numret på det som har förändrats, vem som gjort ändringen. I bästa fall innehåller försättsbladet all nödvändig info plus bilder, men oftast är de inte helt fullständiga. PKIerna kan också innehålla information om vilken ordning vissa operationer bör eller måste göras.

Ändring ska ske 6 veckor innan men kan i värsta fall hända att de får ändringar samma dag som de ska genomföras. Regeln följs dock inte om 6 veckor och de kan få mail om ändring i PKIerna nån veckan innan ändringen ska ske. Ofta förändringar samma vecka. Säkerhetsrisker behöver inte ta 6 veckors regeln i åtanke, utan de behöver återgärdas omedelbart.

ME skriver ner ändringen i en “ändrings-logg” där det står vilka ändringar de gör. Dock behöver teknikerna lägga ner oerhört mycket tid på att hitta vart någonstans ändringen sitter. De behöver alltså ha två dokument uppe (den gamla PKIn och den nya PKIn) och granska och jämföra vart någonstans ändringen är. Förut var det värre, men är inte helt bra nu heller. Bättre sedan ME fick en “kompis-kontroll”, dvs att man korrekturläser varandras PKIer innan de läggs in i databasen. Ibland kommer ändringar för t.ex. 2021, och då lägger de dessa PKIer på “spar” eftersom de antagligen kommer att ändras mycket efteråt. Kan ibland bara vara skal av hur ett framtida PKI ska se ut. Struktur, bilder, artikelnummer, operationer kan tillkomma.

En förändring kan inte göras utan dialog mellan ME och tekniker. Snabba ändringar sker ofta för att man begärt en förändring från produktionen. Dvs att teknikerna har begärt att ett specifik PKI måste ändras på något sätt. Är sällan de får in saker som de inte hinner göra, kanske 1-2 ggr per år på hela avdelningen. Teknikerna fungerar som en “spärr” och kollar kvalitet och felsöker PKIerna när de får dem från ME. Är ofta fel och blir således flera ändringar varje vecka pga fel från start. Kan vara ur aspekter som ergonomi, effektivitet, vad som är möjligt osv. Teknikerna köper även in de nya verktygen som behövs. De säkrar balanseringarna, säkrar kvalitet osv. Balanserna är vältrimmade och därför kan små förändringar ge stora, negativa effekter som kanske inte är förutsägbara från t.ex. ME:s håll.

Ändringar kan också komma nedifrån. En montör kanske har en åsikt och tar då det med sin lagledare som tar det med PL som tar det vidare till mötet. Produktions ledare har alltid en dialog med produktion innan de gör ändringar i monteringarna. Teknik, PL, skyddsombud har möten varje vecka. Ibland kvalitet, ME, andra som gäster. Huvudsyftet är att alla är utbildade i vad som ska göras. Uppdateringar och ändringar. Uppdateringar ska informeras på detta möte 2 veckor innan förändringen sker.

Produktionsledaren tar infon vidare från mötet till lagledarna. Produktionsledarna är även ansvarig för att PL från andra skift får informationen.

KRITISKT: “rätt från början”. Är det ett fel från start så är risken att felet förs vidare. Är inte alltid de kan upptäcka felen även om de felsöker PKI:erna. Speciellt om de är många PKI:er, t.ex. Vid ny bil. Är större risk att felet förs vidare då. Alla stegen är som grundpelarna i ett hus; faller en så faller hela huset.

WES - görs av lagledaren. Vad, hur, varför, textrader, bilder. T.ex. monterar vi inte den här saken här så kommer inte det här funka eller så kommer det här att hända. Finns i form av pärmar. Finns ibland också visuella, förenklade instruktioner på varje station (som grundar sig i WES:arna). OIS - ska tydligt framgå vad som ska göras.

C.4 Interviewee 4: Production Managers

Livscykeln från att ni får PKI-texter tills användning av montör;
Stående möte varje måndag med teknikern som kommer ner.
Förändring/nytt -> försättsblad som alla tre skift får. Kvittera/signera att de fått informationen -> teknikern lägger upp i SBS Toolbox. PL gör WESar, med bilder.

PL bedömer vilken sekvens beroende på operationerna. Förskriven PKI-text i WESen, och även en ruta från PL där de förtydligar vad PKI-texten säger. PKI-texten kan PL inte ändra, men de kan formulera sin egen ruta hur de vill, samt hänvisa till bilder.

OIS: hela balansen, hela arbetsmomentet i rätt ordning.
WES: ett moment i OIS:en som beskriver själva arbetsmomentet i en specifik detalj. Innehåller bilder.

Info till montör oftast via: informationsstyrning.
Större: samlar laget. OP-licence för att verifiera att montörerna vet vad de ska göra och gör rätt. Praktiskt och teoretiskt.

Om PL bedömer att det är för kort tid så tas dialogen med teknikern och generellt så skjuts det på förändringen.

Testkörning: tester på hur det funkar i produkten. Det pågår en längre tid, de kommer ner och verifierar att det fungerar, om de säger att de behöver backning på förändringen så tar de med sig produkten tillbaka och återkommer med förbättringar sen.

Större förändringar i balansering: Kaizen, på grund av upptakt, nedtakt, rationaliseringar.
Mindre förändringar pga kvalitetsbeskymmer, förbättra balanser osv.
Problem: ofta saknas ritningsnummer eller artikelnummer på verktyg som är utsända till en viss operation. I många fall saknas bilderna. Ibland kan PKI:erna upplevas lite otydliga. Då får de höra av sig till teknikern eller beredaren och försöka få klarhet i vad det är som gäller. PL arbetar mest med WES och OIS.
PKI:erna ligger i datorn, inte visuella, plockar bara fram dem när de behöver gräva djupare i momenten. Operationen och benämningarna är det från PKI:en som kommer till OIS:en.

Montörerna hanterar aldrig PKI:er.

Utbildningsfasen: montören får sätta sig ner med pärmarna; WES och OIS. Oklarheten -> fråga LL -> LL tar vidare till PL. Sedan går de ut och praktiserar. Sedan kollar handledaren och PL att det är rätt. När bekväm: signera att det är OK att personen går själv.

WES är förvirrande. Inte lättförståeliga. Stationspärmarna för varje balans finns i vid lagtavlan. I en pärm finns alla OIS:er och WES:ar för alla olika bilmodeller för den enskilda balansen. Finns BI (förenklad balansinstruktion) vid varje balans som är en förenklad instruktion, visuella stationstavlan. De kan inte ta upp pärmen och börja bläddra när de går balansen.

C.5 Interviewee 5: Operator

1. Ja, men först fick man då... Jag hade väldigt många att gå med, alltså handledare. Min handledare jag hade blev sjukskriven, så då blev det liksom att man fick kastas runt lite. Men jag gick med en då, så fick man kolla några bilar först, sen fick man liksom börja montera lite, alltså med en grej, sen när man kunde den fick man montera en annan grej, och sen försöka montera hela monteringen. Nämen och sen när man kunde det så fick man ju läsa pärmarna. Så att, nämen lite i taget, kolla sen montera, och så byggdes det på.
   (a) När man kunde all montering då fick jag sätta mig och läsa pärmarna. Så det togs det faktiskt tid till, mer än vad det gör nu faktiskt. Nu är det lite sisådär, ska vi ha pärmar, ska vi inte ha pärmar? För de pratar om att vi bara skulle ha vid balanserna, skriva lappar på det viktigaste, eller ja, nyckelsymboler och sådär
2. Jo, men dom är bra, asså dom, man förstår ju vad man ska göra när man läser. Men jag själv tycker ju att, asså det är precis som man göra, så det är onödigt att ha pärmarna. Alltså för man lär sig precis det man gör, bara man får lära sig rätt så är det ju som det står liksom.
3. Asså det är ju väldigt mycket text som man inte behöver läsa. *Kan du ger något exempel?* Hm, ja gud... Asså det jag fick till mig när jag skulle läsa pärmarna var, men sikta in dig på nyckel-symbolerna. Det va liksom det som var det viktigaste att läsa i pärmarna. För sen så kunde jag allting, det var bara att man skulle lägga nyckelsymbolerna på minnet typ. Så att det är mycket med text än nyckelsymbolerna, och nu förstår jag själv att man måste läsa allt för att det är väldigt mycket text än vad man bör kunna tänkte jag säga. Ja men vad ska jag säga, men typ så.
   (a) *T.ex. att du placerar verktygen där de egentligen inte ska placeras, för att det är mycket smidigare.* Ja men alla, det har man ju. Ja men lite så typ. Vissa balanser som jag uppfattar, är lite stressade och då har man, nämen då tar jag med mig dragaren när jag fixerar bat, vad säger jag, handtagskonsolen, och sånna grejer har man ju för att spara tid. Det handlar inte om uppjobb, utan det är bara för att man liksom inte vill bli nerjobbad.
   (b) Synfel men inte så illa.
   (c) Ja alltså, det påverkas inte så att, nej.
4. *När det är en förändring i instruktionerna, det kommer en ny montering, eller om någonting ändras.* Typ vid ombalansering tänkte ni typ? *Ja.* Förra gången var det faktiskt väldigt dåligt, för att då var det, nu var det inte så jobbigt för mig för jag hade ändå varit här, jag hade liksom monteringarna inne. Nu var det någon montering vi fick in från ett annat lag, men jag tänker på nya alltså, de hade aldrig funkat, då var det liksom, ja men vi hade typ 7 mimuter på oss eller någonting att, på måndag morgon. Så var det liksom; ah den här är såhär, och den här är såhär. Sen skulle vi kunna det liksom. Så att, vi hade ju gått igenom innan, förändringarna, men det vart ju inte att, exakta ordningar, utan det fick vi ju se på måndag morgon. Och det var ju samma gången före det vid ombalansering, då kom jag upp på balans och bara körde

på som vanligt “nä men vi ska sätta in den här splitlinen”, jaha men det är ingen som har sagt det till mig. Det är dåligt faktiskt.

5. Inte vad jag kommer på nu faktiskt. Det enda jag kan uppleva är, när jag var ny fick jag gå in på balans själv ganska fort. Jag kom in, jag var här en lördag och då var det två balanser jag var lite långsam på. Så då fick jag gå emellan dom hela dagen för att jag var promt tvungen att gå ensam, eller ja rotera ensam på måndag morgon. Så att, det lite, sånna grejer tycker jag är oacceptabelt. Asså för att en lärling ska få den tiden man behöver. Varför blev det så? Personalläge. Och det betyder brist på folk? Ja, och så har det varit lite nu också. Det har varit väldigt dåligt personalläge. Men jag tycker ändå att, asså jag menar man vill ju ändå ha bra kvalité. Stressa in en montör. Jag menar jag fick fråga mig till allting, och så det var ju ingen som gick runt med mig och förklarade grejer och så. Sen har det liksom, det har jag ju sagt, och då har jag bara fått svar att, liksom att tiden finns inte, och så kanske det finns tid till nästa montör. Men jag tycker ändå att det ska vara lika för alla liksom. Så att det är väldigt, ja men väldigt stressigt, alltså allt ska gå så fort, bara för att man ska kunna gå ensam liksom, så nu släpper vi dig typ. Så det är väl typ bara det.

C.6 Interviewee 6: Team leader

1. Jag hade en person som utbildade mig, hur länge tog det, kanske tre dagar, två dagar. Sen fick jag gå själv. Efter det fick jag läsa pärmarna, men det var efter, efter att jag hade gått själv en måndag ungefär. Då fick jag läsa pärmarna.
   (a) Ja dom brukar lösa av så att, man får sitta i lugn och ro.
2. *Utformning, placering.* Dom brukar faktiskt, vissa är bra vissa är sämre. Vissa är tydligare vissa är inte så tydligt.
3. Kanske lite tydligare bilder. Något annat? Nej.
   (a) *T.ex. att du placerar verktygen någonstans för att ha de lättare tillgängligt?* Ja man jobbar ju lite, man hittar ju sin egna teknik. Man försöker ju följa standarden så mycket som möjligt. Har du något exempel på någonting du..? T.ex. att det står att man ska såpa en list, det kanske man inte behöver på alla bilar, så man hoppar över det.
   (b) Nej.
   (c) *Vet om någon som har det, och om arbetet i sådantfall tar hänsyn till detta, att det kanske anpassar sig till personen som har problem med någonting?* Inte om det inte är arbetsskada, så nej.
4. Ja det är oftast efter ombalansering. *Och hur går det till?* Då skriver vi ut nya WES:ar och OIS:ar. Då informerar vi laget alltid vid uppstart, då informerar vi att det ligger i pärmarna, och att allt är nytt. Men sen så får man faktiskt inte så mycket tid att läsa. Inte efter det.
5. Nej, inget speciellt.

C.7 Interviewee 7: Operator

1. Jag gick som lärning i 2 veckor tror jag ungefär. Och sen så fick jag gå själv. *Hur gick en lärningsperioden till?* Jag gick ju bredvid då, en annan handledare som visade och så, sen gick hon bakom mig sen. Och sen så fick jag gå själv då, och så, men jag hade ändå stötting och sådär. Det var ju stressigt i början och sådär. Jag gick väl lärning i 2-3 veckor kanske. *När fick du läsa instruktionerna?* Det fick jag väl under upplärningen, efter varje balans så sa dom till mig "läs den här pärmen", för balansen då.
   (a) Ja, dom sa att jag skulle sitta och läsa dem. Och då kanske jag hade en kvart på mig att läsa pärmen. *Så då fick ju läsa en kontinueligt under hela din upplärning?* Ja, efter varje balans då.
2. Jag tycker dom är lite såhär, svårlästa ibland.
3. Vissa begrepp typ i pärmen kan vara lite svåra att förstår. Kanske lite med lättlästa då.
   (a) Nej inte vad jag kommer på. *Typ ta med dig vektyget när du egentligen inte ska göra det enligt instruktionerna, där du lägger det på ställen där det inte är avsatt att ligga?* Ja, ibland kan det ju vara ganska långt man behöver gå för att hämta typ. Så då man kan ju ibland ta med sig det fast man inte får typ.
   (b) Nej. *Vet du någon som har det?* På bandet menar du? *Ja.* Nej jag tror inte det, nej. Inte vad jag känner till.
   (c) -
4. Ja alltid. Vi får infosyrningar att läsa och skriva på att vi har läst dem. *Är det åtsatt tid då så att ni ska få göra detta, eller hur. . . ?* Nej, vi går ju på balansen, så kommer lagledaren med pappret, och säger att man ska läsa det, så tar han för mig då istället medans jag läser och skriver på det. *Och då har du ju lång tid du vill på dig att läsa?* Ja.
5. Nej. Jag vet inte, tror inte det.

C.8 Interviewee 8: Operator

1. Det var ganska bra faktiskt. Man, jag fick tid att lära mig, jag fick inget stress på mig. *Gick du bredvid en person eller?* Ja, exakt. *Blandade det att det var olika personer?* Mest var det en, men ibland om någon är sjuk måste någon annan ta över. När jag började var jag Lernia, så jag fick gå upp, eller hur säger man, lära mig från en person, sen när jag kunde en balans så låste dom mig på den balansen. Tills dom hittade personal dom kunde lära ut. Vissa kanske vill lära ut, vissa vill inte lära ut. *Så du började vara låst på en balans, eller var det några du varvade mellan?* Nej i början var jag låst på en. *Hur länge?* Länge faktiskt, jag har ingen aning. *Men instruktionerna då, när blev dem introducerade? Den pärmen som finns.* Jag tror innan eller under arbetet, dom säger efter du är klar kan du läsa, inte efter jag är klar men, men när du kan, ja under. *Var det när du hade lärt din balansen eller innan, eller under du började lära dig?* Ibland var det innan, ibland var det efter, men mest sa

dom pärmen är här men du kan läsa det efter, när du känner dig redo kan man säga, att gå ensam.

  (a) Ja, jag fick tid faktiskt.

2. *Både när det kommer till placering och utformning, och hur det är formulerat?* Ja faktiskt, men ibland vissa är det klart att man frågar. Om man inte förstår så frågar man såklart. *Tycker du dom är svåra att förstå?* Vissa ord kanske, men inte allt. Men när man koncentrerar sig så förstår man. Men är man stressad, kanske man vill vara klar, pärmen är ganska stor. Man orkar inte läsa, när man jobbar man vill jobba och tiden går snabbare.
3. *Det kan vara hur dom är utformade, bilderna, vart den är placerad, ja vad som helst.* Att det inte repererar samma, hur säger man. Vi säger kanske en bil, vi säger V60 och S60 t.ex. Dom har kanske samma instruktioner, exakt vad man gör. Det kanske kan stå på en sida, hur säger man, att V60 och S60 har samma, stället för att blanda två gånger tills man kommer samma lösning kan man säga.
   (a) *T.ex. att du gör, du tar med dig ett verktyg fast du inte ska det, eller placerar det?* Ja såklart. Ibland när man är nerjobbad försöker man ta allt man har. Dom flesta gör det.
   (b) Nej.
   (c) *Vet du någon som har det, eller har haft det? Och hur arbetet tar hänsyn till det? Blir det anpassat på något sätt?* Vissa ja, vissa nej. *Är det med hjälpmedel, eller blir du flyttad någonstans?* Både och, det beror på personen. Kanske vissa inte får den hjälp man behöver, vissa får det. Det är olika från person till person.
4. *Alltså att det kommer en ny montering eller att monteringen förändras eller så, får ni reda på det, och hur blir ni informerade?* De, jag vet inte faktist. Hur ska man. *Är det någon som kommer och berättar det för er, lagledare eller produktionsledare, har ni möte eller får ni reda på det när ni jobbar?* Ja, kanske 1 vecka innan eller 2 att det kommer vara ändring. T.ex. v.48 kommer vi att ha en ändring på balanserna. Men under veckan så kommer dom lära ut innan det börjar. *Och det är lagledaren som informerar, produktionsledaren?* Båda.
5. Nej, inte något jag har i huvudet.

C.9 Interviewee 9: Operator

1. Här på Doorline? *Ja.* Jag gick ju upplärning i 4 veckor. *Hur gick det till?* Ja, men hade ju en person som man gick bredvd och lärde sig. Lärde en hur man skulle montera. *När fick du läsa instruktioerna då, alltså pärmen?* Det är så länge sedan, nämen man gör ju det alltid efteråt. När dom tycker att man har lärt sig en balans, lärt sig det man ska göra på de olika balansera får man sätta sig och läsa pärmarna.
   (a) *Kände du att du fick sitta i lugn och ro?* Det kommer jag inte ihåg, som sagt det är 10 år sedan, det kommer jag inte ihåg.

2. Jag skulle aldrig kunna lära mig att montera efter pärmen. Inte en chans i världen. Dom är krångliga. Det är väldigt krångliga instruktioner. *På vilket sätt tycker du att dom är krångliga?* Dom är svårskrivna. Hade det varit mer lätt-fattligt "såhär och såhär" och så, men det är det inte. Jag tycker personligen att dom är väldigt krångliga, fattar ingenting om jag läser dom, blir inte klokare ett dugg. Somliga tvärt om.
3. Om de är mer raka, klartext hur man gör. Det ska inte vara luddigt, utan shoff shoff shoff, såhär gör man. Så att man fattar. Är det klartext såhär och såhär gör ni, och sen dessutom bilder då fattar man. Men det här som är. Och så just det här att man läser dom här WES:arna så är det oftast blandat med alla olika modeller i all text dessutom. Så att på varje papper ska det ju stå en modell, det är papper för varje modell om man säger så, men ändå är det väldigt blandat i texten på något konstigt sätt. Så det är ju inte klart hur den modellen, utan det är inbladat andra modellern med, så det är väldigt, det är lite luddigt.
   (a) *Typ att du tar med dig verktyget, du har en egen metod som inte.* Nej jag försöker faktiskt montera som man ska göra. Jag är nog den enda som gör det tror jag. *Men du har aldrig tänkt, ja men gör jag såhär hade der gått lite fortare, eller det hade blivit lite enklare för mig?* Nä men oftast så är sättet som man lär sig från början, det brukar vara bra. Där de räknar ut vad man ska göra, det brukar vara bra. Om man lär sig att jobba efter det sättet så funkar det bra. Tycker jag, eller det har funkat för mig i alla år iaf.
   (b) *Jag ser att du har glasögon, men har du några fler förhinder, typ dyxlexi eller andra fysiska begränsningar?* Ja jag har en hand som är kass.
   (c) Nä men syn, jag ser bra med glasögon. Men jag har lärt mig att använda den, min finmotorik har försvunnit. Så att jag har lärt mig att jobba med andra delar i handen, det funkar på denna banan, men jag skulle aldrig kunna byta till en annan bana. *Men känner du då att det är du som har anpassat dig till banan?* Ja, det är ju jag som har fått anpassa mig. *Det finns inga hjälpverktyg?* Nej det finns inte, det går inte. Jag kan inte ha hjälpverktyg till en hand som, nej det går inte. Vet du man får bara hitta lite genvägar hur man ska lösa problem, det funka iaf.
4. Hur vi får information om detta? *Ja.* Vi får väl, jo vi blir informerade om att nu ska vi, muntlig information får vi på varje balans. Så nu ska vi göra ombalansering snart, då har vi ju ändrat om en del. Så då får vi det både muntligt, dom går runt och säger "såhär gör vi här, och det gör vi här". Så dår flyttar vi monteringarna fram och tillbaka runt på hela banan. Så ja. Se står det ju skriftligt på papper också vad man gör på varje balans då i början.
5. Nej, det är bara det att jag vill ha med. *Ja tydligare?* Tydligt varje modell, inte massa ludd runt om. Utan på denna modellen är det; så, så, så,så. På denna modellen är det; så, så, så,så. Alltså det kommer ju, även om det är samma sak så ska dom va uppdelade så här va.

C.10 Interviewee 10: Operator

1. Jo, först fick jag lära mig en balans. Och sen när jag kunde den fick jag teoretisk utbildning på den också. Sen fick jag stå där själv när det inte fanns personal och så fick jag lära mig resten av banan när det fanns personal.
    (a) Ja, precis jag fick sitta ner och läsa instruktionerna. *Ungefär hur lång tid hade du på dig?* Alltså så länge jag behövde.
2. Jodå de är bra. Det är inte alltid att dom uppdateras i tid med ombalanseringar.
3. *Det kan vara vart de är placerade, urformade, innehållet.* Nä bara att dom är uppdaterade så.
    (a) *Som inte står med in instruktionerna, t.ex. Att du bär med dig ditt verktyg när du inte ska bära med dig det, eller att du placerar den där den inte är avsedd att placeras eller liknande?* Hm, ja det skulle jag säga. Alla har det. *Är det mycket sånt eller?* Nej, inte så mycket.
    (b) Nej.
    (c) *Vet du någon som har det? Och jag tänker då snarare hur arbetet tar hänsyn till det, finns det hjälpmedel, för att hjälpa, som då hjälper folk med olika begräsningar?* Nej, det jag kan tänka är att folk har haft, sånna här, handledsskydd när dom har haft ont i handleden.
4. Ja, ja dom går ju igenom hur det nya sättet ska, hur vi ska arbeta på det nya sättet innan vi ändrar det. *Vem är det dom informerar om det?* Ja, både lagledaren framförallt, och ibland så har vi ägen gjort tester innan för att se, testa dom nya momenten. *Får ni komma med inputs då eller?* Ja, oftast är det dock vänster, Line X för dom har lite extra moment som behöver testas.
5. Nej.

C.11 Interviewee 11: Operator

1. Det gick rätt smidigt. *Men hur gick det till liksom, hur gick processen till?* Jag var med en lärning, eller en som lärde mig. *Som gick bredvid dig då?* Som gick bredvid mig ja. *När blev instruktionerna introducerade till dig?* Under, under tiden. Lite mellan också.
    (a) Ja, men fick sitta med pärmen ibland också. Inte enbart lära sig. *Kände du att du hade, eller var du stressad då liksom? Du hade god tid att läsa?* Nej, man fick god tid att läsa sitta och läsa bara.
2. Dom är rätt tydliga ja med nyckel-symboler som man fokuserade på. För varje balans.
3. Kanske det andra utöver nyckel-symbolerna, kanske att man kan göra det lite tydligare. *Menar du spårkmässigt då eller, är det liksom upplägget?* Upplägget menar jag.
    (a) *Så att det går snabbare eller bli lättare för dig? Typ ta med dig ditt verktyg, eller såhär så det går lite fortare.* Ja det har jag. *Till vilken grad gör du det? Har du många olika metoder eller?* Ja faktiskt, det har jag.

(b) Nej inte direkt.
(c) *Vet du om någon som har det?* Hos oss menar ni? *Ja.* Nej inte vad jag vet.

4. När det kommer nya balanser. Genom ett papper vi ska skriva på med instruktioner som vi får läsa noggrant innan vi skriver på det. Oftast är det så. Och så muntligt också. *Tycker du att det fungerar bra?* Ja.
5. Inte vad jag kan komma på nu.

C.12 Interviewee 12: Operator

1. Jag började gå bredvid en tjej som heter X, fick kolla lite hur hon gjorde. Sen fick jag själv börja testa lite grejer. Började med en sak, och när jag liksom kunde det så fortsatte jag och göra fler grejer tills jag tillslut kunde de flesta grejerna. Eller hela balansen. Och sen så stod hon och kollade på och hjälpte till när jag behövde hjälp och sa till om det var något fel jag gjorde eller så. Så att nä, det gick bra. Och jag har gått bredvid olika så att det har varit mycket positivt för jag har lärt mig olika beroende på vilken person det har varit. Då har det varit lite mer tips på den sidan eller så. Så det har varit, det har varit bra att gå med olika personer för då har man lärt sig lite beroende på person till person. *Ah okej, så alla gör lite olika? Man hittar sätt som funkar för en själv eller?* Ja precis. Så det har varit lite olika knep jag lärt mig där. *Bra, och instruktionerna, pärmen, när introducerades dem för dig?* Det blir ju precis innan, alltså de känner att nej men du är liksom färdig till att gå själv. Så då har man fått läsa igenom den pärmen.
   (a) Ja, det, hon, eller den personen jag gick bredvid gjorde balansen medan jag satt och fick läsa igenom. Så att jag hade god tid på mig.
2. Jo jag tycker det är bra för det är både text och så är det bilder. Så att.
3. Det står ju först på engelska, sen står det på svenska. Kanske dela upp det.
   (a) *Det sa du ju lite att man hittar små egna knep.* Ja alltså det är olika knep, alla gör ju olika, typ med fiskbenet, hur den ska vara satt eller... det är jätteolika. *Så det är hög variation?* Ja, typ hur man sätter i fönstret. Vissa tar den ju rakt in men vissa liksom... så det är jätteolika.
   (b) Nej.
   (c) *Vet du någon som har det här på Line X?* Inte vad jag sett än.
4. Vi har blivit frågade hur, asså, vi kommer, eftersom jag precis lärt mig nu, så, jag fick ju reda på det redan första veckan när jag gick här, började här. Och då sa de det att jag kommer få lära mig nu, sen kommer jag få lära om mig. Så jag kommer ju få göra, lära mig igen. Så att det... det enda vi har fått veta är att ombalanseringen ska ske på en helg och sen ska vi komma tillbaka och då är det under upplärning igen, att man liksom får se hur balanserna är och lära om sig. *Är det muntligt ni har fått reda på det eller?* Nej vi har skrivit på papper, har vi faktiskt gjort. Så vi har fått läsa igenom och då tog teamleadern över liksom, så att man fick läsa igenom det och skriva under att man läst det.

5. Nej. Det har vart lite att banan innan har fått liksom, kan jag kanske inte kontrollera någonting och då liksom kommer det över på oss när vi ska skruva i skruvar och så. Att de kanske gör klart det, att verkligen kolla det noga, förbättra, för vi jobbar ju ner oss *Att det är fel som kommer vidare till er?* Mm, att de kanske bara kontrollerar att, ja, gör om det.

C.13 Interviewee 13: Team leader

1. Den gick till så att först blev jag introducerad på alla balanserna. Sen så fick vi lite djupare träning på samtliga balanser och de olika momenten. Och sen då när man hade tempot och när man i princip var redo att gå själv, då fick man sitta ner och läsa pärmarna, se, jämföra det med hur det är praktiskt. Och sen så, efter det, så följer vi upp med QPS, och sen gick man själv.
   (a) Ja, det gjorde det.
2. Vissa är väldigt bra. Vi har, vi har gjort, vi har börjat med att revidera alla pärmarna, nu under dagtid. Och det är jag som sitter med revideringen. Så jag sitter och försöker få dem till att bli bra. Och om vi säger att vi har hunnit med 20% av balanserna kanske som vi tycker är tydliga, bra bilder och liksom bra beskrivningar. Så att, vissa är bra och andra har bilder sen dörrverkstaden innan Doorline liksom.
3. Ja, jag tycker att det ska vara,alltså bilder vi får utav beredningen, alltså instruktionerna vi får av beredningen, PKI:erna och så. Där, asså där går det inte att härleda något till vad vi ska faktiskt göra. Tycker jag. Det, man får ofta en 3D-ritning av en del liksom som man inte själv hittar liksom. *[litet kort avbrott pga störda]* Nej men, men så, så att jag tycker liksom att för att vi ska kunna göra ett bra arbete här på banan och förbättra, främst då WES:arna är det ju vi gör själva, så tycker jag att man ska få liksom mer referenspunkter, mer fakta som fungerar för oss ifrån beredningen. Ofta får vi själva leta efter referenser, efter amen toleranser och så, istället för att det är något som vi faktiskt har svart på vitt att det här, det här gäller, det här gäller inte.
   (a) *Till exempel att man tar med sig verktygen eller att man gör i en annan ordning för att det är mycket enklare.* Ifall vi har sådana metoder, det lyfts upp rätt var det är. Då lyfter vi det genom teknik, genom våra tekniker, så att vi ska, så att vi får betalt för att göra den metoden på det sättet. För att om vi själva hittar på egna metoder så gör vi jobb som vi inte får betalt för och vi vill ju ha betalt för allt jobbet vi gör. Så att då, vi har ingen, det klart att det finns variationer mellan montörer och så men vi har inget systematiskt, att vi gör såhär istället för det som står i pärmen. *Nej precis, det är väl mer om ni har egna, att folk har egna sätt att göra det på?* Ja, folk har egna. Det finns små variationer. Sen ifall någon tar med sig penseln i första gången eller andra gången liksom, i princip. Så att små variationer finns alltid. Från person till person.
   (b) Nej *Vet du om någon i ditt lag som har det?* Nej, inte vad jag vet
   (c) -
4. *Både till laget och till dig.* Jag får ju ofta det till mig utav våra tekniker.

Ifall det är från, asså från ett ASG-protokoll eller ifall det är någon som de fått ifrån beredningen. Så att de har gjort ett grundläggande underlag. Sen då, det jag gör, är att jag justerar WES:arna så att det passar oss på banan. Och sen så gör vi ju infostyrningar med det så att då har vi. Då tar vi ett utklipp på WES:en och så lägger vi den i ett mindre format på ett papper och så skriver vi en förklaring att "detta ska vi göra nu, vi ska göra det på detta sättet och det här är varför vi gör det". Och sen då så går den informationen ut till alla i laget så får man själv signerar och liksom synka att man har fått informationen.

5. Nej, inget speciellt så. Som sagt, det har väl legat släpande länge. Det finns mycket, mycket gammalt material som behöver uppdateras.

C.14 Interviewee 14: Operator

1. Hur den gick till alltså? *Ja när du gick bredvid, om du gick bredvid, förklara flödet.* Ja, jag fick ju gå bredvid och jag fick även känna på själv direkt om jag ville. Men vet min inlärningsmetod är bäst med att jag tittar först, och sen repeterar jag. Så det var så jag gjorde. Jag fick göra lite som jag ville. Jag fick gå med en handledare i cirka 4 veckor. *Instruktionerna, när blev de, alltså pärmen, när blev du introducerad för dem?* Först gick jag dem här 4 veckorna, sen fick jag sätta mig och läsa dem.
    (a) Ja, alltså man fick ungefär 30 minuter per pärm, 20 minuter per pärm.
2. Jag tycker de är ganska, de är väl ganska exakta faktiskt. Det är ändå, jag tror det är , ja men det är bra.
3. Ingenting som jag kan komma på spontant nu faktiskt. Jag har funderat lite på det också innan men… Att en förändring ska ske här inne, det krävs väldigt mycket. Det är inte… *Men om du fick drömma fritt, hur tycker du, är de lätta att läsa eller?* Ja, men det är dem. De är både på engelska och svenska. *Och det är lätt att hitta i dem eller?* Ja, eller eh, aa… Jag tycker de borde vara mer tydliga med vilken bil det gäller. Typ; "nu läser du om den här bilen, nu läser du om den här bilen". Det tycker jag dem borde vara. Mer tydliga.
    (a) *Att du tar med dig verktyget eller något sådant?* Ja, precis. Det är det jag gör. Vissa stationer tar jag med mig verktygen. Vad gör jag mer? Ja men det är nog det. *Du har några egna metoder?* Jag kan ju inte berätta om mina fusk heller.
    (b) Nej.
    (c) *Vet du någon som har det?* Det finns några som ser dåligt. De måste kanske gå ett steg extra för att se vilken bil som kommer in på banan. Eller på din balans. Så att de vet hur de ska förbereda sig, med vilket material. Så att de tar rätt material till den bilen som kommer in i hans ruta. *Kan det vara lite otydligt att se vilken bil som kommer in?* Asså om du, allt handlar om intresset också. Hur mycket kan du om bilar. Asså då har du lättare att läsa av liksom. Om du är bilintresserad, så har du lättare att känna igen en dörr. Då vet du att den, du behöver inte

läsa specen. Då vet du att, aha den här stora dörren till exempel, den är XC90. Om det är en mindre dörr, ah då vet du att det är en av dem mindre bilarna. Sen finns det också vissa punkter man kan titta på, på dörren som du kan avgöra då om vilken bil det är. Och det är det som då, de som kanske har lite sämre syn har svårare med.

4. Låt mig tänka här bara. Ibland då så har vi ju lite längre stopp. Då blir vi ombedda av lagledaren att gå igenom pärmarna. Ibland har de kaizen, ombalansering, och så vidare. Då får vi till oss att de kommer ha kaizen till exempel i helgen eller någonting. Då vet vi själva att någonting kommer hända i pärmarna. Men det är inte så riktigt konkret att "ah nu har vi ändrat pärmarna, nu tar vi tid för att läsa detta". *Så det kan vara lite oklart när ni ska..?* Ja det kan det absolut. *Så sitter ni ner och läser och..?* Ja precis. Vi något stopp såhär, produktionsstopp. Då får vi sätta oss.
5. Nej.

C.15 Interviewee 15: Operator

1. Det var länge sen, jag kommer inte ihåg riktigt. Men man lär sig väl steg för steg, man lär sig grunden först, hur du ska montera så man läser pärmarna så. Och går med någon som lär upp dig på olika balanser tills du kan själv. *Kommer du ihåg om du fick läsa pärmen innan, under eller efter?* Innan.
   (a) Ja, ibland.
2. De är bra.
3. Kanske mer ordningsamt på något sätt, bilder eller texter på något sätt. Så man följer dem lättare. *Lite bättre ordning?* Ordningen, precis.
   (a) *Till exempel bär med dig verktyget eller placerar det någonstans.* Det händer ibland ja. *Är det mycket sådant på Line X?* Ja, det är det. *Är det då främst att man tar med dig verktyg eller är det att man gör i en annan ordning?* Ja en annan ordning. De läser pärmarna men det är inte rätt, det är så stor pärm, det är inte verkligheten när man monterar.
   (b) Fysiska besvär.
   (c) Inte ofta. *Inga hjälpmedel som du kan använda för att underlätta?* Nej, eller det finns vissa hjälpmedel men är du skadad så är det väldigt svårt. *Får du anpassa dig då eller hur funkar det?* Det får PL kolla upp vad man har för besvär och placera en någon annanstans. Ibland är det svårt och ibland går det inte, ibland finns det inga platser och då får man stå där och lida. *Oj det lät ju hemskt.* Ja så är det.
4. På tavlan alltid. *Bara på tavlan då eller?* Ja, eller antingen möte eller så haltar vi och så går PL och berättar vad vi har, nackdelar och så.
5. Nej.

C.16 Interviewee 16: Operator

1. Upplärningen, hur menar du? Hur snabbt jag lärde mig eller? *Nej, hur går en träningsprocess till, alltså när man får gå bredvid och läsa instruktioner och sådär?* Alltså först och främst kollar man ju asså hur personer som du går med bygger och så och så tittar du ju bara till en början. Sen får du känna på lite och så vidare och så vidare. Aa så, så lite mer och så, du kollar i början och de förklarar exakt hur du ska göra det ena efter det andra. Och så vidare och så vidare. Sen får du helt enkelt känna på själv. *Fick du läsa instruktionerna någon gång under den perioden?* Eh nej, efter att jag var klar med upplärningen fick jag läsa.
   (a) Ja, det hade jag.
2. Delvis faktiskt. Speciellt när man är ny, vissa grejer är svårt att förstå och lite allt, man fattar, men asså under tiden så kommer man ju in i det. Man bygger ju och sen läsa, "aha det här hänger ju ihop med detta". Det tar lite tid men du kommer in i det.
3. Lite mer bilder, tycker jag. Det är jättemycket text, så bilder och lite text. Mer bilder helt enkelt.
   (a) Till exempel ta med dig vertyg eller göra i en annan ordning. Ibland händer det, jag känner att det är enklare. Men när chefer står bredvid så måste man ju jobba standardiserat liksom. Så det blir ju lika bra i och för sig så.
   (b) Nej, jag har haft problem med ryggen senaste året.
   (c) *Får du ont i ryggen när du jobbar?* Ja ibland, men jag går ju på medicin nu och så, så det är bättre. *Känner du att du kan anpassa dig så att du inte får ont i ryggen när du jobbar?* Ja, det är därför jag gör det på mitt sätt ibland, jobbar på mitt sätt. Tycker det är enklare. *Om du pratar med din chef, kan den personen hjälpa dig då så att du kan arbeta på annat sätt?* Det är inte alltid. Oftast så får man kolla med mina kollegor om den balans som jag just tycker är jobbig, om jag känner besvär i ryggen, så får jag liksom helt enkelt byta bort. *Okej då blir du omplacerad.* Ja precis.
4. Framförallt är det i infostyrningar som de går runt med, så får man läsa igenom och skriva på. *Okej så då får ni skriva på att ni förstått.* Ja precis. *Men det är ingen muntlig information?* Sällan.
5. Nej.

C.17 Interviewee 17: Operator

1. Jag fick ju då, jag blev tilldelad, eller jag hade väl lite specialfall för jag blev inslängd mitt i en vecka så jag började på en torsdag. Och då fick jag, hon som blev handledare, hon var inte där då, så jag fick gå med folk som inte var utbildade till handledare. Så jag fick första dagen med en person, sen andra dagen med en annan och det var jättebra så, men det blir ju konstigt när det kommer en ny och jag har aldrig jobbat på, som jag skrev, så har

jag bara jobbat här i ett år. Och jag har aldrig vart liksom i någon liknande miljö innan. Så det kändes lite konstigt i början men sen fick jag då gå med samma person och henne gick jag med i ungefär 2 - 2,5 veckor ungefär. Och då kändes det jättebra. Så man går ju med hela tiden, de visar, instruerar och rättar till när det blir fel. *Och instruktionerna, pärmen, när någonstans introducerades den?* När jag hade fått börja prova på att montera, alltså göra alla monteringar, så jag ändå hade ett litet hum om vad det var. Så fick jag liksom sätta mig någon gång och läsa igenom.

   (a) Precis.

2. I pärmarna? *Ja precis.* Jag tycker väl de är tydliga, det är nästan så att de är för tydliga så man vet inte riktigt vad man ska fokusera på. Och det blir väldigt mycket, och det står också på engelska, och sen så på svenska. Och då vet jag, jag till exempel, tog hela och läste på båda hela tiden. Glömde av liksom. Men sen är de väldigt bra, men det är mycket som inte stämmer, till exempel är det många tidsintervall som inte stämmer, som man lärt sig i efterhand. Men just då när jag läste den första gången så var det mer att man läste noga men det är inte så mycket som fastnar när man läser, för det blir väldigt tjockt med mycket text liksom.
3. Jag vet inte, kanske att man ser över dem oftare. För ofta, de säger att det är ofta teknikerna som skriver och så kollar de kanske inte alltid över dem. Och så sitter vi där och skrattar åt att de skrivit att man ska knäppa på sig väskan på 0.4 sekunder liksom. Så det är mycket saker som vi kanske "aha, ska vi göra det här på så kort tid" och så funkar det inte så i praktiken. Så det är mycket sånt. *Är det ofta tiden inte stämmer, att den är för kort i instruktionerna?* Mm, både och. För ibland, efter ett tag så lär man sig ju jobba mycket snabbare. Men det är många sånadär smågrejer som de tycker vi ska göra väldigt fort och så går inte det. Så det är lite både och.
   (a) *Till exempel att du bär med dig verktygen när du inte ska göra det, att du placerar dem där de inte är avsedda att placeras, gör i en annan ordning.* Jag har, det är väl ibland om man, till exempel, vi kallar det nerjobbad, när man liksom hamnar, vi har ju där vi ska jobba enligt standard, och när man jobbar utanför, så är man nerjobbad. Så ibland när man blir nerjobbad så gör man ett moment innan andra, men det är endast då. Annars försöker jag jobba via standard, för jag har också fått problem med min handled. Och då tänker jag det är bra om jag jobbar bokvis, ergonomiskt sätt. Och sen är det, i så fall är det väl vissa, till exempel hoppar över att ha väskan och går och tar material istället. *Okej, sådet är en väska med materialet i.* Precis, så på många är det att vi måste ha till exempel, på en balans så är det att vi måste ha med, för de här nyckelsymbolerna i böckerna som är det som är noga, så då måste vi använda den men på vissa balanser så kan man få välja själv typ.
   (b) *Du nämnde din handled.* Mm precis.
   (c) Mm, de har ju, jag har blivit skickad till feelgood som är deras liksom vårdcentral. Så ganska fort också, jag märker att cheferna tar det väldigt seriöst och verkligen kollar, de har frågat om jag vill byta team till ett enklare, men jag trivs så bra så jag vill inte göra det. Men verkligen, jag

har fått handledsskydd som verkligen är bra och återbesök och tid. Så jag tycker verkligen att de har varit duktiga så, sen är det ju lite upp till mig om jag känner att, jag vill ju väldigt gärna jobba och så, men om jag skulle vilja ta ledigt så får jag ju det liksom. Men samtidigt så om jag ändå säger att jag ska vara där och jobba, så får jag göra det jag ska göra. Svårt att förklara men det är liksom, jag måste ändå klara jobbet liksom.

4. Ja det blir vi, då får vi gå på sådana här, de där lapparna, jag kommer inte ihåg vad de heter. Infostyrningar, då går de runt med dem så får alla i laget skriva på och är det någon som inte är där så sätter de upp en liten bricka så man får ändå alltid till sig. Sen brukar de alltid läsa av ifall det är eftersläntare så brukar de alltid lösa av dem så de får läsa. Sen då att vi får läsa pärmarna på morgonen. Så det finns alltid liksom, kanske inte just under arbetstid, men det finns alltid möjlighet att göra det.
5. Nej. Nej men det är väl kanske att man strukturerar upp dem lite mer. Det kan lätt bli så att när man skriver dem så är det så himla klart för en själv hur man ska göra allting men många som kommer hit kan itne liksom läsa typ diagram eller hur de har tänkt med. Det är ju väldigt mycke tinformation på små ytor så det blir väldigt liksom såhär, och så en linje så som är något eller så.

C.18 Interviewee 18: Operator

1. *Hur var upplägget, vad fick du göra. Hur såg upplärningen ut?* Det börjar ju med att man, det börjar med litet. När vi hamnar på positionen så började ju montören som lärde upp mig att visa lite i taget. Visa liksom allt ihop och pratar samtidigt. Och sen efter ett tag så fick jag hoppa in lite själv i arbetet. Så jag jobbade upp ett moment och sen så gjorde jag det snabbare och snabbare och sen kunde jag ju göra två moment och sen observerade montören att han börjar jobba bra men behöver fortfarande bli snabbare på det här och det här. Och då sa hon det till mig direkt. Du behöver bli snabbare på det här och det här men annars jobbar du bra. Och sen så var det ju vissa andra krångliga grejer då hon fick hoppa in och hjälpa mig i början. Och sen så hade jag ju bra upplärare så hon släppte ju inte mig direkt när jag kunde alla momenten utan hon höll kvar mig i upplärningen lite till bara för att se till att de här småfelen, hur ska man säga, nybörjarfelen försvann. Så sen släppte hon iväg mig. Så det var ju bra på det sättet. *Instruktionerna, när blev de introducerade under upplärningen?* De blev faktiskt introducerade för mig i slutet eller, och faktiskt efter min upplärning. För att det blev så att jag fick lära mig så som de arbetade på banan och sen så det som står i pärmen. För i många fall så måste vi improvisera. Jag vet att vi inte får säga så egentligen men eftersom ni gör ert examensarbete så blir det så att om man blir nerjobbad eller någonting så måste man kunna se till att fixa det under den tiden som man har fortfarande.
   (a) Alltså, jag koncentrerade, jag har ju jobbat på fler ställen än bara här och

jag har ju läst lättlästa instruktioner som bara förklarar allt såhär klockrent. Men Volvos instruktioner är faktiskt väldigt krångliga till skillnad från en lättläst instruktion. Och då blir det liksom en såhär gap mellan, för du vet, de säger massa artikelnummer och alltihop. Så du vet egentligen inte behöver jag läsa, behöver jag kunna alla de här artikelnumrena? Behöver jag kunna de här, det som det står? Och sen så blir det väldigt såhär, kan jag det eller kan jag det inte? Har det gått in? Och sen så är det liksom, jag tycker att det är onödigt att vi har samma instruktioner för många bilar, för två modeller istället för att ha en tydlig instruktion som säger; ta och skruva i skruven. Du gör samma sak på alla bilar. Till exempel, vi ska ta handtagen. Där vi krokar in modulen till utsidan och sen så drar vi en skruv. Och det gör vi på alla bilarna, men i alla instruktioner så repeteras den här instruktionen. Så då blir det såhär, då läser man samma sak om och om igen istället för att få fokusera på okej, detta är samma moment, hoppa över. Och sen läsa det som är viktigt för just den varianten. Så på det sättet så krånglar de till. Att du måste bläddra mer i instruktionen än vad du egentligen ska behöva. För om man bara gör ett bas-set först, som vi hade på ett annat ställe, vi hade bas-montering, sen hade vi varianter som vi öppnade och kollade upp. Om det kommer den här, typ XC90, då har den här varianten, den har två - tre skruvar extra, så visar de alltid bilder. *Var det på ett annat ställe på Volvo eller på ett annat företag?* På ett annat företag, jag har nämligen jobbat fem år på Scania innan.

2. Jag tycker att de är helt undermåliga faktiskt, om man ska tänka ur ett nybörjarperspektiv. För grejen är den att, om jag jämför Scania med Volvo, bara såhär krasst så, det var montörerna på Scania som skrev pärmarna. För att det var ju montörerna som lärde upp de nya montörerna och montörerna på Scania var mycket mer kunniga till, mot tekniker-hållet än vad montörerna här på Volvo är. Men här känner jag att montörerna är mer specialiserade på att bara montera och inte en specifik person för att lära ut och allt det andra. Till exempel, hur ska man säga, det fanns en annan typ av disciplin. Och genom den disciplinen så försökte vi alltid göra det mycket lättare på andra ställen. Jag har ju också jobbat på, som roddare, satt ihop scenbitar och till. Och då var det också ganska simpelt för då var det studenter som aldrig hade monterat ihop någonting. Då var instruktionerna jätteklara, okej, du gör det här och det här. För att om de här scenbitarna vägde 25kg styck och du lyfte de oftast ensam. Så om du tog, om det kom in en ny student och skulle lyfta de här, då sa man till honom direkt; såhär lyfter du dem. För annars så tog det ju kanske två - tre timmar så var han skadad. Hade sträckt någonting eller tappat den på fötterna. Så på det sättet så tycker jag att instruktionerna är väldigt väldigt, för avancerade för det jobbet vi gör. Vi ska inte behöva ha en hel sida för hur vi ska sätta plugg till exempel, vilket det känns som ibland här.

3. Gör dem simplare, gör dem kortare, gör dem mer lättlästa. För man får ju också tänka på att, även om det krävs gymnasiekompetens för att börja jobba på Volvo så finns det faktiskt så att det finns folk från utlandet som

har gymnasiekompetens som kommer hit men kan inte svenska så bra och då måste man också ta den faktorn in. Om vi har en person som är kompetent, kunnig, på arbetsmarknaden, som vi vill få in i företaget, så måste han kunna läsa instruktionerna också på ett så simpelt sätt som möjligt.

(a) *Som inte står i instruktionen, till exempel ta med dig verktyget eller liknande.* Nej, alltså vi på Line X är faktiskt väldigt duktiga på att göra den förbättringen att vi har verktygen på oss. *Men det står inte i instruktionen att ni ska ha verktygen på er eller?* Jo, det gör det. Så det är vi duktiga på.

(b) *Du pratade om att du har dyslexi, och jag ser att du har glasägon, har du några fysiska begränsningar som kan försvåra ditt arbete, skador?* Nej . Det är ju så att jag har idrottat innan så jag har lite, har haft skador innan, alltså sportskador men eftersom jag har rehabiliterat mig och sånt så har jag inte dem problemen. Men jag kan relatera till folk som har dem problemen.

(c) Alltså det enda som är skillnaden mellan att ha dyslexi och en vanlig människa att läsa instruktionerna, det är att det tar längre tid. Och sen är det så att i vissa fall så, våra stationer, vi är alltid, just nu så håller Volvo på och tidspressar och försöker ta bort en gubbe lite varstans och några grejer, så att vi alltid ska jobba. Så, i många fall så känns det som att de bygger instruktionerna efter ett tekniskt perspektiv, som en ingenjör, "ah roboten ska gå åt detta hållet", och man då, tänker inte igenom det här med micro-vila. Så då kan det bli så att, det kan bli lite jobbigt om man blir nerjobbad, så måste man röra sig snabbt sidled, så åt ett annat håll. Och då finns det chans för folk som inte till exempel sportar på eftermiddagen, som jag inte gör längre, att kanske sträcka benet eller någonting. Och då kommer, och folk kommer inte stanna hemma för en sträckning men det kommer ju bli värre med tiden om man fortsätter röra på sig åt det hållet, på det sättet. Så kanske ett bättre rörelseschema kan också läggas in i instruktionerna, där de verkligen kollar ergonomiskt och verkligen skriver i instruktionerna. För då vet dem aa, hade det stått i instruktionerna, vänd dig om ordentligt, snurra inte bara, så att det verkligen trycker in ergonomi i instruktionerna. Mer ergonomi i instruktioner, inte bara den här mekaniska monteringen.

4. Vi får den pö om pö faktiskt. Typ, det är en process som är som ett timglas, det tickar ner liksom. Vi får information ibland och vissa får en annan information och sen så typ emulgeras det till den informationen vi ska ha. Till exempel, vi fick härom veckan att vi inte skulle lyfta av en sak, från logistik. Och fortfarande idag så är det folk som inte har fått den informationen. Så, jag vet inte om det är meningen att vi ska, som kamrater, säga det till varandra eller varför inte lagledaren eller PL har bara tagit det och skickat ut. Det finns sådana här lappar vi får, jag vet inte vad de heter. Tillfälliga instruktioner. *Informationsstyrning.* Ja, precis, informationsstyrning. Att vi skriver flera såna, när det kommer ut sån information. För då kan lagledaren se vem som har fått informationen och sen när de kollar på lagtavlan: "ah, den här personen här, hon har inte den informationen". *Och det sker inte varje gång*

det sker en förändring, att det finns sådana här blad? Nej det finns inte alltid. Utan det blir såhär muntligt. Muntlig instruktion.

5. Nej faktiskt inte.

C.19 Interviewee 19: Process Technician for Line X

Produktion (lagledarna) väljer själva nyckelsymboler, produktionsteknikern är inte involverade alls. Om det är problem någonstans (felutfall) så kan lagledarna sätta nyckelsymbol tillfälligt till problemet inte finns kvar. Dock finns det några som håller på att undersöka om det finns en alternativ lösning till detta. Tanken är att beredare sätter nyckelsymboler om det har med ergonomi att gör, dessa håller även på ta fram ett alternativ gällande hur OIS:en ska se ut.

Vi översätter texten, och vi får inte använda google translate. Så som du tolkar texten ska du översätta. Beredaren bara släpper PKI:et och så får produktions teknikern ta över. Om det är något ord man inte förstår får man ju slå upp, och översätta bäst det går. Om det är olika bilmodeller så kan man kopiera från likadan operation från annan modell. Vi får översätta hur vi vill, men vi kan också få feedback på översättningen och då ändrar vi.

Produktionstekniker balanserar ut operatoionerna. Däremot om man vill flytta en operation måste Produktionsledaren och Skydd ta det beslutet tillsammans. Vi gör också Kaizen tillsammans där vi planerar hur saker ska göras om det kommer en förändring, hur allt ska balanseras. Alla tre sitter med tillsammans och har gemensamt ansvar.

Line X ligger bra till i sina mål, antagligen får de högre mål till nästa år. För att de fortfarande ska sträva efter något.

Det är olika ägare (beredare) till olika PKI:er, de pratar inte med varandra. Även om operationerna är exakt samma så ger de olika betalt i TMU (tidssättningen är olika). Samma PKI-ägare kan ge olika betalt också. De sätter en uppskattad tid m.h.a. SAM-analys. Om de bara får en bilmodell så missar dem de andra. Det har hänt flera gånger att jag har fått ett PKI med en tid, sen tittar jag på ett annat PKI som innehåller exakt samma operation fast för en annan bilmodell, så är TMU satt till mycket lägre där. Då måste jag höra av mig till beredaren, sedan ska tidsättaten komma ner till produktion igen för att mäta tiden, och sedan får jag skriva om instruktionerna. Hade beredaren satt rätt tid från början hade man sluppit hela den processen.

Vi får heller inga försättsblad, eller notiser när tidsättningen ändras, vi måste aktivt gå in varje dag och kolla om det har skett en förändring. Varje vecka är det någon som har ett PKI där TMU har ändrast utan att de vet om det.

Global ME (ME i Torslanda) vill inte ha med fabriken att göra, så måste jaga lokal

ME, som sen går till global eftersom det är global ME som kan göra förändringar. Det är global ME som äger PKI:erna. Om jag bara vill göra en liten ändrign behöver jag inte gå via ME. Dock måste jag komma överens med alla fabriker om ändringen. Alltså måste jag hitta min respektive för Line X i alla fabriker och alla vi måste tillsammans komma överens (Gent, USA och Kina). Denna processen blir alltid omständig, speciellt eftersom Kina väldigt sällan svarar överhuvudtaget. Det är väldigt oklart kring vem som ska göra vad, RD måste också kontaktas, men oklart vem som ansvarar för att kontakta RD.

För att åt komma notisen i PKI:et måste man öppna hela PKI:et.

C.20 Interview 20: Process Engineer, and Technician

Tanken med de nya OIS:erna är att bil-modellerna ska skrivas ut, istället för de olika samlingnamn modellerna har idag. TMU har tagits bort, och istället ser man bara hur lång tid en operation ska ta. Sedan vill vi även att beredaren ska sätta nyckelsymbolerna, så som ergonomi, kvalité och kritiskt moment. Övriga nyckelsymboler får laget lägga till själva. Det ska även tillkomma fler nyckelsymboler. Symbolerna är alltså INTE på väg bort. En av de nya nyckelsymbolern ska användas då det är ett moment laget tycker är väldigt viktigt, montörerna är alltså involverade. Sedan är även tanken att det bara ska finnas WES:ar för operationer som har nyckelsymboler.

WES:arna är omgjorda med ett enklare upplägg. De olika momenten som ingår i operationen har en siffra kopplat till sig, dessa siffror ser man sedan i en bild så att montören förstår vad hen sak se, eller höra.
Det märks att ME inte har koll på vad en OIS är, ibland är PKI:erna så fel att vissa balanser inte går att göra utan två personer behöver anställas.
Vi ska översätta PKI:erna ordagrant. För att skydda sig själv måste man översätta direkt.
Mailar ibland om det är fel i PKI:erna, vissa berdare svarar då samma dag och återgärdarm vissa svarar samma år. Process ingenjören kunde nämna 5 beredare som frågar om det ser bra ut, de ringer då och frågar. Produktions teknikern hade aldrig haft någon beredre som hört av sig ang hur dess PKI såg ut.
Vi brukar samla stora listor med fel vi skickar till ME, listor med fel på PKI:erna. De förstår inte hur viktigt det är här nere. Om vi har 3 dagar i rad där det är fel i PKI:erna så stannar banan. När vi då hör av oss till ME och säger att det finns fel i PKI:erna säger de bara att de inte kan ändra ”ritningarna är låsta, ni skulle sagt detta innan”.
I början av nästa år skall 5 stationer få digitala skärmar, dessa ska främst användas för att logg in och ut på stationerna. Men tanken är att man i framtiden ska kunna ha instruktionerna på skärmen, de ska även finnas videos på hur man monterar. Det vi har gjort är ett skelett man ska kunna tanka in information i. Så pärmen ska bort, vilket sparar massa papper. Vissa pärmar innehåller ca 170 papper.

C.21 Interview 21: Group manager

Lokal ME, ansvar från ett visst skede (slutet) när PKI:erna ska in i fabriken. Man samarbetar då tillsammans med global ME. Global ME är det som finns här, sedan finns det en lokal ME för varje fabrik. I lokal ME finns det då en person för varje område, alltså en person tar emot alla PKI:er för ett område. Lokal ME har med löpande underhåll, och globala är med tidigt i projeket med produkutveckling.

Just nu är det en liten kris gällande vem som gör vad eftersom detta är ganska nytt. Fördes in för ca 1 år sedan. Framförallt lokal ME har lite svårt med vem som gör vad, och tilliten brister.

Det finns stora brister i detta, ansvarsområden behöver redas ut. Det blev en A- och B-laga känsla när detta skedde och folk blev arga.

D Appendix D: Surveys

Enkät för montörer på Line X

Projektets syfte är att hitta förbättringspotential i Line X's instruktioner. För att nå syftet behövs information gällande användningen och uppfattningen av instruktionen, och därför utförs den här enkäten och efterföljande intervju.

1. **Hur länge har du jobbat på Volvo Cars?**

   ____

2. **Hur länge har du jobbat på Line X?**

   ____

3. **Vet du vad en WES är?**
   Check all that apply.
   - [ ] Ja
   - [ ] Nej
   - [ ] Other: ____________________

4. **Vet du vad en OIS är ?**
   Check all that apply.
   - [ ] Ja
   - [ ] Nej
   - [ ] Other: ____________________

5. **När blev du först introducerad för instruktionerna (pärmen)?**
   Check all that apply.
   - [ ] Innan upplärning
   - [ ] Under upplärning
   - [ ] Efter upplärning
   - [ ] Aldrig
   - [ ] Kommer ej ihåg
   - [ ] Other: ____________________

6. **Vet du vart pärmen ligger?**
   Check all that apply.
   - [ ] Ja
   - [ ] Nej
   - [ ] Other: ____________________

7. **Hur ofta läser du instruktionerna?**
Check all that apply.

- [ ] Varje dag
- [ ] Ca 1/vecka
- [ ] Ca 1/månad
- [ ] Ca 1/år
- [ ] Aldrig

8. **Känner du att du har tid att läsa instruktionerna?**
Check all that apply.

- [ ] Ja
- [ ] Nej
- [ ] Ibland

9. **Blir du uppmanad att läsa instruktionera när de förändras?**
Check all that apply.

- [ ] Ja
- [ ] Nej
- [ ] Ibland
- [ ] Nej, får informationen muntligt
- [ ] Other: ______________________

10. **Läser du instruktionerna när du blir uppmanad att läsa dem?**
Check all that apply.

- [ ] Ja, lite snabbt
- [ ] Ja, noggrant
- [ ] Nej
- [ ] Ibland

Figure D.1: Survey 1

Enkät del 2: Instruktion

En kompletterande enkät för att samla information om instruktionerna vid Line X.

Projektets syfte är att hitta förbättringspotential i Line X's instruktioner. För att nå syftet behövs information gällande användningen och uppfattningen av instruktionen.

1. **Till vilken grad följer du instruktionerna (pärmen)?**
   Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Inte alls	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Gör exakt som det står

2. **Om du svara 1-9 på frågan innan: vad är det du gör annorlunda? Till exempel: bär med dig verktyg, gör saker i en annan ordning. Ge gärna exempel på exakt vad du gör och på vilka balanser.**

   ____
   ____
   ____
   ____
   ____

3. **Hur högt prioriterar du tid? Dvs att snabbt jobba upp dig om du blir nerjobbad och att inte stoppa bandet.**
   Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Lågt	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Högt

4. **Hur högt prioriterar du kvalitet? Dvs att inga fel följer med produkten från balansen du går.**
   Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Lågt	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Högt

5. **Om du fick välja mellan att; 1) göra rätt men stoppa bandet, eller 2) göra det snabbt och riskera att det blir fel, men inte stoppa bandet. Vad hade du valt?**
   Mark only one oval.

   ◯ 1) göra rätt men stoppa bandet
   ◯ 2) göra det snabbt så att bandet inte stoppas

6. **Hur får du feedback när du monterat fel? Beskriv gärna hur det går till och hur ofta feedback ges.**

7. **Vilka konsekvenser får det för dig när något blir fel?**

8. **Ranka från 1-5 det som du känner är viktigast. Sätt en 1:a på det du tycker är viktigast, och en 5:a på det du tycker är minst viktigt.**
Check all that apply.

- [ ] Egonomi
- [ ] Kvalité, inga fel på produkten
- [ ] Att inte stoppa bandet
- [ ] Följa instruktionerna till punkt och pricka
- [ ] Bra stämning på arbetsplatsen

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Figure D.2: Survey 2

E Tables

Table E.1: Citations from interviews with operators on Line X

Human attributes	
1	”Some work stations are hectic and therefore I bring the tool with me.”
2	”Sometimes I skip some steps in the instructions when they’re not needed.”
3	”Sometimes I bring the tools since the walking distance gets too long.”
4	”I was introduced to the instruction after my training period. ”
5	”I have an injury in my hand that I have learned to work with. It is impossible to adopt the working method for my disability. I have to adapt and find ways that suite me.”
6	”The person who was supposed to train me was not present, which meant that I had to be trained by several operators who were not educated to educate.”
7	”Yes, I have my own methods of working, which does not correlate with the instructions.”
8	”When I had an idea of how to do the assemblage on the work stations, the instructions were introduced to me.”
9	”I was introduced to the instructions after the training period. I learned the way others worked on the line first, and then read the instructions.”
10	”I usually bring tools with me, but I don’t want to tell you about all my cheats.”
11	”The folder is quite large, you’re not motivated to read it, especially not when you’re working and want the time to pass quickly.”
12	”Sometimes I deviate from the instructions since it’s easier.”
13	”I have back pain and I, therefore, have my own way of doing things. My way is easier. ”
14	”Sometimes when you are falling behind you tend to do the operations in another order to catch time.”

15	”I’ve learnt different work methods depending on the supervisor, everyone works differently.”
16	”I was introduced to the instructions when I was ready to work independently.”
17	”First I had a 4-week training period, and then I got to sit down and read the instructions.”
Instructions	
1	”Volvo’s instructions are actually very difficult to understand, especially when comparing them with a legible instruction.”
2	”The instructions are too advanced in proportion to the work we do. Make the instructions more simple, shorter, easier to read.”
3	”They are sometimes difficult to read and understand.”
4	”More ergonomics in the instructions, not just the mechanical assemblage.”
5	”Instead of repeating the same work method for different car models, they could have the same instructions for all models with equal assemblage.”
6	”I could never be able to learn to work according to the instructions. Not a chance in the world. They are too difficult and complex.”
7	”The WES’s have a mix of different models in the same text.”
8	”The instructions are deficient when looking from a beginner-point of view.”
9	”The instructions are in English and Swedish in the same document, maybe the languages should be separated.”
10	”Some instructions have good pictures, and some pictures haven’t been updated for ages.”
11	”The instructions should be clearer and highlight the car model.”
12	”The instructions should have a better structure to make them easier to read and understand.”
13	”You read the instructions in the folder but they’re not correct, the folder is too big, it’s not applicable to the reality when you assemble”
14	”The instructions are hard to understand, especially if you are new. After a while, you understand the instructions and use them as a complement to the actual work.”
15	”The instructions have a lot of text, it should be more pictures and less text.”
16	”I think the instructions are clear, maybe even too clear. It is hard to know what to focus on.”
17	”There are a lot of things in the instructions that are incorrect, for example, the time intervals, which I have learned while working.”
18	”Sometimes we wonder if the technicians read the instructions after they have written them. We often sit and laugh at the time intervals chosen by them.”

19	”The structure need to be better. Maybe the instructions are very clear for the person who wrote them, but it might be harder for many who work here.”
20	”There is a lot of information on a small space.”
21	”The people developing the instructions have a technical, engineering point of view. They don’t consider aspects such as micro-rest. ”
Work culture	
1	”There are several occasions where we have to improvise. I’m not supposed to say it, but if you fall behind, you’ll have to fix it during the given amount of time.”
2	”Sometimes you can’t be transferred to another line when you’re injured due to lack of spots. When it happens, you just have to suck it up and suffer.”
3	When the managers stand next to you, you have to work according to the standard, instead of working like you usually do.
4	”At some stations, the key-symbols indicate that the usage of one thing is important, but on other stations, you can choose for yourself more.”
5	”As long as you’re taught the correct method, the instructions in the folders are unnecessary.”
6	”It takes a lot for a change to happen around here.”
7	”It’s not about working too fast, you just don’t want to fall behind.”
8	”When you have a disability, for example, injuries, the work is sometimes adapted to your needs but sometimes not, it depends on the person.”
9	”I cannot always talk to my boss about my physical issues, instead, I talk to the other operators and switch to the station that suite physical problems better.”
10	”Last time we only had 7 minutes to learn the new instructions, which was very hard for the new operators.”
11	”Sometimes changes are implemented overnight without informing the operators, so when we start working we are expected to learn the changes within a second.”
12	”When work stations are rebalanced, the operators are informed but don’t get that much time to read the updated OIS’s and WES’s.”
13	”We get handed the “infostyrning” the team manager takes over the work station and I can then read and sign the paper.”
14	”The instructions aren’t always updated when the work station is re-balanced.”
15	”Sometimes during stops, we are told to read the instructions. And sometimes we are informed that a change will be made over the weekend. But most often we are not really told that a change has been made and now you have time to read the instructions.”

16	”Sometimes different operators get different information on how to do things.”
17	”Not all changes in the instruction have an “inforstyrning”, some changes are just introduced to the operators verbally. ”
18	”Due to a lack of staff, I was forced to speed up my training period and work independently before I felt ready.”
19	”An apprentice should have the time he or she needs to learn the work stations, but we don’t.”
20	”During my training period, I was locked to one work station for a long period of time, I don’t remember how long.”
21	”They told me: ’here is the folder, you can read it when you’re ready to work independently’ ”
22	”After you’ve been taught how to work on each work station, you get to sit down and read the instructions.”
23	”During my training period, I had to work alone when there was lack of staff, and learn the other stations when there was enough staff again.”
24	”I’ve learnt different work methods depending on the supervisor, everyone works differently.”
25	”When you can keep a good pace while working and you’re ready to work independently, you get to sit down and read the instructions.”
26	”Everyone has their own methods.”
27	”Everyone has their own way of doing the work.”
28	”Sometimes when you fall behind you grab all the tools and materials you have. Most operators do this.”
29	”Of course, there are deviations between the operators. But we don’t have a systematic way of working that deviates from the instructions.”
30	”We often bring our tools or assemble in a different orders when working.”
31	”When reading the instructions, I was told to focus on the key symbols.”

Table E.2: Answers to question 2 in survey 2; *What do you do differently? For example: take the toll with you, do things in another order. Please give examples om exactly what you do, and on which work stations.*

Citation	Type of deviation
”Sometimes I do differently because it feels better ergonomically”	Improve ergonomics
”Do things in another order”	Order
”Item X, 2 item X at a time. Item Y, 2 item Y at a time”	Skip
”Do not use tool on item X ”	Skip
”Do not use tool on item X work station”	Skip
”Do some things in another order”	Order
”Oftenly other order”	Order
”Place item B before item A”	Order
”On work station X you do not follow the operational order”	Order
”I do operation X more then you are supposed to on work station X”	Wrong
”On the work stations where it is possible I try to avoid using the material-bag, since I get back-pain from using it”	Improve ergonomics
”I walk without the material-bag on work station X”	Wrong
”I start with the wrong operation at some work stations to keep the pace and not fall behind”	Order
”... Work in another order...”	Order
”On work station X I place item B, fixate item C, then item A, and then item D”	Order
”I put item B before i pull item A, so that you do not forget to put item B”	Order
”Work station A: place tool under my arm. Work station B: I mark specification before I get the material. Work station C: Mount item A at the same time as I pull item B”	Order
”Do things in an order that I believe is faster and better”	Order
”Do things in another order...”	Order