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Learning Situations about Digitalization

Development of a Workshop Using Learning, Leadership and Storytelling Theories

Master's thesis in Learning and Leadership

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Abstract

With the great need to stay competitive on the global market in the manufacturing industry, constant efficiency improvements are required. This paves the way for a new industrial revolution: digitalization. Therefore, the need for knowledge and experience about the possibilities and challenges of digitalization is vital. Projects like Smarta Fabriker with the purpose to disseminate knowledge about digitalization to companies and schools as the next generation employees are conducted to fulfil these needs. The Smarta Fabriker project offers an activity-based workshop experience that teaches about digitalization topics.

This thesis focuses on the development of a workshop as a learning situation together with the project Smarta Fabriker. The workshop is developed with application of theories that promote learning and knowledge transfer and its performance is tested and evaluated to identify the benefits of the new workshop. The new workshop is evaluated in comparison to Smarta Fabriker's already existing workshop to be able to distinguish improvements with the new workshop.

The evaluation shows that the participants remember more of the content of the new workshop than of the former one, two weeks after the workshop. Furthermore, the participants claim that they experienced the new workshop as rewarding. However, the results show no statistical significance according to the performed tests due to the low number of participants in the evaluation. The results show only trends of what is the contribution of the applied theories of learning regarding increased learning. Therefore, no general conclusion can be made without further investigation.

Keywords

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1 Introduction

This chapter leads the reader to the aim and question of this work by giving a background and introducing the objective of this work. Further, the research question is defined.

1.1 Background

In recent years, there has been an increasing interest in digitalization in many different areas. One of those areas is the manufacturing industry, which is on the highway of its fourth revolution, the so called "Industry 4.0". This means that the industry goes from traditional factories to smart factories. Products, machines and systems can communicate with each other - to improve processes, assure quality, shorten time-to-market and much more. Digitalization makes it possible to save and use data in order to improve working methods, increase effectiveness and in the end, stay competitive. (edig, 2019)

This is not only a topic that companies themselves deal with. Governments all over the world have understood the importance of creating an economical sustainability through digitalization. The Swedish government spends a lot of resources in order to help companies in their digitization process. One example is the project Smarta Fabriker, financed by the region of Västra Götaland in Sweden that has the purpose to disseminate knowledge about digitalization to companies and schools as the next generation employees. Smarta Fabriker offers an activity-based workshop experience where people learn about different digitalization topics. To show the participants of the workshop what is possible with digitalization, the team behind Project Smarta Fabriker has built different demonstrators. Those demonstrators are to be extended by a new demonstrator that gives the possibility to talk about a holistic perspective on the whole process from product development, over supply chain to customer satisfaction and the advantages of digitalization in this process. The new demonstrator consists of a collaborative robot that is installed in a smart environment which means for example that the machines are connected and every step is traceable. The project Smarta Fabriker develops the demonstrators together with partners from different companies that provide knowledge and cutting-edge technologies and with interns from a secondary high school who lead the workshops.

1.2 Purpose

The object of this work is to develop a workshop with accompanying manuscript that can be applied on the newly created demonstrator about digitalization. The workshop and an accompanying manuscript are developed in accordance with a theoretical basis. In addition to that, the workshop is tested and evaluated.

1.3 Delimitations of the Project

The study aims to show how Teaching Competencies and Storytelling together contribute to the outcome of the workshop. Further, the developed workshop is only evaluated with two test groups. Therefore, the evaluation can't be used to make any general conclusions but to show potential areas of improvement.

1.4 Research Question

This work is about the development of a workshop about digitalization with accompanying manuscript. The question to be answered is:

- How does the usage of the model Teaching Competencies and Storytelling in the development of a workshop contribute to the outcome of the workshop?

2 Theoretical Framework

To comprehend the content of this thesis regarding aspects of learning, leadership and theories applied on the developed workshop, a theoretical framework is established. This is presented in the following chapter with the object to clarify what research has contributed to these aspects and to understand the phenomenon of learning and leadership that characterizes the workshop as a learning situation.

2.1 Teaching Competencies

"Teaching Competencies" by Samuel Bengmark (2019) claims that there are three main aspects of being a good leader in a learning situation. Leadership competence, competence to prosper learning and knowledge about the subject in question. The importance of this model for the effectiveness and successfulness for learning situations lead to the question how to modify these three aspects depending on the audience. In order to get a better understanding about the three main aspects, the theoretical chapter is structured with those three headings. Dahlkwist (2016) has a similar definition. He claims that there are three areas of competencies that a teacher should have: subject, didactic and leadership competencies. The subject competency includes that the teacher knows the subject that she's teaching, stays willing to train further and is attentive to changes in her surrounding that regards the subject. The didactic competencies include that the teacher knows what, why and how she should teach a specific theme. The leadership competencies include that the teacher leads the class regarding discipline and student care as well as split the class into groups for a task and make individual adaptations for the students.

2.1.1 Learning

The most evident explanation of learning as a mechanism is where one understands or learns something that previously wasn't known. But this can quickly be divided into different *types* of learning, such as mental processes including discernment, memory or analysis, but also other types of learning, of a more physical than mental nature such as mobility where you learn to throw a ball or dexterity skills to play the guitar. Consequently, there are several types and forms of comprehension in a human being that have to be met from a teaching perspective to be able to encourage learning. To

meet these comprehensions, a teacher needs to adapt different strategies depending on the situation if it involves the previous mentioned mental or physical nature of learning. Within these basic theories of learning it is understood that adaption of your education and what you mediate as a teacher is vital for a fruitful learning situation (Philips & Soltis, 2015, p.13-14).

Along with adapted teaching for different types of learning there are several dimensions to create positive prerequisites for the actual acquisition of knowledge in a learning situation. The object needs to be motivated. Hence, a motivated environment has to be created. The objects are individuals, which means individual backgrounds, different previous knowledge and varying ability to absorb new knowledge. So not only does the teacher need to adapt to different types of learning but also to the individuals participating alongside with creating a positive and motivating environment. To meet and fulfil these prerequisites as a teacher it is required to do a selection of the content in the education and arrange a pedagogic entirety which is not a self-explanatory task and also underlies a long history of theories of learning (Philips & Soltis, 2015, p.15)

A relevant difference between the science of learning and other sciences is the application and diversity of theories that are current in the science of learning. Unlike most other sciences where only one theory is correct and fulfils all applications in that area, the science of learning applies several different theories. This is eligible due to, as previously shown, there are different types of learning. For example, one theory can explain how a child learns that fire burns but at the same time the theory can't distinguish the learning of linear algebra. Therefore, the importance of diversity amongst the theories of learning is emphasized to cover the full spectrum of learning. Some scientists and philosophers have tried to develop a more comprehensive theory of learning that includes all aspects and types of learning, but without greater success (Philips & Soltis, 2015, p.17-18). Hence, there is a worthwhile effort to recognize a diversity of theories regarding learning throughout the history.

Theories of learning that have characterized the view of the way in which to learn and teach today are presented. As mentioned earlier, the diversity and mix of usage of the theories is relevant in order to gain an understandable and propitious view of learning.

Theories of Old and Its Impact on Today's View on Learning

One vital aspect and an important contribution from the English philosopher John Locke's theory regarding learning is the importance of what previous knowledge an individual already has and needs to be able to learn something new. This finding raises the question about what is the child and man required to know before we proceed? And what else is important to learn? With this in mind, a learning situation has to be founded and created on the basis of what the participant knows. Making assumptions about previous knowledge of the participants can easily result in a failed learning situation. Therefore, Locke's theory aided future learning theories and educators by emphasizing the importance of previously known knowledge (Locke,1947, p.65).

Problem Solving as a Learning Method

A different way to think of how learning evolves within humans is to consider a learning process as something you actively do and engage yourself in. This way opposes the previously mentioned view of learning as a relatively passive process where, according to the advocates of those theories, learning is something that happens to the individual, instead of something you do or achieve (Philips & Soltis, 2015, p.56-67).

A known and one of the major advocators of this view of learning was the philosopher John Dewey who argued that for a satisfied learning situation, the student needs to be able to relate to the problem or task in question that makes the student engaged or committed to the problem. These are core conditions that derives from the students' own area of interest and experiences and that need to be fulfilled according to Dewey for prosperous learning (Philips & Soltis, 2015, p.56-67).

Dewey explains in summary his basic course of action and thinks to take in consideration regarding learning situations:

"Thinking only begins when a person feels that he is faced with a real problem. Then our consciousness is set in motion, it struggles to formulate the problem more clearly, looks for suggestions to possible solutions, overviews aspects of the problem situation that could be relevant and uses previous knowledge in an attempt to better understand the situation. Then we begin to design an action plan, a hypothesis about how the

problem can be solved in the best way. Then the hypothesis is tested, and if we then succeed in solving the problem, we have learned something"

(Philip & Soltis 2015, p.65)

Another advocate for this theory was Wolfgang Köhler (1887-1967) who brought important insight through his experiments on chimpanzees that needs to be considered when creating a task for a student. His studies emphasize on the importance of creating a learning situation that isn't too difficult or complex for the student that exceeds the student's abilities to solve. If that is the case, the student will undoubtedly fail and doesn't learn anything (Philips & Soltis, 2015, p.56-67).

Learning from a Cognitive Perspective

The biologist and sociologist Jean Piaget (1896-1980) had a more biological approach of learning and has greatly set his mark on today's way of teaching. He saw learning as a cognitive process where a structure is built within an individual based on his experiences and actions. These actions and experiences are gathered and arranged and put in relation to each other to form the cognitive structure that creates his kind of world and how it works and what he relates to. The learning process starts when new information, often in form of knowledge, is presented and added to the existing cognitive structure (J. Piaget, 1970, p. 704).

The contribution this brought to today's view of learning is the realisation that learning is a development process that takes place in several stages. With that, a mindset among educators has grown to pay attention to what developmental stage the student is at and adapt the content accordingly. Furthermore, this gives teachers the important insight that a student not only receives new knowledge and information during education, but also arranges that knowledge within itself when its cognitive structure is questioned and changed. This is an important aspect as an educator to take into consideration as this is a great effort by the student. One can't assume that the cognitive structures others have constructed are anything like our own and therefore, one cannot consider oneself to know the students' individual understanding (Philips & Soltis, 2015, pp.79-84).

The Social Context of Learning

An earnest shortcoming the mentioned learning theories all have in common is that according to them, the student is "a lone explorer" and a thorough view of their affiliation in social contexts and how it affects a human being are not taken into account. This important aspect is something the following theories of learning take into consideration. The previously mentioned theory regarding a cognitive perspective of learning does take some social aspects into account. Such as it suggests that the child is interacting with and exploring his environment to learn and then re-design his cognitive structure. But the child is still considered as a lone explorer where he alone discovers and learns new things to change his perception of the world.

The social context of learning is an important aspect to take into consideration when creating a learning situation. Meaning that other people and instruments play a part in the learning process and that one rarely learns something without it. For example, when learning a new theory, it is extremely rare to learn a theory without guidance and alone reinvent it (usually it is only the original creator of the theory who accomplishes this), usually, you have a teacher, classmates or literature to help as support and cooperation to understand the theory (Philips & Soltis, 2015, p. 84-89).

The pedagogue John Dewey, who also was mentioned in previous theories of learning, describes his ideal school as a community that involves students in meaningful activities that require cooperation to solve. The task of the educators is to create "conditions for the students that stimulate their own thinking" and then support the students when needed. According to Dewey, real learning is achieved in a situation where the learning interacts with others with common interests or appropriate activities and the teachers' task is clearly not to tell about the knowledge (Dewey, 1619, p. 344).

Another scientist in learning who was convinced of the social aspects' influence was Lev Vygotsky, who questioned earlier theories of children's developmental stage and was interested in the learning potential a child has. This would include what a child can accomplish with guidance of peers and adults. Thus, he invented the concept of "zone of potential development" which meant to what extent different children need different amount of help to solve a problem and thus can be developed and learn. Vygotsky said that we learn a great deal from other people and not only with other people (Phillips & Soltis, 2015, p. 91-94).

Later scientists such as the psychologist Michael Cole, have demonstrated through studies that students have the ability to solve meaningful problems and tasks with the help of actively utilizing their environment and its resources, such as colleagues. This has given birth to the concept of "situational learning" that highlights the aspect that learning not only can be explained as something cognitive within man but also as a result of situations where the student is actively involved with meaningfulness (Philips & Soltis, 2015, p. 94-96).

Knowledge Transfer and Applicability

Being able to apply one's knowledge in one area to another to be able to solve a problem, is something that partly forms an educational ideal. Therefore, it is of great interest to research in this area and understand what makes satisfactory knowledge transfer possible. The following explains factors that both can promote and inhibit the highly desirable knowledge transfer (Philips & Soltis, 2015, p. 129).

Something that has been stated through studies that enhances knowledge transfer is, naturally enough, how well the original knowledge was learned by the recipient. The primary knowledge should have sufficient quality, since the easier it is to revive the memory of the knowledge, the easier it can be applied to new knowledge. Furthermore, knowledge acquired through solid understanding is more likely to be eligible for transferring or applying it to another area than knowledge learned by heart has. The use of concrete examples that amplifies the students learning by highlighting its context and meaningfulness can strongly strengthen the student's understanding and therefore his knowledge transferability. Although, the use of examples should be used carefully because a too narrow connection to a certain experience can hamper the progress of this ability. In that case, the student can only connect his learning experience to a certain example and not to a more general understanding about the problem. Another thing that does promote the knowledge transfer is abstract reflection along with meta-knowledge, meaning being able to reflect on what intellectual- and thinking strategies one uses to solve a particular problem. However, despite of these factors that promote and inhibit knowledge transfer, it is still considered something that is difficult to identify (Bransford & Schwartz, 1991, p.64-65, 82-83). This is because a concrete application of the knowledge one has undertaken rarely specifically can be used in other cases. However, it is considered that a knowledge base is created that later can be applied to new problems. Much like an engineer who is not expected to

have learned everything she should be able to conduct at a new workplace. Instead, she is expected to have the ability to learn and be able to utilize her resources, in the form of knowledge from her education, to solve her new tasks (Phillips & Soltis, 2015, p.117-132).

2.1.2 Leadership

This chapter gives an explanation about what leadership is, describes different types of leadership and methods for motivating people.

Definition of Leadership

Leadership is not only getting a group to *do* specific things but also get them to the point where they *want to do* specific things (Elmholdt et al., 2015, p.9). This modern definition of what leadership is shows very clear how the mentality regarding leadership has changed. A leader shall not only get others to obey him, but he should form other's beliefs, wishes and priorities (Elmholdt et al., 2015, p.9). Leadership shall also be defined in comparison to management. While management regards only administration of resources, leadership creates visions, inspires and brings forth passion in the employees. According to "Teaching Competencies" (Bengmark, 2019), leadership involves three main aspects: 1. form goals and visions, 2. organise resources and 3. bring along people, motivate and give feedback. The first aspect means that a leader should be able to see possibilities and problems to set a goal. The second aspect is about the leader's ability to organise resources in order to reach the set goal. This includes that the leader makes sure that resources like time, physical tools and human resources are on the right place at the right time. The third aspect is about getting people to want to reach the goal through motivation, team work, support, giving feedback and monitor goal completion.

Different Types of Leader Personalities

Even if there is a clear unity that there aren't any obvious qualities for a leader that ensures effective leadership, it is possible to state some qualities that can lead to effective leadership in the right context. Those qualities are high level of energy and high stress tolerance, orientation to inner control, emotional maturity, personal integrity, big social need of power, quite high orientation to accomplishments, quite high self-confidence and quite low need of group belonging. The quite high self-

confidence, for example, influences the workers with a higher optimism. (Elmholdt et al., 2015, p.25)

In order to be a good leader, it is important that the leader understands how the group works and can adapt his leadership according to the situation (Elmholdt et al, 2015, p.13). To get a better understanding of which qualities a leader should have and for which group which methods are suitable, this chapter gives an insight in some types of leader personalities.

One type of leader personality to point out is the transformative and inspiring leader. A transformative leader calls out to the employees' moral values to increase their consciousness about moral values in order to get them to make social changes. To achieve that, the leader is very clear about the sense of the work, he himself sets a good example and leads the team to set their own interests behind the teams' interests and he stimulates development of self-fulfilment. In addition, this leader should be an inspiration. To be inspirational, the leader should be open, humble and show his own flaws and shortages. Furthermore, his actions are led by intuition and good timing. Also, he is empathetic, passionate and extremely realistic, which means that he puts high expectations on his employees. Finally, he takes advantage of his employees' uniqueness and their competencies. (Elmholdt et al., 2015, p.31)

Another type of leader personality is the authentic leader. This kind of leadership is characterized by the leaders' loyalty to himself and his values and that he doesn't adapt this to any expectations from his surroundings. This is supposed to get the employees to trust the leader. Further, this leader isn't interested in status or honour, he only acts upon his convictions. An authentic leader needs to be very conscious about his body language. The leader needs to be present and be able to identify himself to the situation. Further, he has to build a version of himself that is authentic according to the organization's culture. (Elmholdt et al., 2015, p.35-37)

Another type of leader personality is the flexible and teachable leader. Flexibility is an important quality for today's leaders because the organizational structures get more and more dynamic and go through changes all the time. This type of leader is good in adapting her behaviour, methods and actions to different situations. Through usage of different types of behaviours depending on the situation, the leader can improve the

level of innovation, creativity and effectivity. The leader has to balance the paradoxical possibilities for each situation. For example, it can be good to be very weak in one situation but very strong in another. Or in one situation it is good to have a close relationship, in another situation it is good to keep the distance. In order to be able to adapt the style of leadership to different situations and people the leader has to be reflexive and needs to act on the fly. The leader needs to collect a lot of experience and use this to improve his behaviour in new situations. (Elmholdt et al., 2015, p.39-40)

Leadership in a Social Context

Since our society changed from being an industry society to a knowledge society, the leadership has changed a lot. The fact of having a knowledge society and globalization causes an increased uncertainty and complexity which asks for new leadership styles. The psychological view on leadership therefore changed from dealing with controlling the organization with hard traits to creating meaningful processes. (Elmholdt et al., 2015, p.46)

One of the tools for the new leadership style is sense-making which refers to the leader's ability to create a meaningfulness behind decisions. But not only should the leader create those senses for different decisions. Expressly, the leader should discuss the meaningfulness with the employees, let them reflect over it, let them try and adjust (Elmholdt et al., 2015, p.48). The relationship between leader and employee is very important in modern organizations because a positive relationship increases the employees' motivation to do a good job. An improvement of the relationship is earned through trust, respect, dedication, loyalty and mutually support but also through mutual values and the possibility for mutual commitments and influence (Yukl, 2012, p.223). The exact way of implementing those things in the leadership depends on the organization and the people working in it. If a leader succeeds with these attributes, the employees feel that their need of being led in a direction is fulfilled and the leader's need of getting his employees to work effective and with dedication is reached. (Elmholdt et al., 2015, p.52)

The Specialties of a Teacher's Leadership

This sequence is about the specialities regarding the leadership in learning situations. In these situations, many unexpected things can happen. Therefore, a leader of

learning situations has to be spontaneous, good in improvising and be able to make quick decisions. There are eight qualities that are mentioned specifically to improve the leadership of a teacher: be able to take initiative, habit of collaboration, sensitivity, giving feedback, conflict treatment, able to make decisions, clearness, targeting. The sensitivity of the leader is very important from the first moment, where the leader meets the group and has to see how the atmosphere is. If this is a group where the leader sees a lot of passive students, she needs to be organized, structured and specify the learning goals. If there is a group of very active students, the teacher needs to open up for a lot of interaction in the class, let the class work in different variations and be enthusiastic. (Dahlkwist, 2016, p.14 ff.)

The leader needs to be able to adapt her pedagogical skills to different situations which makes improvisation, flexibility and ability to create variation during the lecture very important factors. The situation-fitted leadership combines a variating amount of task- and relation-oriented leadership. The task-oriented leader focuses only on explaining what the students should do and how they should do it. The relation-oriented leader is more focused on supporting, helping and inspiring the students. How much task- or relation-oriented the leader should be is dependent on the situation. What situation the leader is in can be analysed through different factors. These factors are the culture and motivation of the group, age, competencies and maturity of the group members, the task that the group shall do, and the time frame the group has to finish the task. Even if the leader has adopted her leadership to the situations there can still be adaptations to be made for some individual students. In order to create a prosperous learning situation, the leader needs to work proactive and plan the upcoming situation well but still be good at improvising. (Dahlkwist, 2016, p.19-20)

However, the leader should always have high expectations on the students. Tests have shown that groups that have leaders who have high expectations on their group succeed better than groups who have a leader who has low expectations on them. This phenomenon is called *halo effect.* This means that the teacher evaluates students from their physical appearance or their external behaviour and draws conclusions on their whole personality. This can often be misleading and should be avoided. In addition to that, some students can draw much attention to them which makes the leader only see them and draw conclusions for the whole group. The leader should reflect about the group and shouldn't draw conclusions too early. Another phenomenon

is that the leader sees the student out of her own personality and if the student is different, she thinks for example that the student can't be successful. (Dahlkwist, 2016, p.26-27)

Leading Discussions

The leader should be conscious about the importance of her role during a group discussion. Firstly, it can be good to introduce the discussion with a provocative question. Another important thing is to get a question more to the point if nobody is responding to it. Also, it can be helpful to point out underlying conflicts and let the group argue about them. Further, the leader can repeat specifically what a student said, something that is important for the group to discuss and understand, and let the others respond to that. Also, the leader can point out a theme that interests a lot of students. (Dahlkwist, 2016, p.71, 140)

2.1.3 Subject

In order to be a good leader, he or she needs to have a knowledge about the subject of interest. The leader should know the content which means to know the facts, understand it, be experienced in the subject and have a familiarity with the content to give a more nuanced insight. (Dahlkwist, 2016, p.24)

There are quantitative and qualitative knowledges. Quantitative knowledge is built when a person learns a new fact, for example the definition of a word. This knowledge is often known as something a person knows by heart. The qualitative knowledge arises when the person uses the quantitative knowledge in different situations and understands it for real. Further, there can be different combinations of experience and theoretical knowledge. In fact, there are four different combinations: 1) the person has no experience in a certain field and only some knowledge that only has been learned by heart, 2) the person has theoretical knowledge but no experience in the field, 3) the person has not reflected on the theory behind a certain subject but knows how to practice it in a good way and 4) the person has a lot of experience within the field and continuously reflects critically about the theoretical perspective. (Dahlkwist, 2016, p.24)

2.2 Storytelling

In this chapter, several views on storytelling are collected to come to a conclusion how storytelling is defined for this investigation. In order to understand what a story is, what makes a story a "good" story and why stories should be told in order to disseminate ideas, this chapter gives an explanation.

According to Denning (2011) a story is a narrative that connects several events in a creative sequence. Further, a story needs a plot and some kind of character in it. As described in "The Ten Faces of Innovation" (Kelley, 2016), storytelling is one crucial part of the success of a company. According to the book, storytelling is crucial for innovation, which is necessary for today's companies' success, since companies today are more valued when their ability to change is high, which happens through innovation. In the innovation work, the storyteller is the one who creates stories in order to "increase internal morale and external awareness" (Kelley, 2016, p.16). The thing with stories is to build an emotional connection between the subject and the listener. Other than only telling facts or statistics, stories remain in people's heads and inspire other storytellers to disseminate the facts. "The best way to get humans to venture into unknown terrain is to make that terrain familiar and desirable by taking them there first in their imaginations" (Tichy, 2007). This quote shows that humans find it hard to change and need help in order to be willing to change.

In order to motivate people and inspire them, a leader needs to touch their hearts. Touching people's heart happens through telling stories. Storytelling can be seen as a possibility to translate the dry numbers, lists, diagrams into a sense-making for people to get them to understand the leader's goal (Denning, 2011, p.19). Storytelling contributes to the activation of the audience's imagination which leads them to think actively. This fosters interest and engagement (Denning, 2011, p.37).

An investigation has been made to see how stories influence the way of persuading people. The investigation compared how well the test group got persuaded by a story in different ways: by listening to specialists' statistics, by listening both to a story and to statistics or listening to a policy statement told by a senior company executive. The investigation showed that a story alone had the biggest impact on persuading a group of people. (Denning, 2011, p.37)

It is not easy to define what a "good" story is, since it depends on the situation and the audience, which story to use to fulfil the purpose. A story that can be effective for one group can be totally ineffective for another (Denning, 2011, p.39). To create a good story for the right situation, different tools can be used. Stories in business situations are meant to "spark action, transmit values, foster collaboration, or lead people into the future" (Denning, 2011). Telling stories can be compared to telling myths, since it is not important to tell all the facts but rather have authenticity and have an underlying truth (Kelley, 2016, p.158). Stories can be used to create some form of credibility while getting to know a new customer, for instance. Through telling stories in first-person narrative one can show one's experiences and gain respect. Further, it contributes to good storytelling if the storyteller asks the audience about their own experiences regarding the topic, to also be able to create new stories around those insights. One way of storytelling is to create a character which can be a fictional or a real person. In some cases, this person also becomes a hero in the story. (Kelley, 2016, p.161)

Further, it is beneficial to tell positive stories. Even though the stories have to be believable and underlined with necessary evidence, they shall be told in a positive way. (Denning, 2011, p.22)

In order to prepare people for change, a story has to create an image of the future and show how to get there, without being too concrete and precise. People need to create the analogy to their own organisation on their own (Denning, 2011, p.27). For that, it is helpful to let the audience hear about a change in the same or in another organisation that has already happened. (Denning, 2011, p.31)

Not only is it important to find the right story for a group but also to find the right way how to tell the story. The performance of the leader is very important for the effect of the story. In general, it is effective to tell the story in a clear and simple way (Denning, 2011, p.45). Even though the story should be thought through precisely, it should sound as if it is improvised in the same moment it is told. For a leader, it is necessary to practice the telling of the story but still relive the story every time she tells it (Denning, 2011, p.49). While telling stories, it is also important to use the right words. It is possible to create own word combinations that are either self-explanatory or you explain them to the audience in order for them to remember it. The words that are used reinforce the stories and contribute to the dissemination of the story (Kelley, 2016, p.162).

Further, the emotions transmitted through the story should as well be carried out through the storyteller's non-verbal communication (Denning, 2011, p.50). Even the setup of the room has an influence on the effect of the storytelling - it is advantageous to put the room in an order that brings the group into a constellation of a conversation, e.g. in a half-circle and no podium between the leader and the audience (Denning, 2011, p.51). Interaction through eye contact with everyone in the audience, gestures for emphasizing important parts and using a lively tone of speaking are important factors for keeping people's attention during the whole story (Denning, 2011, p.52). The usage of visualisations can be helpful but isn't necessary and should if used be used only to symbolize through pictures and no/very little text (Denning, 2011, p.53). Further, getting to know the group before telling a story for them gives the storyteller the opportunity to tell the story adapted to the audience and show them the freshness of the story.

If storytelling is used in tours or workshops, it is not advantageous to always let the same specialists deliver the tours. In order to keep the storytelling varied and fresh, it is beneficial to let a variety of different personalities be the tour or workshop leader (Kelley, 2016, p.163). Still, it is important that the storyteller shows who she is to gain the audience's' trust (Denning, 2011, p.27).

3 Methodology

This chapter describes the methodology that is used for this study containing data collection, design of workshop with manuscript, execution of workshop and evaluation. The data is collected by interviewing partners involved in the project and by participation in Smarta Fabriker's activities to create content for the workshop. In a next step, the workshop is designed with the mentioned theories and tested and evaluated with two test groups. The evaluation consists of surveys, observations and a discussion with a group of people with pedagogical expertise.

3.1 Data Collection

This section describes what relevant data is collected and how it is collected. Data collection is made with partners of the project Smarta Fabriker to gather data regarding their interests in the project and what they want to mediate. Data collection is also made in connection with Smarta Fabriker's activities to aid in the creation of the workshop by collecting experiences in similar learning situations.

3.1.1 Interviews with Partners

In order to fulfil the object of what Smarta Fabriker's partners want to mediate, the relevant partners who contribute in the demonstrator are interviewed. In the interviews, information regarding each partner's contributed technology in the demonstrator is collected together with information about what the different partners want to mediate and put in the spotlight. Both regarding their technology but also regarding their view of what insights and values to disseminate regarding digitization. During the interviews, the interviewee is asked to explain their technology and purpose with project Smarta Fabriker with examples and applications that puts it in a context.

The interviews were conducted with individuals from respectively companies who are involved with their company's participation in the project Smarta Fabriker. As preliminary work before the interviews, the interviewee takes part of the questions that are chosen to be asked during the interview in order to prepare the interviewee. The prepared questions have been developed in consultation with the supervisor at Smarta Fabriker in order to get the interviews to be as relevant as possible for the content of the demonstrator. This is because the interviews take place at an early stage of the

process, when the interviewers do not have a high level of insight into the demonstrator and what the project Smarta Fabriker wants to mediate. The structure of the interviews is based on practice derived from Metodpraktikan (Esaiasson et al, 2017) to ensure a reliable quality of the interview.

3.1.2 Participate in the Project Smarta Fabriker's Activities

By participating in activities that are similar in structure to Smarta Fabriker's learning situations, data is collected. This data contains the observers' own experiences in the activities where they themselves are participating (Esaiasson et al, 2017, p.316). The observations during the activities are based on what the observers themselves experience and make them remember the content that is brought up, how the leaders of the activities mediate the content. These observations are made in order to see what content and topics are perceived as receptive to participants in such learning activities together with in what context it is mediated in. The result of this collection of data gives insight and inspiration to what content and how it is presented to be prosperous for learning. Hence, it is something that contributes to the development of the manuscript. This is done to see how today's industry is currently working, what their challenges are, with the purpose of acquiring relevant content for the workshop.

During this data collection, the observers are also participants of the study since these observations are about the observers experience in the different learning situations. Since the interpretations of the observations are relying on the judgement of the observers, they are discussed with other persons in the project to get a more validate interpretation.

The activities the observers participate in depend on Smarta Fabriker's schedule. This leads to the participation in Smarta Fabriker's own workshops, a two-day conference that a partner hosted and an industrial fair.

3.2 Design of Workshop

This chapter describes the process of how the workshop is designed and what the manuscript contains. The manuscript is developed in consideration with the theory of Teaching Competencies and storytelling to create content that workshop leaders can absorb and talk about.

The layout of the manuscript is as follows:

- Purpose of the manuscript for the user to establish the usage of the script.
- Equipment used in the workshop, as a checklist for the user to rely on in preparation for each workshop.
- Important pedagogical and leadership perspectives when leading a learning situation, this section is referred to as *"Tips för målgruppsanpassning".*
- Content of the information the workshop will attend categorised in the project Smarta Fabriker's topics to disseminate knowledge about digitalisation. This content is divided into information and use cases for each topic.
- Suggestion on what stations the workshop can contain.

3.2.1 Teaching Competencies in a Manuscript

The developed manuscript is designed with the theoretical model of Teaching Competencies as a base, since the model provides knowledge about important aspects of what makes a good leader in a learning situation. This is highly relevant for the developed manuscript that has workshop leaders for project Smarta Fabriker's workshops as a target group. By taking into consideration important aspects that make a good learning leader, the manuscript is structured in a way that enables the workshop leader to absorb the information and disseminate it further in an advantageous way.

3.2.2 The Aspects of the Teaching Competencies in the Manuscript

The three main aspects the model of Teaching Competencies includes are competence to create learning, leadership competence and the knowledge one has about the subject to be taught. These three aspects are addressed as learning, leadership and subject. Information about leadership and learning aspects are structured together in one section of the manuscript and referred to as *"Tips för målgruppsanpassning".* The purpose is to assist the workshop leader in how to lead the group and to address important pedagogical perspectives. This section is summarized in two subcategories depending on which target group the workshop is aiming to that affects the way in which the users should disseminate their information and activities. The aspect subject in the Teaching competencies model is integrated through a section of the manuscript that is divided into subject areas that Smarta Fabriker has defined for their entire project.

To get an understanding what learning, leadership and subject are in the context of developing a manuscript for workshop leaders in digitalization, a literature review is conducted.

3.2.3 Storytelling in a Manuscript

The part of the manuscript referred to as the content is the information that workshop leaders should mediate. It is divided into both information and stories regarding each topic that brings forth use cases or other stories that emphasize on the topic's purpose. Thus, storytelling is applied in the manuscript to give the user the opportunity to use it as a means to disseminate knowledge about digitalization. The purpose of using storytelling as content on what users should convey is due to the contribution storytelling brings according to the theoretical framework in this thesis. Storytelling is in summary an effective way of communicating knowledge about new subjects and, above all, creates an interest with the audience together with an effect that lasts.

3.3 Workshop Evaluation

The following section attends the process of evaluating the workshop. The purpose of the evaluation is twofold: to identify improvements of the workshop and to distinguish improvements with the new workshop in relation to the already existing workshop. This section describes how the process of evaluation is executed and which result it can generate. The design of the investigation is presented, together with deeper insight of how each step of the investigation process is executed.

3.3.1 Design of Evaluation Method

The evaluation contains observations, surveys and interviews of participants in project Smarta Fabriker's activities were the workshop is meant to be implemented. The performance of the workshop is evaluated together with the contribution of the aspects of storytelling and the model of Teaching Competencies. This is done due to the implementation of the theoretical models in the developed manuscript with a possibility to discernment of the effect of these aspects.

The evaluation of the workshop is performed at two different occasions with two different groups of participants. At the first occasion, the participants are a school class

from a senior high school. At the second occasion, the participants are a group of individuals from the industry with pedagogical education.

The evaluation is divided into two different parts with different objectives. The objective depends on the prerequisites of the workshop the participants are participating in and what is possible, due to the prerequisites to investigate. In one case, the purpose is to identify what is perceived as positive with the new workshop. This is done by evaluating the participants' experiences after performing the workshop. In the other case, the purpose is to compare the former workshop with the new workshop and to compare the learning experience between the two workshops.

Two surveys to evaluate the participants perception of the learning experience and how the learning situation is experienced as a whole with the new workshop are conducted. Interviews with participants with adequate education is held for the same purpose. In line to evaluate differences between the former and the new workshop, observations are conducted during the test occasions where the different workshops are performed. This aims at investigating the workshops' observable influence on how the learning situation is perceived by the participants. Two weeks after participating in the workshop, the participants answer on a survey. The survey evaluates whether information from the former and the new workshop is remembered best as a measurement of what content one learns in the workshops.

3.3.2 First Occasion for Evaluation

The evaluation at the first test occasion consists of observations and three surveys with a school class from senior high school, together with associated teachers as participants. The object is to evaluate the new workshop both in relation to the former workshop and in relation to what is a prosperous learning experience in a workshop environment.

The workshop during occasion one consists of two phases, one with the former workshop with its corresponding manuscript as content and a second phase with the new workshop with its corresponding manuscript as content. Both phases last for approximately one hour each and the participants of the workshop are divided into smaller groups and rotate between the four stations according to the manuscripts. Each station consists of a learning situation where the participants are actively involved

with the content and interns at the project Smarta Fabriker are leading the workshop as workshop leaders.

Observations

The observations are conducted during the two phases and enable the possibility to identify differences in the participants' learning experience during the different workshops. The observations have to be well-planned and structured (Esaiasson et al, 2017, p.318). Therefore, the parameters to observe are defined ahead for the observers.

The observations are focused on the degree of activity that affects the learning experience of the participants in the workshop. This is done by studying a number of parameters. These parameters are:

- *Listen: How well do the participants listen and how focused are they during the former/new workshop?*
- *Being active: How active are the participants in discussions during the former/new workshop?*
- *Asking questions: How much questions do the participants ask during the former/new workshop?*

Confirmative behaviour such as body language, nodding and expressions are studied and recognized by the observers to interpret the parameters. These parameters are relatively observable as the former and the new workshop are set in relation to each other, which can distinguish possible differences. It is important to separate observations and interpretations in one's notes (Esaiasson et al, 2017, p.322). In the moment of observation, only notes are taken and afterwards those notes are interpreted and discussed among the two observers.

Surveys

The three surveys are carried out to evaluate the performance of the new workshop and its effect on the participants' learning experience. The surveys are conducted at two different occasions during the workshop and in one occasion one to two weeks after the workshop to examine a more long-term learning experience.

The first survey is conducted in conjunction with the participation in two of the stations of the new workshop where the participants answer a question about what they have learned. Here, they may give examples and briefly explain it. This is done in order to examine if the participants perceive the purpose of the content the workshop leader wants to mediate. This adds information to whether the workshop leader succeeds in conveying his information to the participants.

A second survey is conducted after the new workshop and summarizes the workshop session. This study aims to gather information about the learning experience, that is based on the new manuscript as a whole. It also treats the aspect whether the participants can make use of what they have learned during the different parts of the workshop and put it in a context or field of use. This result gives an insight on how the manuscript affects the participant's learning experience and how it correlates with project Smarta Fabriker's purpose. This survey is designed with multiple-choice questions due to its ability to be answered quickly, which according to the Metodpraktikan (Esaiasson et al, 2017) is important for high data quality.

A third survey is replied by the participants two weeks after the completed workshop. The survey consists of eight questions regarding factual issues about the content in both the former and the new workshop, one question for each station of the two workshops. This result gives an insight on what content from both workshops the participants remember and is considered something that they have learned. For a fair assessment, the questions should have the same level of difficulty. Further, the order of the questions is randomized to ensure that the order does not affect the results.

The surveys are being developed in an iteration process to reduce the risk of redundancy in the questions and that the questions are misunderstood. According to Esaiasson et al (2017), it is also important to test the surveys on others than only on the one who designs it. Hence, the surveys are tested by interns at project Smarta Fabriker to reduce the level of confusion regarding the survey questions.

3.3.3 Second Occasion for Evaluation

During the second occasion for evaluation, the participants of the workshop are ten people from industry with pedagogical background. The evaluation consists of a group interview and discussions with the participants with the aim to highlight development

potential of the workshop. With their adequate education to identify opportunities for improvement in a learning situation, it is possible for the participants to add beneficial information regarding how and what to rework with the workshop for a greater result.

Group Interview and Discussions

The group interviews and discussions are held after the conducted workshop with the aim to identify the new workshop's strengths and weaknesses in a discussion climate. Due to a discussion session there are only a few questions that constitute the basis of the interviews:

- *"What did you find positive and enjoyable with the workshop? And why?"*
- *"What didn't you like with the format of the workshop? And why not?"*
- *"What would you have done differently? And how?"*

The outcome is depending on the feedback and answers from the pedagogues that will eventuate in a result regarding improvements for the workshop. The results will be summarized into what is perceived as good and what potential development that could be done with the workshop.

3.4 Analysis of Test Results

This chapter contains the methodology of how the results are analysed. The first part deals with how the observations are analysed and the second part deals with the analysis of the surveys containing statistical methods.

3.4.1 Analysis of the Observations

Since the observations are put on record through taking handwritten notes, the analysis starts with writing the crucial parts of the observations in a digital document. This means that all the information that is interesting for the current observation are put on record. These notes shouldn't exceed one A4-page (Esaiasson et al, 2017, p.324). For this investigation the pivotal information would be how the audience behaves during the former workshop in comparison to how they behave during the new workshop. Then, the observations are read again and again by the observers to categorize the observations in order to find patterns (Esaiasson et al, 2017, p.325).

Further, it is necessary to question the validity of the observations. The observers have to be aware of the fact that the mood of the audience is a factor that is hard to catch through observations. It is therefore crucial for the observers to use their own judgement to analyse the observations. It is beneficial to have two observers, which this study has, since they can discuss about their different opinions (Esaiasson et al, 2017, p.325). The fact that the manuscript of the new workshop is developed by the observers has to be taken into consideration, since people often have a better view on their own developments. Further, other factors that can influence the audience's behaviour is taken into consideration: time of the day, who is the workshop leader. Therefore, when analysing the results, they have to be interpreted with caution.

Further, the value of the observations is discussed. The test situations that can be realized during this work can give a first insight on if the new workshop is feasible and if it gives the expected effect. But, since there are only two testing situations, it is not possible to draw a general conclusion because firstly, not all types of groups are tested (only students and teachers and not company groups) and secondly, every group has a different character, behaviour and different interests so the amount of testing situations doesn't give the possibility for general conclusions.

3.4.2 Analysis of the Surveys

Comparing two different cases, it is crucial to test all factors that could influence the result. So, the first step would be to identify the factors that could have influence on the test (e.g. time of the day) (Esaiasson et al., 2017, p.97). In this study, this is not possible since there were only two occasions to have test groups with the new workshop - one occasion with a school class and one with a group of teachers. The target groups for the developed workshop are children/teenagers and adults. This means that each target group is tested only in one occasion each.

The questions that are not multiple-choice-questions are analysed through first a qualitative analysis of the answers where the answers are classified into different categories. Those categories are to be defined before the data is collected. For survey 1 this means that the categories are the different purposes of the station that the workshop leader wants to mediate. For survey 3 this means that the categories are right or wrong. It is decided in advance what answers are counted as right and what is wrong.

For a descriptive question (how…?), which one part of the questions of this study is, the method to use is univariate statistical analysis. The most used tools in this method are a frequency table and percentage calculations, measures of central tendency and measures of dispersion. (Esaiasson et al., 2017, p.363). The frequency table shows the quantity of a certain response for a variable. The central tendency shows at which point the distribution of the responses has its central point (Esaiasson et al., 2017, p.364). This parameter can either be defined as the factor mode, which is equal to the response with highest frequency. Another possibility is to calculate the arithmetic mean, normally used when the response categories are an interval scale. If the distribution of the answers isn't according to a Gaussian distribution, the median can be a more significant parameter than the arithmetic mean. The median is the value where the quantity of the answers is divided into two parts (Esaiasson et al., 2017, p.366). To calculate the measures of dispersion, different methods can be used depending on the scale of the answers. If it is a nominal scale (answers are divided into categories) the index of dispersion is calculated (Esaiasson et al., 2017, p.367) that shows how the answers are distributed on the scale. For example, a right/wrong question has a nominal scale of answers (right, wrong). If it is an ordinal scale (used to classify answers and rank them) the index range can be calculated through defining the range between the lowest answer and the highest. If it is an interval scale (both classified and ranked answers but also the range between the different units are equidistant) there are many calculations to choose between: standard deviation, range, mean absolute deviation and coefficient of variation (Esaiasson et al., 2017, p.369). The last mentioned gives a relative dispersion.

For explanatory questions, two-variable statistical analysis is used. In explanatory questions the correlation between variables is discussed. The first step might be to make a cross tabulation - write all data in a table with the statement as a row and different columns for the groups of answering people. The table can be used in different steps. First, the absolute numbers are inserted, later it can be used to calculate different percentages for the row, for the column or the total percentage. (Esaiasson et al., 2017, p.373)

Further, different coefficients to describe the correlation between the variables can be calculated. If there aren't any correlations, the variables are statistically independent (Esaiasson et al., 2017, p.381).

Since the population of the statistics is small, a t-test is taken into consideration. The t-test is used for small populations where the standard deviation isn't known. It is used in order to test the significance of the study. In this study, one test group visits two different workshops and gets tested through survey 3 about the two workshops. Therefore, one-sample t-test is used which in this case means that one group is tested with two different stimulations. The mean value of correctly answered questions from the former workshop is used as test value in a statistical analyse with the software tool SPSS from IBM. The null hypothesis is that there isn't a significant difference between the mean value of the former workshop and the mean value of the new workshop. The alternative hypothesis is that the mean value of the new workshop is higher than of the new workshop. The discussion chapter shows how the result was analysed. (Leard statistics, 2019)

4 Result

The following chapter presents the results of the study where the developed manuscript for the workshop is presented together with a summary of the partners interests. In addition to that, the results from the evaluation of the workshop are presented.

4.1 Summary of Partners' Interests

The collected data from partners in the project Smarta Fabriker based on their interests in the project and in the new workshop is compiled and used for the content of the manuscript for the workshop referred to *"Genomförande".* Appendix I contains the summary of the partners' interests.

4.2 The Workshop Manuscript

The workshop has four stations and the groups stay around 15 minutes at each station. The attendants take part in groups of maximum eight people. More participants in one group would not be suitable because at station 1 and 2 the participants are actively engaged and using the techniques which creates a bottleneck. Further, station 3 and 4 are based on discussions.

The developed manuscript for the new workshop is presented as an appendix, see appendix II. An overview over the stations conducted during the workshop is given in the following Figure 1. The graphic shows the four stations that are conducted during the workshop called "Monteringsfabriken" (Assembly factory) and what subjects those stations contain.
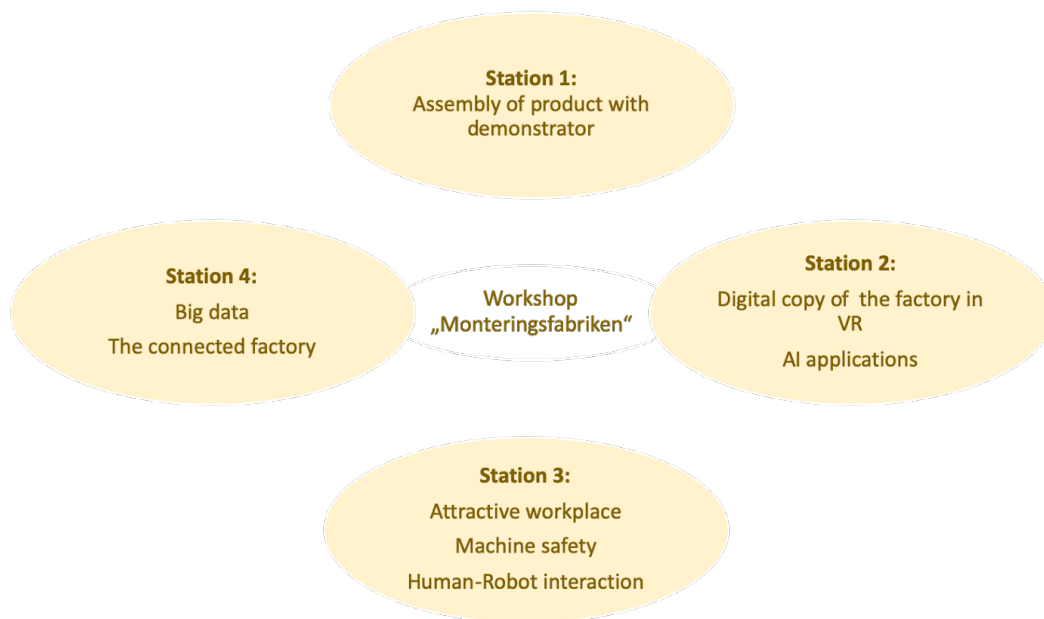
Figure 1 - Overview new workshop

4.3 Workshop evaluation

This chapter contains the results of the different parts of the evaluation of the workshop. Those are the results of the observations, the surveys and the feedback of the group of people with pedagogical expertise.

4.3.1 Results of Observations for the Different Workshops

The observations from the former and the new workshop are presented in the three categories: Degree of listening, degree of activity in discussions and to what extent the participants were asking questions. A summary of each of the categorized observations with their interpretations is presented for the former and new workshop and a detailed version with each observation documented as an appendix, see appendix III.

Degree of listening during the former workshop:

- While the leader tells stories, the group is nodding and seems to understand what the leader wants to mediate (e.g. stories about deflection of carton, AR for remote operations, pokemon go, stop in factory).
- The group is quiet when the leader talks.

- When the leader talks about techniques without giving examples does the audience lose focus and doesn't listen properly.
- Even if the audience shows that they have knowledge in a specific topic, they don't seem to understand when the leader talks too quickly.

Degree of listening during the new workshop:

- The workshop includes a lot of discussions and the participants seem to listen relatively well to what the leader and the other group members have to say. The leader gave the group a high degree of attention (e.g. through eye contact) that perceived to make the audience listens well. In the cases were some of the participants was perceived to lose focus was when the leader had not given them attention.
- The frequently asked questions of the workshop leader to the participants forced them to engage with the content and was perceived to make them listen.
- When the leader tells stories about real-life examples or when the other attendants talk about their own experiences, the audience seems to be more interested and listens more actively.

Degree of activity in discussions during the former workshop:

- There was an increase of how the participants were actively involved at workshop stations which entailed a high degree of experience-based activities which contributed to discussion amongst the participants and workshop leaders.
- When the leader of the workshop asks questions with a "have you ever experienced...?" that can be answered with a simple yes or no answer is participation rarely more elaborate than that.
- When the participants were asked, it was observed by interpretation of their body language that they were active for discussion. This behavior was enhanced when they were asked about the subjects they had previous knowledge of. At these occasions, discussions could emerge.
- The primary participant group, who were senior high school students, very rarely answered open questions that give room for an answer to discuss further and which allows the participant to explain and share their thoughts with the group.

When these types of questions were answered, it was answered by their responsible teacher who was part of the group.

- When the leader of the workshop was perceived to talk fast, the group did not seem to actively participate in the content and thus could not contribute or participate in any form of discussion. The same phenomenon arose when the workshop leader talked in too long sequences without involving the participants where he later made an attempt to ask a question, which he himself eventually had to answer.

Degree of activity in discussions during the new workshop:

- Questions about the participants' own experiences (e.g. "Who has worked in a factory before? What do you think about working in a factory?") are answered very actively and the answers given are detailed. The attendants seem to like talking about their own experiences.
- When the leader asks questions frequently during the workshop, the group stays active during the whole time.

To what extent the participants are asking questions during the former workshop:

- The participants did not ask other questions to the workshop leader more than a few times, but at most only respond to what they are asked. On the occurrence it happened it was not the primary group of senior high school students that asked the questions. It was the responsible teacher that also was a part of the workshop group that asked these questions.

To what extent the participants are asking questions during the new workshop:

- A few students ask questions unrequested (e.g. "How much is this technique used today?")
- Some of the teachers ask questions after the leader asks, "Are there any more questions?"

4.3.2 Results from Surveys

This chapter contains the results from the three surveys answered by the test group containing students and teachers. The result from survey 1 shows if the purpose of

station 3 and 4 of the new workshop is received by the participants. Survey 2 shows the overall impression of the participants after the new workshop. Survey 3 makes indications about what the participants remember about both the former and the new workshop after two weeks.

Survey 1

The first survey is conducted directly after two of the stations of the workshop, station 3 and 4. The question of this survey is "What did you learn at this station?" to see if what the participants learned is the same as what the workshop station is supposed to transfer. The planned main messages of each station are used as categories. The answers of the participants are put into the categories. There will not be made any difference about the teachers' or the students' answers.

At the station "Attractive work" (station 3) the leader wants to disseminate the following main messages: 1) Advantages of digitalisation for human's work in factories and new functions for workers when robots make the monotonous work, 2) Risk analysis with collaborative robots. The answers that don't fit into a category are put into the category "Other". Participants who mentioned one of the topics are put into category "Partly", those who mentioned both topics in their answer are put into category "Completely" which means that they received all the main messages. 23 people replied to the survey. The results are shown in Figure 2. In appendix IV, the answers of the participants are showed.

How well the participants have received the content
Station 3

74%   9%   17%

Partly   Completely   Other

Figure 2 - Result Survey 1, station 3

At the station "The connected factory" (station 4) the leader wants to disseminate the following main messages: 1) Why data is valuable, 2) The purpose of Traceability. The answers that don't fit into a category are put into the category "Other". Participants who mentioned one of the topics are put into category "Partly", those who mentioned both topics in their answer are put into category "Completely" which means that they received all the main messages. 22 people replied on the survey. The results are shown in Figure 3. In appendix IV, the answers of the participants are showed.
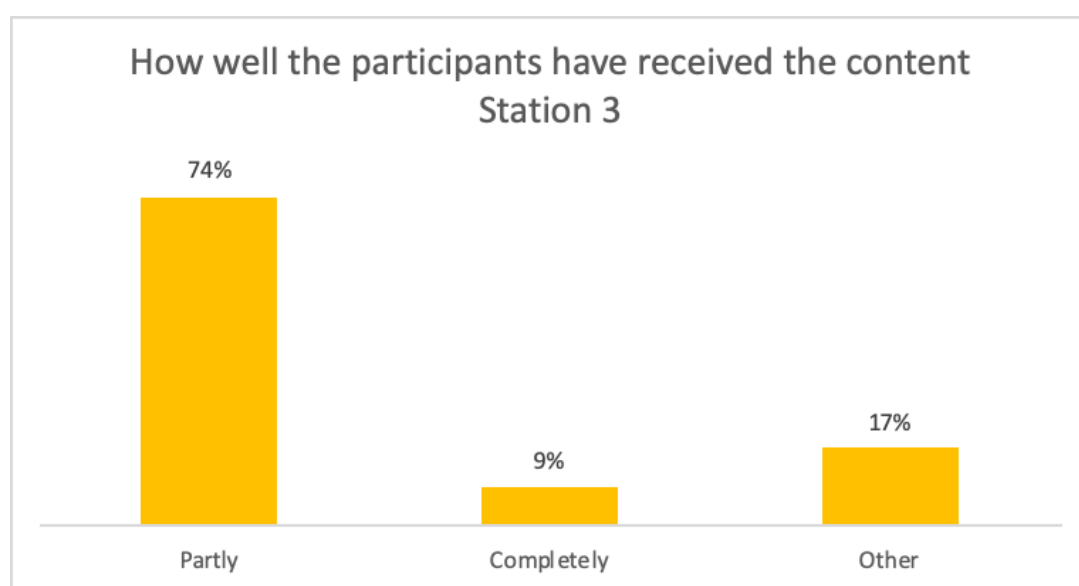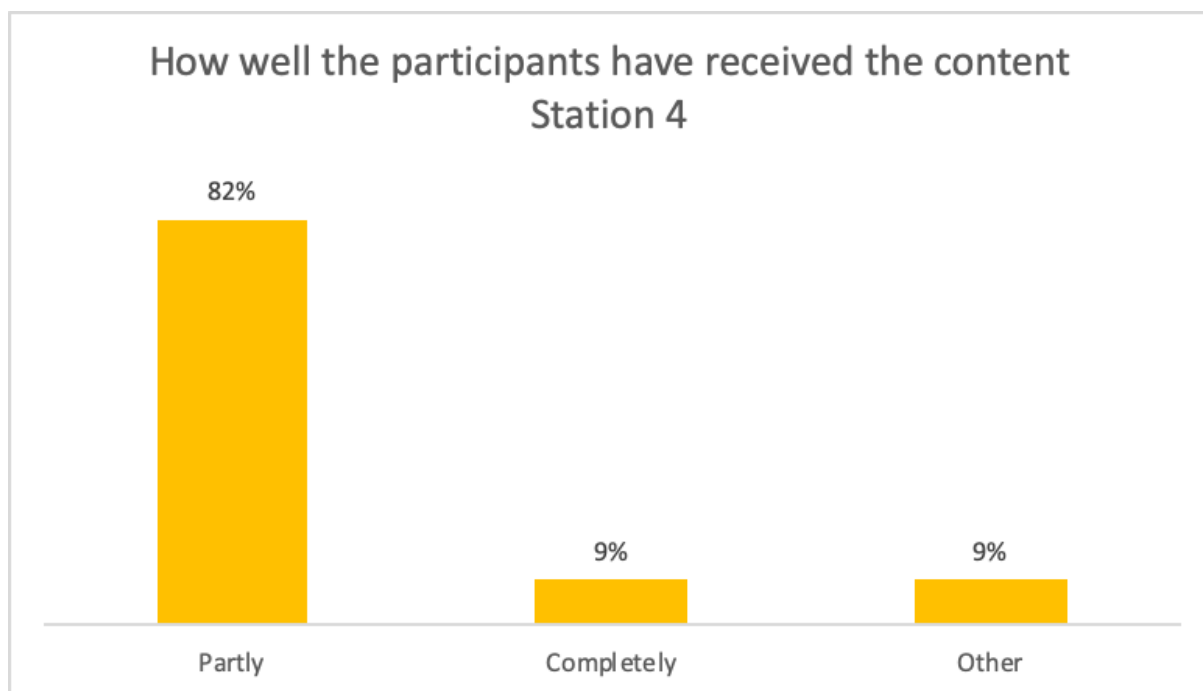

Figure 3 - Result Survey 1, station 4

Survey 2

Survey 2 is conducted after the whole workshop and is about the attendant's impression of the newly developed workshop. 18 people replied on the survey. There will not be made any difference about the teachers' or the students' answers.

The first question is about if the participants learned anything new during the workshop. As Figure 4 shows, did 61% of the participants answer that they learned a lot of new things, 33% answered that they learned some new things and 6% answer that they didn't learn anything new.
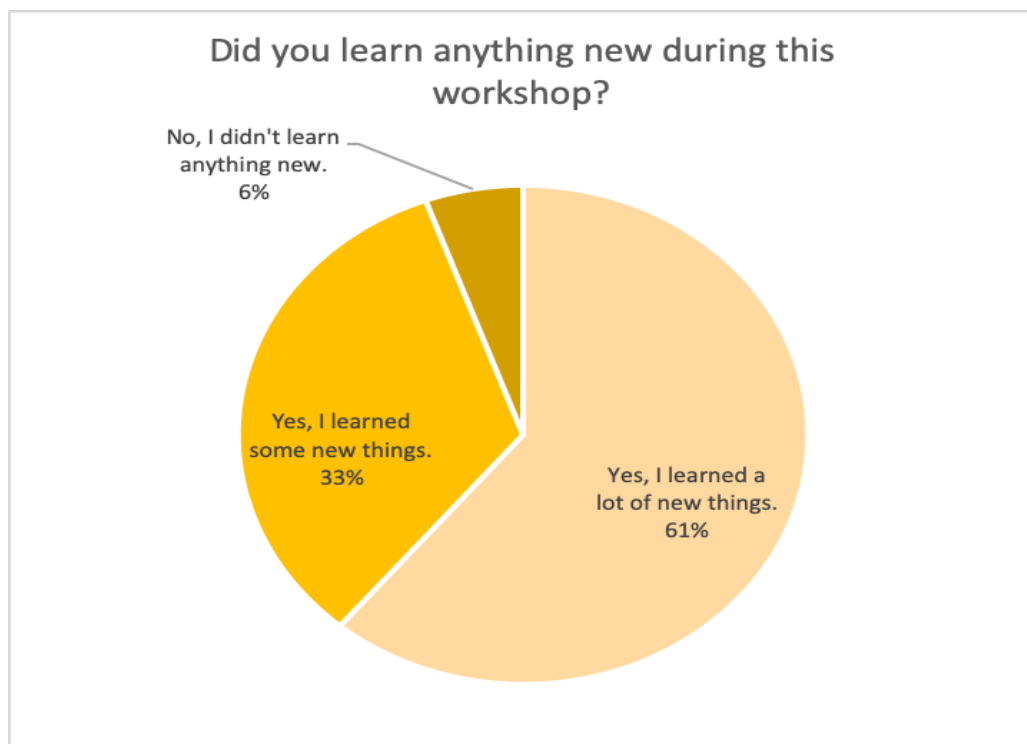
Figure 4 - Result Survey 2, question 1

On the second question, the participants were supposed to cross the adjectives that describe their experience at project Smarta Fabriker. Figure 5 shows that 53% of the participants crossed that they found it interesting and 39% found it enriching at Smarta Fabriker. 4% of the participants found it boring and 4% found it "nothing special". 0% found it fun at Smarta Fabriker.

Figure 5 - Result Survey 2, question 2

The third question is about how well the participants understood the workshop leaders. As Figure 6 shows, did 67% of the participants cross level 4, which means that they understood nearly everything. 28% said that they did understand everything. 6% answered that they understood on level 3, so there were some things they didn't understand. Nobody replied that they didn't understand anything.
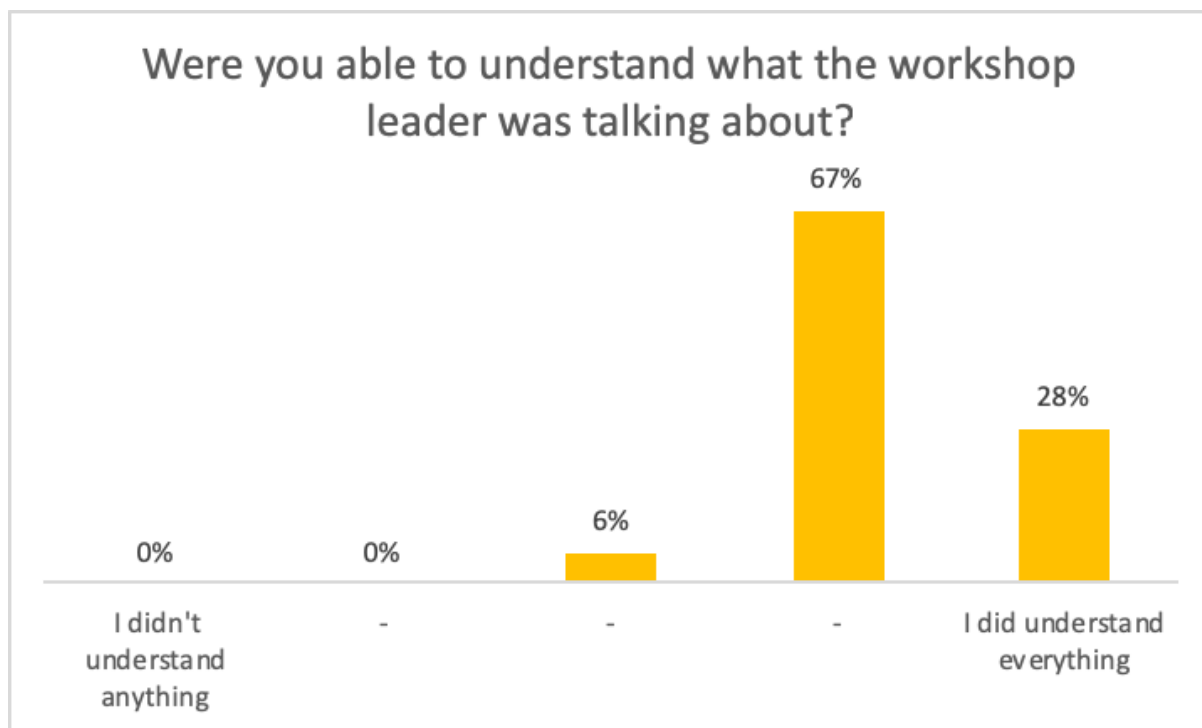
Figure 6 - Result Survey 2, question 3

Survey 3

Survey 3 is conducted two weeks after the respondents attended the workshop. This survey is about what the attendants remember from the workshop after a longer time. The questions in the survey refer to both the former and the new workshop, four questions for each workshop. To ensure that the students take their time to reply to the survey, one of the teachers gets the link for the survey and lets the class reply to it during his lesson. Eleven participants reply to the survey. The questions and the specific answers are presented in appendix V.

Table 1 shows the survey answers for each attendant (A to K). "1" means the right answer was given, "0" means no answer, a wrong answer or insufficient answer was

given. Question Q2, Q5, Q7 and Q8 are questions regarding the new workshop stations, the rest of the questions are about the former workshop stations.

Table 1 - Result of survey 3 for every single participant (answer right=1 / wrong=0). Questions with (N) are about the new workshop.

Participant	Q1	Q2 (N)	Q3	Q4	Q5 (N)	Q6	Q7 (N)	Q8 (N)
A	1	1	1	1	1	0	1	1
B	0	0	0	0	0	0	1	0
C	0	0	0	0	0	0	1	0
D	0	0	0	0	0	0	0	1
E	1	0	0	0	0	1	1	1
F	0	1	1	1	1	1	1	1
G	0	1	1	1	0	1	1	1
H	1	1	1	1	1	1	1	0
I	1	1	1	1	1	1	1	1
J	1	1	1	1	1	1	1	1
K	1	1	0	0	1	1	1	1
sum for Q	6	7	6	6	6	7	10	8

To get an overview of how the distribution of correct and wrong answers are for every single question, Figure 7 is created. This diagram shows the questions belonging to the new workshop in light yellow, the questions belonging to the former workshop in dark yellow. The questions with the highest amount of correct answers are question Q7 "Data is the new oil" and question Q8 "Attractive workplace", both questions are about the new workshop.

Distribution of answers for every single question

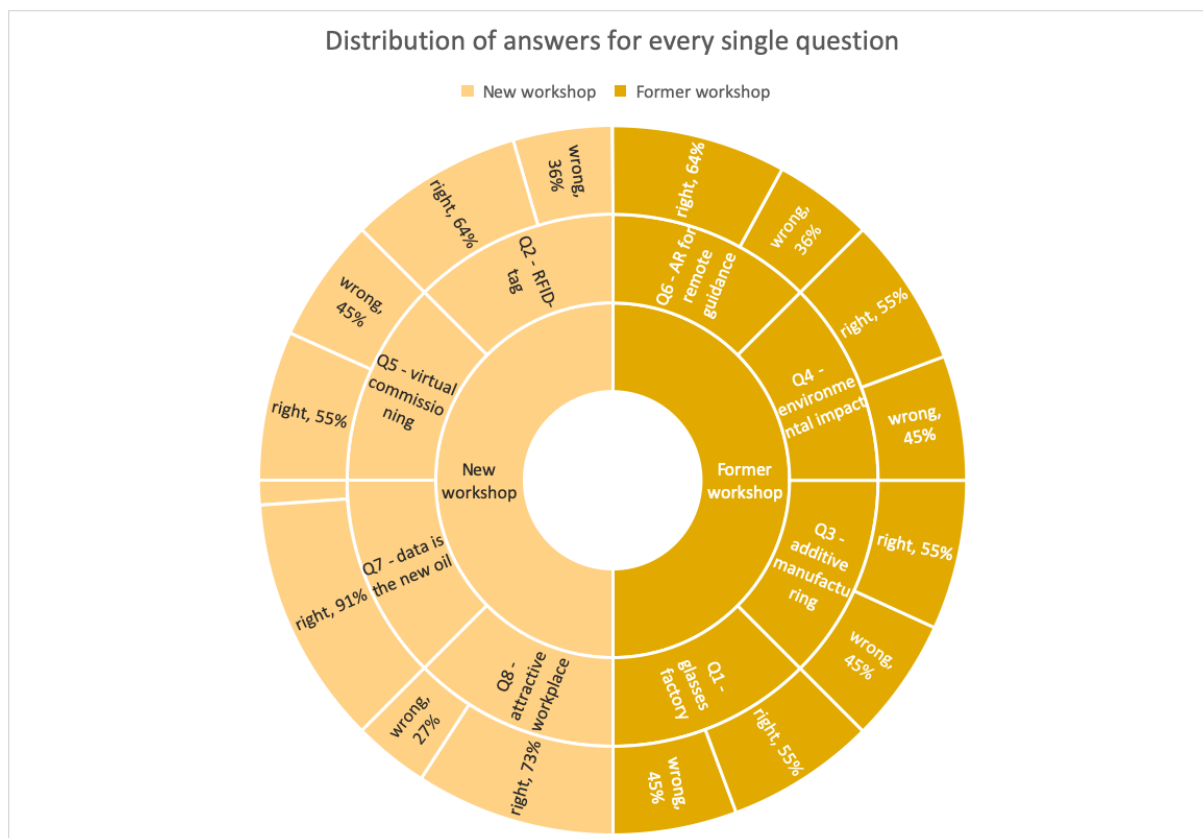*Figure 7 - Result Survey 3 for every single question*

To see the total amount of questions replied on correctly, the following diagram is created. Figure 8 shows that 70% of the questions about the newly developed workshop are answered correctly. 57% of the questions about the former workshop are answered correctly.
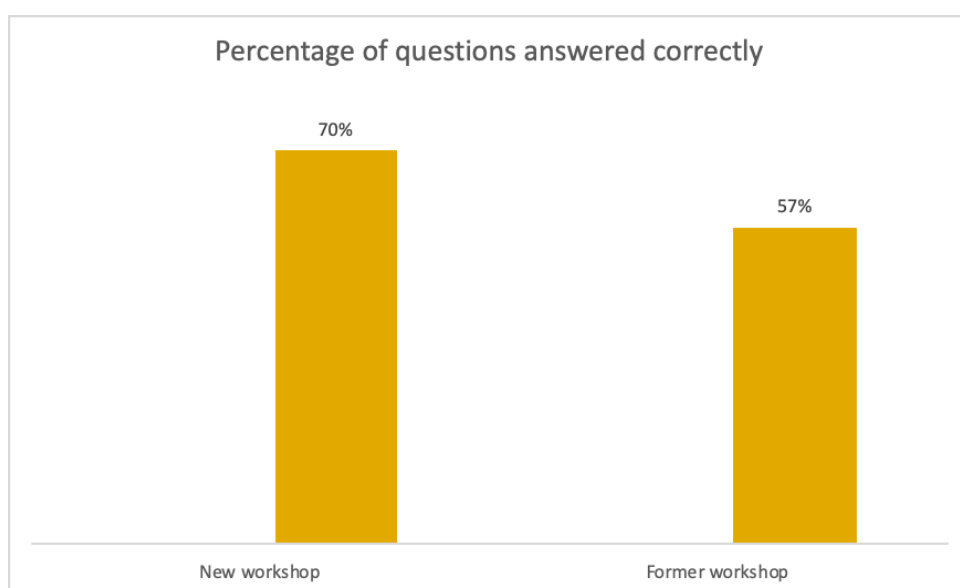

Percentage of questions answered correctly

Figure 8 - Main result survey 3

4.3.3 Feedback from a Group of Participants with Pedagogical Expertise

The results of the evaluation with the group of participants from industry with pedagogical education is presented in this section. The result is only based on the perceptions of the participants and is their subjective opinion. The result is summarized in positive aspects and potential areas of improvement with the workshop. In addition, the participants' contributions to continued work with the workshop is presented.

What the group of participants deemed as good about the performance of the workshop according to the manuscript was primarily that a climate that promotes discussion between the workshop leaders and the participants was created. This was due to the fact that the workshop leaders were considered inclusive in their leadership and asked a lot of questions for the participants about their activities which made them keen to respond with elaborate answers and input to discussions. It was also considered that the usage of several user examples of cases where the technology that is being talked about is actually used and utilized in real life situations to have a positive effect on the learning experience. This allowed the participants to understand the purpose of the different techniques or topics during the workshop.

What was considered as potential areas of improvement by the participants was that the workshop could consist of more activity-based learning, it was considered to be a quite low degree of where the participants actively could perform tasks and contribute to the learning experience. It was even times where it was considered that the workshop leaders were the ones who accounted for most of the activity on a few occasions. Additionally, it was considered to have been better if there had been any sort of visual display on how applications of the techniques discussed in the workshop are used in real life. This would enable to see the possibilities and benefits of such technologies and it would be easier to familiarize and make use of it. In addition, it was pointed out that the room in which the workshop is carried out has very poor acoustics, which is something that one has to adapt to through various measures in order for the participants to be able to perceive what is conveyed.

For future work with the workshop, one participant suggested the implementation of "work cases" to distribute to the participants during the workshop at stations with low degree of activity-based learning.

5 Discussion

This chapter consists of an interpretation of the results and its relevance and contribution to this study. Further, the chapter analyzes the validity of the results and what factors could have manipulated the results. This discussion is applied on all parts of the results which are the data collection from partners, the workshop and all parts of the evaluation.

5.1 Data Collection from Partners

The result of the collected data from the partners in the project of making the new workshop station brought a major contribution in terms of content to the workshops. The collected data from the partners constitutes the actual information that the workshop leaders mediate in project Smarta Fabriker's workshops. The information from the partners is regarding respectively field of expertise along with their own experiences of using their technology. This contributes through information regarding each different technology that is important and interesting to bring about. With the partners experience in their field, they contribute with relevant and eye-opening use cases, that we make use of as stories in the content of the workshops. Hence, as a result, the content of the stories is of such nature that it is relevant to today's industry and users.

5.2 Applications of Mentioned Theories on Workshop

The cornerstones of the Teaching competencies - learning, leadership and knowledge of the subject - have been applied to the overall structure of the manuscript.The relevant leadership aspects have been applied in a section intended to give the workshop leader support and help in leading his group of participants, regardless age, previous knowledge or purpose of the workshop. This section is adapted for the different target groups in order to distinguish between performance in order to lead the different target groups with good results. The section chooses to address the problem of not actively reflecting on your leadership when leading a group, which we have experienced is a shortage of previous manuscripts where the focus is almost solely on the content to be mediated.

The contribution from the learning aspects of Teaching Competencies appears in the same section of the manuscript where, like the leadership aspects, support and help for the user is explained to succeed in mediating the intended content. Here too, audience targeting is adapted as it is considered a highly relevant factor for successfully mediating the content in a favourable manner. The help from the manuscript emphasizes to a large extent the importance of listening and assessing the knowledge of the participants and to anticipate their challenges in order to then be able to adapt the content and execution of the workshop. In line with explaining the content in a way that is receptive to the participants, storytelling is applied as a form of teaching. This is not only because of storytelling's strengths and benefits in presenting inspiring knowledge, but also to pave the way for explaining in a different way with the purpose of giving the listener a new perspective. Getting a new perspective is an important part of learning.

The content of the manuscript is largely designed with stories, that practically can be defined as user examples, within the various topics that the workshop includes because of its strengths and advantages. In addition, complementary explanations of each topic are included in the manuscript to create a larger and more theoretical understanding for the user. In this way, a greater degree of confidence with the topics is created and also, a greater likelihood of being able to interact well with participants with expertise knowledge is achieved. Although if the level of knowledge differs between the workshop leader and a participant with extensive experience in the subject, the possibility to reason and discuss at a relevant level is in our opinion enhanced with the aid of both basic theories and user examples in real life situations.

5.3 Comparison Between the New and Former Workshop

During the first test occasion, both the former and the newly developed workshop were tested. Through observations and survey 3, a comparison between the two workshops can be made. This chapter discusses the results of the observations and survey 3.

5.3.1 Observations

The categories in the observations have such nature that they are relatively visible to observe a behavior that affect learning in its very basic form: by listening, activity in discussions and whether they ask questions. These are factors that we perceive as a

positive overall feeling about the workshop and things that create a good climate in a learning situation. Although they are relatively visible to observe are they still difficult to interpret and how they contribute to learning. Therefore, it is important to emphasize that all observations are interpretations of the observer and should be treated as such.

Through the results of the observations regarding the degree of listening among the participants, it can be pointed out that during both the former and new workshop, the use of storytelling was perceived as making the participants listen better than in occasions when storytelling was not used. This strengthens the theory that storytelling has a positive effect on the learning experience, at least in the way we have defined positive factors for learning. Further positive effects that could be observed regarding the degree of listening were a frequent and high interaction with the participants. This is a climate that is desired to achieve with the support and help through the new workshop to lead a group of participants. Where something that needs to be emphasized is that the degree of listening was perceived to drop when the workshop leader did not use the advice from the new workshop on how to talk and explain technology to a group of participants. This was evident during the moments when the workshop leader talked in high pace or for too long without explaining user examples and stories. This issue is addressed through the contribution from the theory of Teaching competencies with leadership and learning aspects.

Regarding the observable result of how active the participants were during the discussions of the workshop, the conclusion is to actively involve the participant in discussions by asking directed questions frequently is prosperous for a higher degree of activity with the participants. Although open questions allow for an answer with a greater width, they were rarely answered in the way it is advantageous in. But it was observed that the answers still were relatively short, with a few exceptions were the workshop leader asked about their own experiences or after a while with several frequently asked more simpler questions. This is a result that favours the new workshop due to the urging of just those types of questions during the workshop in the manuscript. However, it is difficult to successfully create and formulate several of these questions spontaneously that also are based on and a further development of the participants' answers. Hence, perhaps a more detailed and greater pool of questions as examples to use during the workshop is something that should have gotten more attention in the creation of the workshop.

The questions asked by the participants throughout the workshops show no significant difference. During both occasions the degree of questions asked was very low with only a very few exceptions during the new workshop. The fact that the workshop leader's experience differ, could be the explanation for the small variations between the outcome of the questions asked.

5.3.2 Survey 3

Survey 3 was answered two weeks after the workshop was held. The purpose of the survey was to see what the attendants remember from the workshop.

The most overall diagram (Figure 8) shows that the attendants reply more often correctly on the questions regarding the new workshop than on the questions regarding the former workshop. 70% of the answers on the questions regarding the new workshop are answered correctly. 57% of the answers of the questions regarding the former workshop are answered correctly. The question that shows the best result with 91% correct answers is question Q7 about "Data is the new oil" in the new workshop. The second-best result with 73% correct answers shows question Q8 about "Attractive workplace", also from the new workshop. This might indicate that the participants learned more at those stations than at the other stations. Still, the fact that they answered significantly better on those two questions might come from other circumstances than just because of the conscious usage of stories. Firstly, the stations that belong to questions Q7 and Q8 were conducted by workshop leaders who are more experienced in leading a group than the other workshop leaders. This could have contributed to a better understanding for the participants. The other workshop leaders are students from secondary school while the workshop leaders from station belonging to question Q7 and Q8 were university students with acknowledged pedagogical skills. Secondly, after the conduction of the stations that belong to question Q7 and Q8, the participants answered on a short survey about the station. This could have improved the participants' ability to remember the content better since they already had to write an answer about those stations another time.

Another interesting result is found through analysing the survey attendant-specific. There were three attendants that only answered correctly on one question, the other questions were answered wrong. The questions that were answered correctly were in two cases question Q7 (see Table 1, attendant B and C) and in one case question Q8

(Table 1, attendant D). The fact that those three attendants only know the answer on one question might indicate that they didn't learn so much during the day at Smarta Fabriker. But, and this is interesting for this investigation, they remembered something from two stations of the new workshop. What the performance of those two stations about questions 7 and 8 had in common, was that both of them were held as a discussion. The workshop leader asked questions to the attendants to which they could relate to and in both cases that started a conversation between the attendants. In addition to that, at both stations the usage of storytelling was high. At the workshop station for question Q7 the main message was to understand the value of data, explained through the catchy phrase "Data is the new oil". As mentioned in theory, catchy phrases support people's ability to remember a story. In addition to that, a story about traceability was told that could have touched the participants. The question Q8 referred to the station about "Attractive work" where the participants discussed own experiences they had while working in a factory to understand better the problems in factories and how they can be improved through digitalization.

The hypothesis of this work is that the attendants remember the content of the newly developed workshop better because the newly developed workshop contains stories. According to theory, stories make people remember facts better and enables them to tell the story to another person. The significance of this study is though very low since the range of tested participants is quite low. Further, the groups can differ a lot in character, interest and behaviour even if it is a group at the same age. Also, the fact that the investigation is made through a survey has to be taken into consideration because it can't be controlled how ambitious the persons are who answer the survey. Even though the study on this group shows a difference between the correct answers between the new workshop and the former workshop, it is only a very small group and it could be a coincidence that this specific group shows this result. For this investigation it can be said that the percentage of correctly answered questions is 13% higher for the questions about the new workshop than about the former workshop. Still, this can't be used to make a statement about the whole target group, but it can be made a statement about a trend that this investigation might indicate. So, what this investigation indicates is that the new workshop might show a trend to better results in what the participants remember after two weeks. The investigation shows that the reasons for the successful outcome could be the following:

- Workshop stations are held in a discussion form and let the participants be active in a cognitive way.
- Workshop leaders are experienced in leading a group and holding a discussion.
- Workshop station includes conscious usage of stories.
- Directly after the workshop station the participants answer on a survey with question "what did you learn at this station?"

In order to test the statistical significance, a t-test with the software tool SPSS from IBM was made. The null hypothesis is that the former and the new workshop don't show any significant difference in their mean value of correct answers. The alternative hypothesis is that the new workshop shows a higher mean value of correct answers than the former workshop. The test value is therefore 0,57 which is the mean value of correct answers of the questions regarding the former workshop. The program SPSS shows the following result of the t-test (see Figure 9).

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
new	11	,7045	,33200	,10010

One-Sample Test

Test Value = 0.57

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
new	1,344	10	,209	,13455	−,0885	,3576

Figure 9 - Result of one-sample t-test on survey 3

As you can see in the figure, the plot shows that the mean value of correct answers of the new workshop is 0,7045 which means that in average 70% of the answers are correct. This value we knew already. What the program shows in addition to that is that this value is higher than the test value. Though, and this is the most important fact about the test, the significance is 0,209 which is a very high value. A value for Sig. that is >0,05 means that the test isn't significant. In order to be significant, the value of Sig.

has to be <=0,05. Therefore, the alternative hypothesis is rejected and statistically, the null hypothesis is approved. This means that the mean value of the correct answers of the new workshop is not significantly higher than the value of the former workshop.

It can further be discussed, if the way this survey was formed is the ultimate way to get information on how much the participants remember. Firstly, the result would be more validate if there would be at least two questions about each workshop station since there are several topics discussed during one station and one of them could have been better received. The more questions are asked, the more the investigation can show how much the participants learn. Secondly, the design of the survey could be done in another way. There are some aspects that would support the usage of interviews of the participants two weeks after instead of a survey. The advantages would be that the participant could be asked more questions if they could answer the basic questions. So, the investigation could show what degree of knowledge this person has. In addition to that, the person who is interviewing can ensure that the interviewee is concentrated and answers on the questions thoroughly.

5.4 Evaluation of the New Workshop

Survey 1 and 2 and the feedback from the group of people with pedagogical expertise indicate how well received the new workshop was and what has to be further improved.

5.4.1 Surveys

Survey 1 shows how well the main messages of two stations of the new workshop are received. Since there were 23 participants who answered survey 1 and the result shows clearly that most of the participants fall into category "Partly", the result is quite significant. Both Figure 2 and Figure 3 show that the main messages of both station 3 "Attractive work" and station 4 "The connected factory" were received partly by most of the participants (74% and 82%). Only a few participants mentioned both main messages in their answer. This finding suggests that the attendants only received half of the content that was planned to be communicated. This data has to be interpreted with caution though, because it could be that the attendants didn't understand that they were supposed to write all the things that they learned, or they were too lazy to wright more than one thing they learned at the station. This survey can though indicate which main message was received better and on which main message the future workshop

leader has to highlight more. At the same time, we think that those main messages that were mentioned are the ones that are more important. Therefore, the result isn't surprising but rather shows how important the workshop leader is for what the group receives.

Survey 2 shows the atmosphere among the participants after the new workshop. The result shows that 33% of the participants learned some new things and 61% learned a lot of new things. So, 94% of the participants learned something new during the workshop. Only 6% of the participants answered that they didn't learn anything new. In this study this was one person out of 18. It is surprising that this one person answered that he/she didn't learn anything new since the content of the workshop is something that a usual secondary school student or a teacher doesn't know. Still, all the other participants stated that they learned something new which acknowledges the new workshop since one of the purposes of the workshop is to create knowledge about digitalization.

The second question of survey 2 indicates that 92% of the participants, so nearly all, found the new workshop interesting or enriching. This is a confirmation for the workshop since it is very important to create interest in technology through the workshop. Even if the investigation can't show if the workshop created any interest in technology, it still can be stated that the participants found it interesting and enriching which also means that they would want to deal with those topics again if they would have the possibility. There is one person who answered that he/she found the workshop boring and nothing special as well as enriching and interesting. This is the only person who marked "boring" and "nothing special". The fact that this person chose both positive and negative attributes might indicate that he/she found some parts of the workshop positive and some negative. This is a conclusion that could be drawn for all the participants. Even if they stated that they found the workshop interesting or enriching there could still be parts that they found boring. But this investigation doesn't give any information about that, only a general view.

The third question of survey 2 shows a high satisfaction regarding how well the participants understood the workshop leader. Still, even here, this reflects only the general impression but doesn't give any feedback to a specific workshop leader. The result shows that most of the participants could understand nearly everything or

everything of what the workshop leader said. This indicates that the level of the content was adapted to the target group.

5.4.2 Feedback from a Group of Participants with Pedagogical Expertise

Based on the evaluation with the participants with pedagogical expertise and experience from industry, parts of our theory regarding the design of a workshop could be attested and confirmed. The use of storytelling as a form of education in a workshop format where the purpose is to disseminate knowledge and to achieve insights regarding the opportunities and challenges of digitalization was confirmed. The participants themselves pointed out the benefits of user examples, defined as stories, as the thing and content they could see themselves remembering after this workshop. With, according to us, the participants pedagogical background and experience from the industry, their arguments regarding what is a good learning situation do have acknowledged weight.

Further, in a somewhat less evident way, we can see confirmation of the benefits of our developed workshop through the connections between the participants' positive feedback about the discussion climate, their positive attitude towards how they were treated by the workshop leaders, and the instructions in the workshop about taking discussions to the participant's arena. To ask what the participants themselves consider as opportunities/challenges with the technology in question is according to us addressing the aspect of creating a positive discussion climate and attitude as workshop leader. Acting this way as a workshop leader has the purpose of making the participants feel welcome to start or engage in a discussion regarding their own activities, where the workshop leader addresses opinions and arguments with openness and curiosity.

With the opportunity for improvement, this group of participants emphasized more activity-based learning. In our opinion, more activities would have an advantage for better learning which is also supported by theory. This is due to the well-established theory regarding active learning as a learning situation as it engages the participant to a higher level and has a proven effect of learning. But the difficulty with the application of a more activity-based learning situation to our workshop are the limited possibilities due to the nature of the content and equipment used in the workshop. The majority of the content consists largely of discussion topics and where it is considered difficult to

create a content where one actively can perform something relevant as a participant. An opportunity which, on the other hand, has been discussed as future work to try to address this issue, both between us authors of the report and between the participants in this group, is to create "work cases". The object with these cases is to engage the participants with the content. In this way the workshop achieves a higher degree of activity-based learning. The work cases are meant to get the participants to connect the content of the workshop to their own or similar businesses through examples of how improvements can be made or how the technology can make beneficial changes. The work cases could also illustrate the usage of the technologies which could provide the participants with greater insight on their possibilities and challenges. Through those cases, the participants can work in smaller groups, discuss and find solutions together.

6 Conclusion

This project was undertaken in order to design a workshop about digitalization for the project Smarta Fabriker using the theory of Teaching Competencies and storytelling, including the stories the partners of the project Smarta Fabriker want to mediate. Furthermore, the aim was to evaluate the workshop and identify if the usage of theory and storytelling improves the outcome of the workshop. The final result of this work is a workshop with accompanying manuscript that has been designed in accordance to theory of Teaching Competencies and by using storytelling. This manuscript includes the content that the partners of the Smarta Fabriker project want to mediate. In addition to that, the content that the partners want to mediate is presented in a separate appendix.

The main results of the evaluation of the workshop shows that the test group remembers the content of the new workshop better than the content of Smarta Fabriker's former workshop. In fact, this result shows that the same group of people answered 13% more correctly on the questions about the new workshop than about the former one. However, it should be mentioned that this result isn't statistically significant according to the conducted one sample t-test since the amount of tested participants is too small. Thus, no general conclusion of this result can be drawn and only a trend could be identified. Further studies should be taken into consideration to provide more definitive evidence.

Other phases of the evaluation show that the test group listened better in case the workshop leader narrates a story compared to if talking about facts. Further, in situations where the test group gets very active through involving them into a discussion, the participants listen better and talk about their own experiences. Another part of the evaluation shows that the participants themselves assert that they learned something new during the workshop and nearly all the participants found the new workshop enriching and interesting.

A further evaluation of the workshop is to be conducted. Following are our recommendations for future work:

- Firstly, it is important to point out that usage of theory for the workshop manuscript worked well. Though, and this is important for the performance of

the workshop, the transfer of the learning and leadership knowledge to the ones leading the workshop has to be developed. The learning of the workshop is highly dependent on how the leader performs and therefore, the leaders need to read, discuss, experience, try and practice the recommendations about learning and leadership. This includes also that the workshop leader knows some questions by heart that he/she can ask the participants and knows how and in which pace he/she should talk to different target groups. This should be a process with ongoing feedback and reflection. Even if this seems quite hard and time-consuming, it is important because if the purpose of the manuscript shall be fulfilled, it is necessary to give it time and effort.

- Secondly, during this study, only evaluations with test groups from schools were made. Hence, a further study on different target groups from the industry should be made to evaluate the performance of the workshop of different target groups. This would show how the workshop is received by industry groups and what should be adjusted. The remaining question is if the workshop can be performed in the same way as it is stated in the manuscript right now or if some parts should be adjusted to make the workshop fit better for industry groups.

- Thirdly, it would be of interest to increase the degree of activity-based learning. Two of four stations of the workshop involve activities where the participant is able to try out the technology. Still, the two other workshop stations are based on discussions and narratives of the workshop leader. A progression of this work could be to develop a possibility for participants to get more active even at the stations where they shall discuss certain topics. This could be done through giving the participants real-life or imaginary cases where they together in smaller groups solve problems. Their goal should be to see how digitalization could solve their problems or how digitalization should be used.

To sum up, the investigation can't give a precise answer to the question of how the theories of Teaching Competencies and storytelling contribute to the outcome of the workshop but can show hints of how the usage of those theories could have affected the outcome. We claim that the usage improves the outcome of the workshop, but only if the workshop leaders apply those recommendations summarized in the manuscript.

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Appendices

I. Summary of partners' interests

Kontakt	Frågeställningar
Björn Magnusson – ABB	digital tvilling: det svåra är att ändra kulturen- folk vill se på det de köper och ta på det
	ta in virtual commissioning
	vad är det för typ av människor - typ 4 olika stories
	buzz- words - (t.ex. digitalisering, kollaborativ robot) → fråga "Vad ser ni här?" och se vad de svarar, tolkar deras svar och terminologi på ett mått hur mycket de kan.
	öpna frågor: vad tror ni att den här stationen kostar?
	SME-företag: fördel att roboten kan lära upp sig själv
	100% digitalisering: från att ordern kommer in till att den är färdig producerad
	varför digitalisera? Löner stiger med digitaliseringsgrad - hela tiden flytta sig i värdekedjen för att annars blir man utkonkurrerad (Indien, China,....) - SME-företaget i smuland är levarantör till Ikea, behöver tillverka x antal produkter i olika serier, fixar det bra med digitalisering där man enkelt kan programmera vilka versioner/typer av produkten man ska tillverka. Det hade inte varit möjligt i en produktion som inte var digitaliserad - Därför blir man inte utkonkurerad.
	för att överleva måste man digitalisera
	för barn: tänk på din morfar som jobbade i varvet, varför gör vi inte det nu? Våra förfädrar har haft möjlighet att jobba hårt för att utveckla teknik - så att vi har det så bra som vi har det idag
Åsa Fasth- SII-lab	IoT-plattform när man vill äga all data själv - alla komponenter och dess datainsamling behöver sparas på en egen plattform för att kunna kommunicera med varandra.
	Smarta Fabriker använder inte detta, hämtar bara data från komponenter när det efterfrågas och samlar det i Azure för analys. Denna kommunikation sker med hjälp av Cybercom.
	Nya yrkesroller behöver skapas: IoT-ansvarig som ansvarar för att komponenter och dess data är kapabla att kommunicera med varandra och ser helheten.
	den klassiska automatiseringspyramiden - används fortfarande men nu ska man gå över till att alla kan kommunicera med alla utan att ha mellansteg i kommunikationen
Strain labs	Skruvförband med spårbarhet som kan läsa av deras realtids-status
	99% av alla skruvar är inte tillgängliga att kollas
	Uppkopplade skruven gör att man vet om en skruv behöver åtgärdas
	Exempel på case:
	Börja litet med liten investering - provcase, 5000kr Där man sedan får något fysiskt att arbeta med - Gör något som de kan prova mot en låg kostnad
	Flygplatsbelysning - Lamporna får inte lossa - Lossar dessa måste man dra ut alla skruvar och lossar de slocknar de vilket kan leda till katastrof - En uppkopplad skruv kan förhindra detta - Kan få loss en timma extra per dag pga skruvarna på flygplatserna för att låta fler flygplan lyfta är ökning av miljardbelopp
	Kolla järnvägsväxlar

	överallt där det finns ett krav eller behov att inspektera
Atlas Copco (Skruvdragare) Magnus Sjölöf	<u>Vad vill Atlas Copco visualisera i demonstratorn?</u> sitt verktyg som hjälper att omvandla massor av data till användbar information Atlas Copco ger rekommendationer på konfigurationer av verktyg genom analysera data → förbättra processen möjlighet att skapa nätverk av alla maskiner, fabriker av företaget i hela världen → ämnesområde "global samverkan" → hjälpa andra med egna erfarenheter <u>Vad gör dem Industri 4.0 eller så att säga "smarta"?</u> kvalité och spårbarhet - Datan lagras för möjlighet till förbättring och kvalitéetssäkerhet. om något händer (personskada) kan produkten trackas och man kan titta på t.ex. åtdragningskurvan av skruv → man slipper återkalla t.ex. flera tusen lastbilar för man ser att just den lastbilen hade en ovanlig form på åtdragningskurvan I dagsläget har olika konfigurationssets (olika steg i utvecklingen hos en produkt) olika mjukvara för olika produktanpassningar. Men datan som Atlas Copcos skruvdragare samlar kan användas för att föra över konfigurationssettet till produktion → förkorta time-to-market genom digitalisering → (Volvo AB) <u>Problematik:</u> väldigt mycket data har samlats in, men inte många där ute i fabrikerna/produktion som förstår datan → men de systemen som finns idag hjälper en mycket eftersom de är kloka svårt att vinna förtroendet för att företagen vill egentligen inte ge ut sin data (kanske för att de är rädda att de kan bli anklagade för olika saker om en olycka händer) olika filsosofier: daimler ger all data till ett företag och får tillbaka analyserad information med rekommendationer/varningar vs. BMW vill göra allt själv <u>Uppföljning intervju:</u> Viktigt att poängtera det ekonomiska värdet i att digitaliser Det nya är <u>flexibel</u> montering Global samverkan - Tillverkningsenheter i hela världen som kan dela med sig av sin konfigurerade data som andra sedan kan applicera. Därmed samverkar enheterna globalt Försök att maximera nyttan med en cobot så man förstår användingen av den Viktigt att tänka på - Ett flödesschema som vi sedan effektiviserar med hjälp av digitalisering - visar tydligt på att det blir bättre mmed hjälp av digitaliering.
MVV (Casat–monteringssystem) Jesper Broberg	Vad vill MVV visualisera i demonstratorn? Casat system - visar instruktioner till montören, samlar data kring "allt" som ger en möjlighet till spårbarhet Vad är det som gör Casat lämpligt som monteringssystem? Visar monteringslinan och operationerna som ska genomföras. Använder Yumi som en gateway för signalerna som "godkänner" de flesta stegen i processen. Bilder på montörens arbete på ett pedagogiskt och bra sätt

	Vad gör det Industri 4.0 eller så att säga "smarta"?
	Roboten ger instruktioner, sedan bockas operationen av antingen med en signal från roboten eller så klickar användaren på "vidare" när uppgiften är utförd → roboten är uppkopplad
	IoT - Uppkopplad på nätet så åtkomst finns överallt.
	Sensorers signaler är uppkopplade
	Casat är en informationshub som sparar ner information, tex. temperaturen vid en viss order och om det är problem kan det analyseras - big data som loggas - spårbarhet!
	API - används för att kommunicera mellan olika system
	konstruktörerna tar på sig sin jacka med RFID-tag så den inte behöver registrera sig själv,
	Hur kan vi demonstrera det som inte syns på ett bra sätt? Ni samlar ju ganska mycket data/spårbarhet mot varje produktionsorder.
	Mycket intressant för industrin med spårbarhet gör att det går att analysera och förbättra operatör, maskin etc.
	Bara intressant för viss publik - Går inte att visa på alla genomförande, tar för lång tid för "alla" kommer få felmeddelande.
	Kan stänga av/sätta på funktionen med spårbarhet.
	Kan välja att prata om det efter genomförande beroende på vilken publik
	Hur fungerar kommunikationen mellan de olika systemen och behöver man tänka annorlunda när en cobot är inblandad jämfört med manuell montering?
	IT-mässigt: Kör programmet som redan är fördefinierade hos ABB och roboten ger svar när den är klar
	produktionstekniskt perspektiv: cobot är ett produktionstekniskt nytt verktyg
	Behöver ändra sitt sätt att tänka på investeringen (Vad kan coboten göra, vad kan montören göra medan hen väntar på coboten?)
	Ändra sitt beräkningssätt på produktionen med en cobot, nya möjligheter till skillnad från en robot - "kan minska flaskhalsen med x mycket, snabb att starta och installera, se det som ett hjälpmedel/en skrivdragare"
	cobot kostar mycket mindre än en stor vanlig robot → dvs man måste inte investera så mycket och är mer flexibel!
ABB (Robot – Yumi) **Robotstudio/robot** Magnus Seger	Vad vill ABB visualisera i demonstratorn?
	Vad är det som gör Yumi så lämplig som robot?
	liten och ofarlig (kan inte allvarligt skada människan)
	Vad gör Yumin Industri 4.0 eller så att säga "smart"?
	Reinforcement learning - Maskinen lär sig själv via en "agent" vad som är rätt och fel operationer för att slutföra ett uppdrag.
	Nytt: Maskinen är medveten om människans närvaro
	Hur kan vi demonstrera det som inte syns på ett bra sätt? Ni samlar ju ganska mycket data i molnet.
	det viktiga är det som inte syns: att roboten lär sig med tiden genom att samla erfarenhet, robotstudio
	samarbetet och dess fördelar → i digitaliseringen går allt väldigt snabbt och det är därför nödvändigt att samarbeta
	Är det något särskilt som är viktigt att nämna kring Robotstudio?
	Simulering efter simulering så att roboten får mer och mer erfarenhet
	Största mjukvara för robotsimulering

	I början har roboten ingen erfarenhet, vet inte vilka operationer är "ok" eller "inte bra". simulering visar det!
	Med hjälp av simulering förkorta tiden att programmera robotar. Framför allt förenkla robot-programmering! Så att även människor med mindre kunskaper kan programmera dem
	Vad är viktigt att tänka på när det gäller samarbetet människa/maskin?
	Maskinsäkerhet framförallt!
	Roboten ska göra de tråkiga, monotona och slitsamma uppgifter, människan ska göra finmotoriska och problemlösning
	Om man inte har råd med en helt automatiserad fabrik är det en möjlighet.
	Varför har industrin så svårt att implementera kollaborativa applikationer i sin verksamhet. Finns det något vi kan göra för att underlätta?
	Okunskap kring hur robotar kan användas i industrin. De inte kan se nyttan med kollaborativa robotar tydligt.
	Att okunskapen och ovissheten kring detta nya ämne medför en osäker satsning vilket medför risker som företag inte gärna tar.
ABB (Robot – Yumi) **Maskinsäkerhet** Anette Wester	Vad är viktigt att tänka på när det gäller samarbetet människa/maskin?
	det finns en standard för robotsäkerhet
	riskanalys: viktigt att tänka på alla möjliga felgrepp som kan leda till faror → detta blir mycket svårare i en flexibel produktion, man får ha olika säkerhetszoner för de olika produkterna som tillverkas, tex. om man ger yumin ngt farligt i handen
	säkerhetsmetoden "power enforced limiting" - man gör roboten så pass svag att den inte allvarligt kan skada någon
	det får inte vara möjligt att den träffar någon kring ansiktsområdet för att det inte går att testa (ingen ställer upp) hur starkt ett slag får vara där
	säkerställa genom programvara, men också fysiskt?
	samhället styr vilket mindset vi har angående säkerhet
	Varför har industrin så svårt att implementera kollaborativa applikationer i sin verksamhet. Finns det något vi kan göra för att underlätta?
	hon skickar kontakter som vi kan fråga detta om!
	missförstånd: vanliga robotar går inte att använda som kollaborativ robot
	problem: ofta saknas det ett syfte som företaget inte kommer på - ergonomiskt eller ekonomiskt
	motivation: roboten är bra på att göra repetitiva jobb, människan gör det som är svårt att automatisera för människan kan ta beslut mer flexibelt än roboten → båda har sina fördelar
	hitta nya branscher att automatisera
Cybercom (App, cloudlösning, etc) Henrik Lövetoft	Viktiga poänger med Smarta Fabriker enligt Cybercom:
	industry 4.0 - tekniken i ett sammanhang och värdet ska förmedlas - beroende på målgrupp
	Visa vad man kan åstadkomma - "om studenterna kunde skapa det här, borde ni också kunna det!"
	Visualisera med Rubiks kub → visualisera med något roligt bara för att förstå sammanhanget och sedan kunna applicera det till deras verksamhet (Rubiks kub = monteringsinstruktioner i fabrik för en produktion).

	Vad är "Pain" (något som inte funkar så bra som skulle bli bättre med hjälp av t.ex. AI) och vad är "Gain" (något helt nytt som kan ge värde)? Hur kan man ta bort Pain med hjälp av digitalisering?
	Molnet är bra för samarbetet mellan maskinerna och för att använda datan och för att samla informationen som "människan" sedan kan visualisera eller använda vidare (real-tids status).
	cybercom har byggt hololens-AR-fabriken + App för smarta fabriker → visa att de skapar IT-lösningar
	Stor fördel med SF gällande beslutsfattande vilket har gjort fabriken möjlig. Även om det är ett "nej" så är det ett besult. Idéen fastnar ofta i PoC och går inte igenom till pilot för att faktiskt sedan lanseras.
	Kommunikation mellan OT och IT är svår även om kompetensen finns
	Hur lätt upplever ni det att sälja in en molnplattform till industrin? Vad är svårigheterna?
	alla vill ha industri 4.0 men inte alla gör det
	alla stora företag har en eller flera clouds
	vinna förtroendet
	börja i små steg → tratt från stort till smalt: idea, PoC, pilot, industriell lösning → avväga kostnad och vad ger det
	cheferna som inte vet så mycket om IT → berätta varför det här gynnar, profit
Ericsson (Angående garaget) Fredrik Flyrin	Berätta lite om Garage och hur ni gör när ni tar emot besökare där och om det finns något som vi kan lära oss av er och tvärtom.
	Garage är en plattform för att realisera idéer. De guidar innovatörer från idé till projekt.
	Vi kan erbjuda att prata om garage under Smarta Fabrikers workshops där deltagarna kan få idéer.
Microsoft (Azure) Ola Reppling	Ni bidrar med er cloud-lösning Azure till smarta fabriker - Hur implementeras cloud-lösningen? Vad gör den i SF?
	microsoft möjliggör att andra blir coolare
	plattformen för alla partners samarbete
	Vad vill ni förmedla genom SF?
	om vi samarbetar klarar vi mycket! Digitalisering
	"Det behöver inte bli perfekt direkt, bara det bli lite bättre" - Implementeringsprocessen behöver inte vara så komplicerad
	när man implementerar digitalisering kan man börja litet, inte allt på en gång, tänka i moduler och uppgradera varje del för sig
	SF har byggt en bättre fabrik än ex Volvo, Ericsson på grund av att SF har en helhet i sin fabrik till skillnad från partners som är proffs på sina tekniker - SF är proffs på att transformation - Alla partners har sin expertis men kan inte göra så mycket av den utan SF som möjliggör samarbete - Möjliggörs på grund av non-profit.
	engage your customers (veta vad de vill) + empower your employees (ha tillgång till resurser vid rätt tid) + optimize your operations + transform your products → viktigt för att vara framgångsrik
	Vad vill ni förmedla i den nya demonstratorn?
	AI → kollaborativ robot som läser av montören ex.
	Har du en idé hur man skulle kunna visualisera eller visa eran teknik i workshopen?
	Hololens är Microsofts - Det kan synas
	Viktigaste är att Cybercom etc. syns eftersom de använder Microsofts plattform.

	Vad är unikt med er teknik och varför är den smart?
	you join microsoft to make others cool - vi vill inte förmedla hur coola vi är utan hur coola andra blir genom oss
Volvo AB **Virtuell träning** Pierre Johansson	Vad gör era exjobbare för smarta fabriker?
	i förra projektet: virtuella träningen handlade om i vilken ordning man skulle bygga ihop → nu: ha sensorer på fingrarna/armarna/anklarna/axel för att se hur de genomför hela momentet → se att inte ankeln är över axeln, ergonomi
	olika behov av träning: operatör som är helt ny, operatör som har jobbat på annat företag, operatör som har jobbat på ett annat ställe på Volvo, erfaren operatör → helt ny, bygger sällan, bygger alltid
	Lisas och Henriks exjobb: Kartlägga vilka behov det finns och hur man anpassar träning till "current state of kunskap" → för att träningen är väldigt bristfällig + bygga upp en träningsscen
	montern ska ha framsida och baksida - fysiskt vs. virtuella träning → Fråga Johannes om detta!
	Var ser du fördelarna med Virtuell Träning?
	effektiviteten i träningen ökar för att det är lättare att förstå med det virtuella
	om haptiken (vad man känner) kommer in → 3D-printa verktyg? Ger det något?
	ersätter inte träningen på line utan är bra som lärmiljö men man måste ändå öva på riktigt, men man kan få certificiering genom VT → säkerhet
	lära sig exakt HUR man gör rörelser
	Vad vill ni förmedla genom smarta fabriker?
	effektiviteten av VT
	visuell input + uppleva är ofta starkare än när någon berättar
	du får visuella råd
	guidning fram till rätt event
	få feedback
	standardisering → datorstyrd träning är enklare att standardisera, definierade krav
	bättre arbetsmiljö för operatörerna, de kan lära sig olika stationer snabbare och inte bara jobba på en station
	samma data i det förberedande arbete som i det operativa arbete → inte skapa ny data
	små företag kan köpa in VT från företag som har specialiserat sig på det → kan gynna dem mycket
	utvecklingen av VR: från att sitta framför en datorskärm, till framför tex WII eller xbox, till att inte ha något i händerna utan ha på sig glasögon
Volvo AB **Blockchain** Richard Hedman Tel: 076-553 46 19 E-mail: Richard.hedman@volvo.com	(se även powerpoint som han skickade)
	Vi har förstått att du jobbar med Blockchain. Kan du förklara lite kort vad det betyder och vilka fördelar det finns med det?
	gemensam syn på det som har skett – undvika konflikt – vi pratar om samma sak → TRUST, transparenz
	enabler av IoT
	Var kommer blockchain in i smarta fabriker?
	det kommer vara en annan ny monter: blockchain applicerat som supply chain kedja

	Filmen om lastbilen är deras case lastbilen ska komma med leveranser, varje steg bockas av i kedjan Vad vill ni förmedla i smarta fabriker? connectivity, electromobility, automation smarta kontrakt… som säger vad som händer när ett visst fall inträffar – inga konflikter

II. Workshop manuscript

Station Monteringsfabrik

Smarta fabriker, 2019

Det här dokumentet innehåller information om Monteringsfabriken som är en av Smarta Fabrikers demonstratorer. Dokumentet kan användas av de personer som håller workshops för att lära sig mer om de olika ämnesområden som berörs i Monteringsfabriken för att därefter kunna prata om dem under en workshop. Dokumentet innehåller vilken utrustning som behövs för workshopen, tips för hur workshopledaren anpassar genomförandet, dvs. ledarskapet, pedagogiken och innehållet, till målgruppen och en beskrivning av genomförandet med ämnesinnehållet.

Innehåll

Utrustning

- Monteringsfabriken
- Skyddsglasögon, hårband
- Arbetsjacka med RFID-tag
- Dator med HTC vive
- Stor skärm för bild med holistiskt perspektiv, film om robotsimulering, Powerpoint

Tips för målgruppsanpassning

Nedan följer tips till de som leder workshops som kan hjälpa en att anpassa sitt bemötande och hur man leder gruppen beroende på vilken målgrupp det är. Där ett allmänt tips för att leda ett lärandetillfälle är att ha höga förväntningar på gruppen och utgå ifrån att gruppen kan lära sig mycket. Det har en positiv effekt på lärandet om man har höga förväntningar på gruppen och visar dem att man har det.

Introduktion genom att förklara syftet med workshop/denna station

Börja alltid introducera workshopen med att förklara syfte med workshopen. Olika målgrupper har olika syften.

Syftet för vuxna

Syftet är att visa möjligheter med industriell digitalisering för att öka konkurrenskraft t.ex. genom ökad produktivitet, kvalitét, arbetsmiljö och förkortad Time-To-Market.

Syftet för barn/ungdomar

Syftet är att de får se spännande arbetssätt med monteringsstationen och förstå att detta skapades tillsammans med studenter. Deltagarna ska förstå att det är de som är framtiden och med rätt val av utbildning kan de bygga en fabrik.

Identifiera förkunskaperna hos deltagarna för att förhålla dig till

Att veta vilka förkunskaper deltagarna har gör att man som workshopledare kan förhålla sig till gruppen på ett anpassat sätt, vilket gör att deltagarna kan få ut så mycket som möjligt ur workshopen. Någonting som hjälper en med detta oavsett målgrupp är att uppfatta vilket ordval deltagarna använder. Ordval som deltagarna använder identifierar hur väl bekanta de är med ämnet, exempelvis om de använder ord som "kollaborativ applikation", "cobot", "kollaborativ robot", Big data", etc så är de högst troligt väl bekanta inom digitalisering. Det är enkelt att undersöka genom att fråga vad de ser och vet om en sådan här station, om de har sett någon tidigare.

Nedan förklaras ett antal tillvägagångssätt för att hjälpa en att identifiera de olika målgruppernas förkunskaper. Detta är en process som sker under tiden med gruppen och en av de stora utmaningarna med att leda grupper, men man samlar erfarenhet gällande det och blir bättre på det.

Vuxna

Uppfatta vilken grad av kännedom de har om digitalisering genom att uppfatta vilka frågor de frågar - Om de ställer frågor om sådant som är mer komplicerat och mindre uppenbart, så som uppkopplingen, delningen och analyseringen av datan eller om de bara frågar om sådant som är synligt, om roboten eller monteringsinstruktionerna. Om de ställer komplicerade frågor kan man utgå ifrån att de är väl insatta - ställer de bara frågor om sådant som man kan fysiskt kan se på Monteringsfabriken kan man inte utgå ifrån att de kan mycket om det som inte syns utan bara att de är intresserade och då kan man välja att berätta om det som inte syns och leta efter en respons på det. Utifrån den responsen kan man utläsa deltagarnas kunskapsnivå.

Ett tips är att fråga om deras utmaningar och vad de ser för möjligheter med digitalisering i deras verksamhet tidigt. Svaret, tillsammans med det tidigare nämnda om ordval och hur avancerad teknik de väljer att prata om, kan hjälpa en att identifiera deras förkunskaper.

Barn/ungdomar

Till barn och ungdomar är det fördelaktigt att tidigt ställa öppna frågor till deltagarna. Exempel på sådana frågor är:
- Hur använder du dig av teknik hemma?
- Vad är teknik för dig?
- Vad har ni läst i teknikämnet i skolan?

Svaren ger deltagarna en chans att själva förklara vad de vet om teknik och du kan utefter det förstå vilka förkunskaper de har och anpassa ditt genomförande efter detta.

Leda diskussioner och styra gruppen

Nedan följer tips som kan hjälpa en att leda diskussioner och styra gruppen beorende på målgrupp

Vuxna:

Denna grupp är i regel aktiva och intresserade av allt du har att säga och visa eftersom de är intresserade av att kompetensutvecklas inom digitalisering. Därför kan du med fördel leda denna grupp genom att öppna upp för diskussioner och dialoger istället för konkreta och enklare frågor. Sådant som hjälper en med detta är att ställa frågor som relaterar till deras verksamhet och arbete så att de kan ge egna exempel att bygga vidare på:
- "Vad har ni för tankar om hur man kan utnyttja en kollaborativ robot i era företag?" - Ett exempel är i en fabrik i Frankrike som tillverkar motorer till Volvo. Där utnyttjar de roboten genom att den lyfter upp tunga delar och spänner skruvar och bultar på motorerna samtidigt som operatörerna kan fokusera på andra monteringsaktiviteter som är mindre besvärliga och farliga samtidigt som operatören kan tänka på och bidra till att utveckla monteringsprocessen så den blir ännu bättre.
- "Vilka utmaningar finns det i er produktion för tillfället, och kan man lösa det med någon form av digitalisering? Har ni någon flaskhalssituation?"
- "Hur ser kvalitén ut i er verksamhet, har ni något pålitligt sätt att kvalitetssäkra?" Exempel: Monteringssystemet som kvalitetssäkrar monteringen vid valda kritiska steg och som bevakar processen som gör att man kan optimera flödet och identifiera flaskhalsar
- "Hur ser det ut med sjukskrivningar hos era anställda? Finns det några av dessa som kan grunda sig i oergonomiskt arbete? Kan deras arbetssätt förändras?"
- "Vad ser ni för möjligheter? Gällande kvalité och produktivitet i er verksamhet?"

Skolungdomar vet ofta mycket mer än vad många förutsätter, framförallt om man visar att det är okej att tänka fritt.

Det kan finnas grupper som är väldigt aktiva som du kan försöka diskutera kring saker de ser och kan relatera till. Är denna grupp rätt passiv, är det svårt att diskutera och då bör du ställa konkreta frågor kring vad de ser och sådant de kan relatera till för att väcka deras kreativitet. Denna grupp har oftast svårt för att prata om abstrakta saker. Det kan även vara bra att berätta om egna exempel för att få dem att våga prata om sina tankar. Uppmuntra de deltagare som är aktiva till att fortsätta. Exempel på konkreta frågor:

- Vad kan ni se här vid stationen? (en robot, skärmar, skruvdragare…)
- Vad hade du velat ha hjälp med av en robot? Hemma? I skolan?
- Känner ni er trygga med att jobba med Yumi?

Aktivt tänk på vilket språk du använder

Beroende på hur väl bekanta de verkar med ämnet tänk på att anpassa dina ordval själv till en nivå så att deltagarna förstår vad du pratar om. Det är framförallt viktigt att du aktivt tänker på att du inte använder ord som deltagarna inte förstår när du förklarar. Viktigt är att inte skapa en rädsla hos personerna genom att använda svåra och för dem okända ord. Det viktiga är inte att deltagarna kan alla rätta begrepp, det viktiga är att deltagarna får med sig kunskapen och har kul.

Vuxna:

Det är inte säkert att denna grupp har kunskap om vad saker och ting heter inom digitalisering. Men när det är deltagare med högre kunskaper inom digitalisering behöver du inte lägga fokus på att förklara de grundläggande delarna av processen utan du kan med fördel använda dig av den korrekta terminologin. Eftersom detta är ord som deltagarna redan känner till och vet innebörden av, därmed förstår de redan vad du pratar om och kan direkt bidra till en diskussion.

Barn/ungdomar:

Denna grupp är inte van vid att höra eller använda tekniska termer så du får förklara tekniken med enkla ord.

Val av ämnen att prata om beroende på målgrupp och deras förkunskaper

Det som avgör vad du som workshopledare väljer att prata om är upp till dig och hur du tolkar gruppen. Det finns ingen rätt eller fel ordning att prata om de olika ämnena om demonstratorn, utan prata om det du känner är relevant för gruppen. Det enklaste är att börja med det som syns, den kollaborativa roboten och i samband med det ta reda på vad deltagarna är intresserade av.

Vuxna:

Dessa deltagare är från industrin så det är intressant för dem att inte bara fokusera på det som syns och är tydligt utan också på det som inte syns i demonstratorn. Exempel på detta är:

- Spårbarhet
- Kvalitetssäkring genom monteringssystemet
- Samarbetet mellan partners
- Uppkopplingens möjligheter (Global samverkan, förkortning av time-to-market)
- Big data och att insamlingen och analys av data möjliggör faktabaserade beslut
- Attraktiv arbetsplats pga ergonomi, minskad arbetsbelastning, ökat ansvarstagande för montör, under planeringsfasen i fabriken kan operatören påverka sin arbetsplats.
- Skräddarsydda lösningar - 3D-printing

- Datahantering: Strategier för att hantera sin data. Anställa all kompetens som krävs internt och på så sätt utnyttja all data vs. ge utvald och relevant datan till externa företag/leverantörer som därmed också ger rekommendationer etc.?

     Vad finns det för fördelar och nackdelar med respektive alternativ? Datasäkerhet?

Barn/ungdomar:

Barn och ungdomar kan prata om det de ser, men det kan vara svårt att få dem att förstå processerna bakom det de ser.

- Kollaborativ robot - reinforcement learning (fast inte gå in på simulering)
- Nya arbetssätt
- Studenter har skapat
- Monteringssystem (prata om det man kan se på skärmen)
- Uppkoppling
- Variation mellan denna station och dagens fabriker →Denna grupp vet inte hur fabriker ser ut och vilken standard som är "normal" i nuläget. De kan alltså tro att det de lär känna på Smarta Fabrikers workshops är så som det ser ut i verkligheten, trots att det i de flesta fabrikerna inte alls är lika modernt och digitaliserat. Berätta om hur det ser ut i dagens fabriker, att de inte är uppkopplade på samma sätt och det därför finns mycket potential för förbättring.

Kontinuerlig utveckling

Efter varje workshop du håller, reflektera hur det gick, vilka frågor de ställde, vilka frågor det inte gick att svara på, inte se sig som färdigutbildad utan försöker utveckla sig själv. Reflektera själv över det egna ledarskapet med hjälp av de följande 3 feedback-frågorna och prata med de andra workshop-ledarna om det:

- Hur går det för mig? Var står jag?
- Vad är mitt mål? Vart vill jag komma?
- Vad måste jag göra för att nå målet?

Detta är bra att göra efter varje workshop som hålls för att utvecklas så mycket som möjligt.

Genomförande

Det här kapitlet innehåller information om de olika ämnesområden som berörs i Monteringsfabriken som workshopledaren kan prata om. Ytterligare innehåller kapitlet förslag på stories att prata om som är markerade i *kursivt.*

Introduktion

Berätta framför en skärm om följande bild:
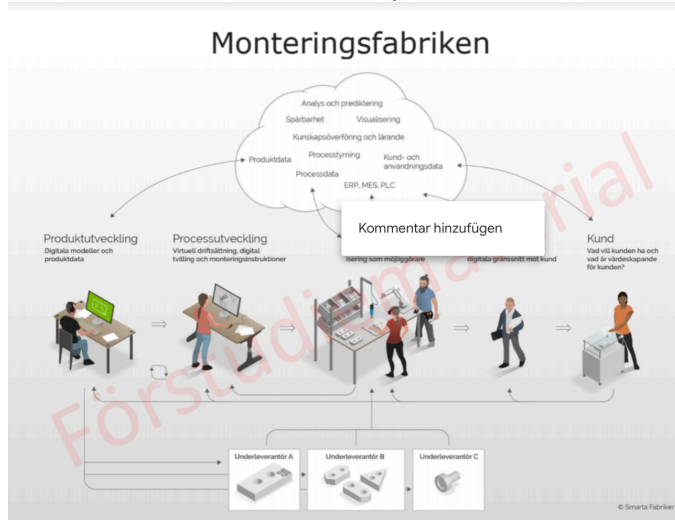
Denna holistiska bild visar ett helhetsperspektiv över hur digitalisering kan tillämpas i ett företag. Den visar hur samverkan mellan produktutveckling, processutveckling, produktion, marknad och kund sker för att skapa en flexibel produktion. Syftet är att med en kollaborativ applikation visa hur man kan skapa nya möjligheter och för att visa samverkan mellan automation och människa. Men digitaliseringen kan inte ses som lösningen för all problematik. Det är viktigt att se över sin process och sitt flöde för att identifiera förbättringsområden eller förändringar, där sedan digitalisering kan göra det mer effektivt eller till och med möjliggöra viss förändring.

Samarbete Konstruktion/Produktion

Med exemplet av produkten som inte går att lossa från spännet syns det att konstruktion och produktion inte har samarbeta*t.*

Man har konstruerat en produkt som inte är tillämpat för processen. Detta är ett mycket vanligt fel och det belyser vikten av att ha med produktionstänket i ett tidigt skede i utvecklingsprocessen av produkter.
Detta är ett exempel på att man måste samarbete mellan alla steg under produktkedjan. När man pratar om det holistiska perspektivet tittar man på alla steg i produktutvecklingsprocessen, dvs. helheten och vem kommunicerar med vem.

Anpassningsbar produktion (Customized production) är ett begrepp som innebär: *Man vill möjliggöra en anpassningsbar produktion direkt från kund till produktion. Därmed krävs en mycket flexibel produktion då slutkunden kan skräddarsy sin beställning. Detta sker i 7 steg i vår process.*

Se artikel på Edig: https://www.edig.nu/artiklar/mass-customization-automated-local-production-with-the-new-flexible-manufacturing-methods

Samverkan människa – automation

Detta avsnitt innefattar information och stories om ämnesområdet "Samverkan människa – automation"

Olika typer av interaktion mellan människa – robot (HRx)

Det finns fem olika nivåer av kollaboration mellan människa och robot i produktionen. Nivåerna bestäms av hur hög grad av interaktion det finns mellan människa och robot. Där monteringsstationen uppfyller den högsta graden av kollaboration, så kallad "Human-Robot Collaboration".

Se artikel på Edig: https://www.edig.nu/artiklar/human-robot-x-hrx-vilka-olika-typer-av-interaktion-finns-mellan-manniska-och-robot-1-1

Vilken cobot ska jag använda?

Det finns ett antal olika robotar med kollaborativa applikationer ute på marknaden. Vilken man ska välja beror på användningsområden. Det finns ett antal jämförbara områden mellan robotar som är värda att beakta vid val av robot. Dessa är exempelvis:

- Frihetsgrader på roboten (DoF)
- Hur mycket roboten klarar av att lyfta, inklusive robotverktyget (Payload)
- Hur mycket roboten väger (Weight)
- Repeternoggrannhet (Repeatability)
- Hur långt robotarmen kan nå (Reach)
- Vad finns det för säkerhetssystem inbyggda i robotarmen (Safety)
- Pris (Price)
- Användarvänlighet gällande programmering (Ease of programming)

Exempel att prata om gällande val robot och kollaboration är: *När man designar sin process behöver man bestämma vilken automatiseringsgrad man vill ha samt vilken nivå av kollaboration som blir bäst utifrån ekonomi, produktivitet, ergonomi och kvalitet.*

Se artikel på Edig: https://www.edig.nu/artiklar/vilken-cobot-skall-jag-valja

Maskinsäkerhet

För varje maskin och arbetsplats genomför man en riskanalys, som för denna station är gjord enligt en ISO- standard för en kollaborativ applikation (ISO/TS 15066).

Även om vår kollaborativa applikation med roboten är relativt harmlös på grund av att den är så pass svag, så kan den innebära en risk för användaren. Exempelvis om roboten greppar något vasst föremål, i vårt fall är ett hörn på vår produkt vasst, så kan den skada en montör. Därmed behövs skyddsglasögon när man använder monteringsstationen. Därför måste man veta vad man gör med sin applikation, eftersom säkerheten kommer i första hand. Ett annat exempel är när man har använt en cobot till att applicera smältlim som är extremt farligt vid kontakt på huden. Vilket medför många risker trots att det är en svag robot.

Denna roboten är så kallad power-enforced limited, är det någon som vet vad det innebär? - Det innebär att kraften som roboten har är begränsad så att den inte kan skada en människa i sig.

Smarta arbetssätt

Med Monterinsfabriken illustreras olika smarta och nya arbetssätt för bland annat montörer och konstruktörer

Med en cobot utvecklas nya arbetssätt där fördelarna med en robot och en människa kan utnyttjas, där roboten i vårt fall kan presentera material eller detaljer som montören ska arbeta på medan montören kan fokuserar på komplicerade finmotoriska arbeten. Arbetet blir på detta sätt mer <u>ergonomiskt för montören</u> eftersom hon inte behöver sträcka efter produkter eller verktyg vid montering utan kan arbeta nära intill kroppen. Vilket kan medföra stora besparingar i och med en högre ergonomi i investeringsbedömningen.

Design for Automatic Assembly är ett viktigt begrepp som innebär att i och med att montering nu sker tillsammans med en robot som har en annan rörlighet och flexibilitet till skillnad från en människa måste också detaljer och komponenter av det som ska monteras konstrueras så att det är anpassat för en robot.

I *Monteringsfabriken var det en del på vår produkt som behövdes göras tjockare vid den delen som roboten greppar i för att skapa en tillräcklig stabilitet. Tidigare när fästet var smalare kunde inte robotens grepp hålla i fästet tillräckligt stabilt för en bra montering.*

Kvalitets-säkrad montering för effektivare produktion
Monteringssystemet instruerar montören vad hon ska göra och visar med bilder hur produkten ska monteras och vad som är nästa steg i monteringen för en kvalitets-säkrad montering och effektivare produktion.

Även rätt låda med rätt produkt presenteras för montören. Detta gör att det blir mycket svårare för montören att göra fel och det blir högre kvalitét på produkterna. Monteringssystemet anpassar sig efter vilken typ av produkt det är som ska monteras genom en ID-scanning av produkten. Så till exempel om det är en produkt som tillverkas väldigt sällan, bara någon enstaka gång i fabrik med jämna mellanrum som är svårt att komma ihåg hur denna ska monteras, så är det ingen fara då montören får upp instruktioner för den aktuella produkten eftersom den har scannats in och då får montören de tillhörande monteringsinstruktionerna. Vilket medför en mycket mer flexibel och mångsidig produktion. <u>Exempel:</u> På Volvo lastvagnar är det endast 10% av lastbilarna som går igenom hela produktionen utan fel. Därmed kan man se värdet i ett tydligt och bra monteringssystem. Tänk vilka enorma besparingar man kan göra genom att montera rätt och minska antalet återkallningar eller efterkonstruktioner i produktion.

Relevant data för monteringen sparas, så som tid för montering, som man sedan kan analysera för att identifiera brister i flödet. Till exempel om en viss produkt alltid tar längre tid än de andra kan det vara lämpligt att balansera om produktionslinan.

När en aktivitet är utförd vid montering, så godkänner antingen montör eller robot steget som godkänt och man kan gå vidare till nästa steg.

Visionkamera i robotens armar gör att man kan kontrollera produkten i utvalda steg i monteringsprocessen för att kontrollera att man inte missat någon detalj. Detta gör att man minskar risken för eftermontering eller kassationer. Kameran kan även kontrollera att rätt skruv dras i rätt ordning genom att kameran kan identifiera vart skruvdragen befinner sig och vara kopplad så att den inte starta om den inte befinner sig på rätt plats.

Trispektor 1000 kameran scannar in produkten för att kvalitetssäkra monteringen. Denna inscanning måste ske med en jämn hastighet som en människa inte hade klarat lika effektivt som en robot. Därför utnyttjas roboten för att scanna den färdigmonterade produkten framför kameran i en jämn hastighet.

Attraktivt arbete

Ett attraktivt arbete kan skapas i och med digitaliseringsmöjligheter inom hela företaget genom att involvera medarbetare i företagets processer, bättre arbetsmiljö, ökat ansvarstagande och känsla av tillhörighet.

I och med en samverkan inom hela företaget kan medarbetare vara mer involverade i verksamheten och känna en högre grad av tillhörighet till sitt företag. De har en möjlighet att påverka sin egen arbetsplats. Exempelvis kan montörerna påverka produktionsprocessen genom sin erfarenhet och tillägg för att förenkla eller förbättra produktionen.

En robot kan vara värt sin investering ur ergonomiska eller arbetsmiljömässiga skäl även för de anställda - genom att den kan ersätta tråkigt monotont arbete för montören som gör att montören istället kan fokusera på mer komplicerade arbetsuppgifter som tillsammans med ett ökat ansvarstagande utvecklas man på individnivå som skapar ett attraktivt arbete.

För att digitalisera sin verksamhet lägger många företag stort fokus på en förändring av tekniken och ser den som det är det som behöver förändras. Men en av de stora utmaningarna med att digitalisera sin verksamhet är att identifiera att det krävs en förändring hos företagskulturen och människorna på företaget. En förändring som innebär att människorna och kulturen får ökad benägenhet till förändringar och vara redo att förändra sina arbetssätt. Allt för stort fokus har lagts på teknik, men utan en förändringsbenägenhet hos människor och kultur i företaget finns det inget utrymme för en digital transformation.

Artificiell intelligens

Upplärningen av roboten i Monteringsfabriken sker genom en AI-applikation där roboten lär sig själv genom att samla erfarenheter om vad som är rätt och fel utförande.

Här användes en typ av artificiell intelligens som kallas för "Reinforcement learning".
Roboten lär sig själv det bästa sättet för att montera produkten - Genom att roboten belönas när den genomför en operation i rätt sekvens och på det effektivaste sättet vet den om den gör rätt. På samma sätt som ett barn lär sig att gå. Barnet lär sig att gå genom att testa olika möjligheter för att ta sig framåt, där barnet får belöning i form av uppmuntran hos föräldern när den gör rätt. Barnet får inte instruktioner att "lyft först vänster ben, sedan höger, osv." Det samma gäller roboten, den testar sig fram med olika operationer för att komma fram till målet.

Roboten lär sig att anpassa sig efter montörens erfarenhet - roboten kan arbeta snabbare eller långsammare beroende på om det är en erfaren eller oerfaren montören, eller välja att genomföra vissa operationer själv som att t.ex. hämta en låda med skruvar eller låta operatören göra det. Allt för att tillsammans skapa en så effektiv montering som möjligt. - En ny oerfaren montör kan därmed börja arbeta självständigt med roboten mycket tidigare då upplärningsprocessen är mycket kortare när roboten kan genomföra stora delar själv.

Upplärningen av roboten och AI-applikationerna sker virtuellt i Azure och som kan illustreras i en simuleringsmiljö. Vid upplärningen och träningen får roboten från början får ett antal operationer som den kan genomföra. Sedan testar den att göra dessa operationer i olika ordning för att se vilken ordning leder till det önskade resultatet. Har den kommit fram till det önskade resultatet får den en belöning ("reward"). På det sättet samlar den erfarenheter och "lär sig" i en virtuell miljö. Detta överförs sedan in i den fysiska roboten och därmed behöver inte roboten fysiskt testa alla operationer och möjligheter för att lära sig det bästa sättet att montera.

Den uppkopplade fabriken

Detta avsnitt innefattar information och stories om ämnesområdet "Den uppkopplade fabriken"

Spårbarhet

Med datainsamlingen från de uppkopplade maskinerna och verktygen kan man använda den datan för att spåra specifika ordrar, produkter och monteringsoperationer.

Genom att spara all relevant data kan man spåra sin montering till produkter för att identifiera avvikelser och förbättra kvalitén. Man kan vid eventuella haverier spåra tillbaka produkten till montering för att identifiera vad som avvikit för att sedan åtgärda det. På detta sätt kan man undvika enorma återkallelser på produkter.

Spårbarhet i skruvdragare

Våra skruvdragare samlar data om varje skruv de drar, som man kan använda av för att spåra sin produktion. <u>*Ett exempel från fordonsindustrin*</u> *på detta är ett tillfälle när ett handtag som chauffören av lastbil använder sig av för att kliva in i lastbilen lossnade när chauffören skulle kliva in och därmed trillade han bakåt och slog i huvudet och skadade sig ganska allvarligt. Då identifierades det att en skruv som handtaget satt i inte satt ordentligt och därmed lossnade. Det som man i vanliga fall hade behövt göra är att spåra tillbaka den nya lastbilen till fabriken och se när den var tillverkad för att sedan återkalla alla lastbilar under den perioden, vilket blir tusentals lastbilar som kostar företaget miljoner. Men istället kunde man kolla på åtdragningskurvan för den skruven och kunde se en liten avvikelse. Som man sedan kunde jämföra med alla andra produkter genom att programmera in att denna avvikelsen skulle ge ifrån sig en notifikation som då visade att 9 stycken lastbilar skulle återkallas istället för tusentals.*

Big data

I och med den stora mängd data som kan samlas med uppkopplade maskiner och verktyg behöver man en strategi hur man ska hanterar, lagrar och även delar datan med andra parter. Detta kommer bli allt viktigare tillsammans med samarbetet. I Monteringsfabriken används Azure som en plattform för samarbete och lagring/hantering av datan.

<u>*Faktabaserade beslut:*</u> *Med insamlandet av datan kan man börja ta faktabaserade beslut som blir rätt istället för att ta beslut utifrån den man "tror" är problem ellet det problem som låter mest. Man kan exempelvis analysera flödet bättre och åtgärda potentiella flaskhalsar.*

Man säger "Data är den nya oljan". Att maskiner är uppkopplade tillsammans med utveckling av AI-applikationer gör att data som samlas in är och kommer bli ännu mer av stort värde. Ju mer data man har insamlat och analyserat desto bättre förutsägelser kan göras och desto bättre kan processen bli anpassad.

Förkorta time-to-market

Time-to-market innebär i stort den tid det tar för en produkt att komma ut på marknaden från det att idén om produkten kläckts. Men det finns också varianter på från vilket stadie själva tiden till produkten är på marknaden startar. Men i regel handlar det om hur snabbt en produkt kommer ut på marknaden.

Med uppkopplade verktyg kan man överföra analyserad data av verktygen som är rätt konfigurerade från sin prototypfabrik till produktionsfabrik som gör att implementeringsprocessen av den riktiga produktionen går mycket fortare. Man behöver inte konfigurera verktygen igen och lära sig vad som

funkar och inte funkar, utan man kan använda den datan från prototypfabriken istället där de redan gjort samma tester.

Att förkorta time-to-market är extremt värdefullt för alla producerande företag, exempelvis så kostade Volvos XC90 mer än Öresundsbron att utveckla sägs det. Att därmed kunna förkorta denna tid medför en stort besparing.

Samverkan produktion och processutveckling är viktig för att korta ner Time-To-Market genom bland annat virtuell driftsättning av fabriker och produktion. I och med virtuell driftsättning kan produktionen planeras, effektiviseras och förbättras redan innan den sätts i drift och därmed kan man spara in mycket resurser i form av pengar och tid.
Se artikel i Edig: https://www.edig.nu/artiklar/virtuell-driftsattning-av-en-smart-fabrik

Nya affärsmodeller
Detta avsnitt innefattar information och stories om ämnesområdet "Affärsmodeller "

Strategi för att hantera sin data
Med den ökade komplexiteten och användningen av datan behövs mer kompetens och expertkunskap. Då ställs frågan om man väljer att genomföra allt med egen anställd personal och lita på kompetensen där. Eller om man väljer att använda sig av leverantörerna till respektive del av produktionen som kan sina produkter väl och är experter inom det området. Tillsammans med detta val av strategi väljer man också hur man vill dela sin data. Man kan välja att hålla allt internt och inte dela någon av sin data till leverantörer. Eller så kan man välja att dela den data som leverantörerna efterfrågar som de kan analysera och göra rekommendationer på som de sedan kan ge till kunden.

Ingång i digitaliseringsarbetet
Investeringskostnaderna för en cobot kan vara mycket mindre än hos en traditionell robot när man tar installationskostnaderna i beaktning. Med en traditionell robot krävs ofta expertpersonal som installerar roboten tillsammans med en skyddsbur, vilket är både tidskrävande och utrymmeskrävande

Det finns nya arbetssätt i och med kollaborativa applikationer med robotar som gör att man behöver ändra sin syn på robotar från den traditionella synen med skyddsburar osv. En kollaborativ applikation kan exempelvis presentera tunga detaljer så som en kardanaxel för en montör medan montören är utanför en säkerhetszon.
En mindre cobot kan dessutom jämföras med en avancerad skruvdragare eller lyftverktyg. → Det räcker ofta att en cobot kan eliminera någon minuts arbete från en flaskhalsstation på en monteringslina. Dessutom bör man samtidigt ha med i beräkningen att en cobot är flyttbar på ett sätt gamla robotar aldrig var så den går t.ex. flytta mellan olika stationer för att ytterligare öka utnyttjandegraden/förbättra ROI (return on investment).

Global samverkan
Tillsammans med uppkopplingen kan fabriker samverka på en global nivå. Exempelvis kan en uppkopplad produktionslina som tillverkar en viss produkt dela med sig av sina konfigurationer på verktygen som en annan produktionslina samma företag har i en annan del av världen kan använda sig av när de ska börja tillverka samma produkt. Därmed möjliggörs en global samverkan av uppkopplingen av maskiner.

Additiv tillverkning

Additiv tillverkning ger oss möjlighet att snabbt skapa skräddarsydda lösningar. Här ser ni 3D-printade detaljer i monteringsfabriken som gjordes för att lösa problem under uppbyggnaden av fabriken. Exempelvis rotationsskyddet för håret till skruvdragaren och gripfingrar för roboten.

Se Edig: https://www.edig.nu/artiklar/how-3d-printing-is-changing-the-way-we-solve-problems

Samarbete

Att tänka på vid samarbete:

- *Tydlig målbild - Vet alla vart vi är på väg i projektet, vad vi vill uppnå och hur vi ska ta oss dit?*
- *Tydliga roller – Vet alla parter vilka roller de har, vilka uppgifter de ska utföra och vilka förväntningar som finns på en?*
- *Tydligt syfte – Vet alla parter vad syftet med projektet är? Och hur har det förankrats hos alla parter?*

Det är omöjligt att vara kompetent inom alla områden - Eftersom tekniken är under ständig förändring och hastigheten av förändringen ökar bara mer och mer krävs det mycket för att vara "up-to-date" i sin verksamhet. Tekniken blir mer och mer komplex och det krävs expertkunskap för att kunna förstå och utnyttja den. I arbetsstationer används många olika tekniker för att skapa en modern och högteknologisk station som är konkurrenskraftig. Där enskilda företag inte har expertkompetensen att utnyttja och förstå all denna teknik. Därför är det väldigt viktigt att samarbeta mellan företagen för att lyckas skapa något. - Som monteringsstationen här, då är det många företag som har bidragit med sin expertis som vi har samordnat för att skapa något nytt och smart.

Ett exempel på samarbete är: Bland annat är spårbarheten i skruvdragaren möjliggjord av Atlas Copco, Simulering och robot är från ABB, det smarta monteringssystemet som används för att skapa en smidig och kvalitetssäker montering är från MVV. Sedan är molnplattformen där all samling av data mellan alla komponenter lagras och distribueras över stationen från Microsoft där användning av datan i molnet kräver ganska avancerad kodning för att de olika devices ska kunna kommunicera med varandra, detta skapar Cybercom.

Detta samarbetet är unikt och ingenting som sker i daglig verksamhet över företag, tyvärr! För vi ser vilka möjligheter det skapar! Det är verkligen samarbetet mellan företagen som har möjliggjort skapandet av denna monteringsstation, som är mer högteknologiskt och innovativ än traditionella fabriker. Som dessutom är skapat av studenter.

Upplägg över workshop

Workshopens utförande sker under ca en och en halv timme. Där den första halvtimmen består av introduktion av workshopens syfte med förklaring av det holistiska perspektivet i en verksamhet. Detta är avsnitt „introduktion" i manuset.

Efter introduktionen delas workshopen upp i fyra stationer som alla täcker olika ämnesområden. Gruppen av deltagare delas också in i fyra grupper där de roterar mellan de olika stationerna. Varje station pågår i ca 15 minuter.

De fyra olika stationerna ska behandla följande ämnesområden:

Station 1
- Montering av produkt – Användning av demonstratorn
- Casat monteringssystem
- SICK kamera – Eventcam och scanna produkt
- Additiv tillverkning

Station 2
- Digital kopia i VR
- Reinforcement learning
- Virtual Comissioning

Station 3
- Uppkoppling – Datainsamling, spårbarhet och faktabaserade beslut
- Global samverkan – Förkorta time-to-market

Station 4
- Nya arbetssätt – HRx, DFAA
- Attraktivt arbete
- Maskinsäkerhet

Upplägg över workshop

III. Observations

Observations from former workshop

	Observer 1	Observer 2
"Listening"	• Attendants nod during storytelling about Volvo-example (stop in factory and how serious that was) • Attendants look carefully at the leader when the leader talks about displays in Microsoft-story • Attendants look around and talk to each other when leader talks quickly • Attendants nod and look at the leader when leader talks about AR in pokemon GO, more than when the leader didn't talk about the example • Attendants look at their mobile phones, talk, look around and yawn when leader talks about environment. • Attendants look at leader when leader asks a question to the group.	• Attendants nod during storytelling about carton deflection. • Attendants are quiet when leader talks. • Attendants listen and smile when other attendants try VR glasses. Only a few pupils want to try VR glasses. • Attendants look around at other things when leader talks. • Attendants nod during storytelling about AR in remote operations.
"Activity in discussions"	• Attendants answer leader's question about how "cut-the-cables" can improve a factory and ask follow-up questions. • Attendants don't answer questions about the connected factory when leader talks very quickly. Leader answers his own questions. • Attendants don't answer question about what they think about the topic environment. The leader answers his own question. • Attendants answer with their own thoughts and opinions at question about stop-trouble-shooting in factories. • Attendants answer with their own thoughts and opinions about how to solve the problem about the story "deflection of carton"	• Attendants reply very briefly on the question "Have you worked with 3D-printing before? Where?" - "Yes, at school" • A few attendants reply in a tired way on open questions about environment. • Only teacher replies on question "Where do you see possibilities with AR?" and mentions possibilities for children who can learn and play with AR. • Some pupils answer briefly on question about area of use of AR.
"Asking questions unrequested"	• A few attendants ask questions when leader explains example about Pokemon GO and example about cut-the-cables • No more questions from attendants at the end.	• Teacher asks a lot of questions (e.g. "How does VR help us in production?", "What use cases are there with 3D-print?") • Nobody of the pupils asks questions unrequested.

Observations from new workshop:

	Observer 1	Observer 2
"Listening"	• Leader has eye contact with nearly all attendants during the whole time. • Some of the attendants look around when leader himself wasn't focused on the attendant. • Attendants nod during story about trucks and story about microsoft.	• Attendants listen during the whole time. • Attendants nod interested when leader tells about her own experiences from when she worked at a factory and tells about stories from friends experiences from work in factories.
"Activity in discussions"	• Attendants think about and answer on questions like "What means data is the new oil?" • Attendants give detailed answers with examples of their thoughts and opinions. • Attendants answer with own thoughts and discuss further out of the groups thoughts after question "Why do you think data is valuable?"	• Attendants get active and answer smiling and laughing after leader asks question "Who of you has worked in a factory before?" • Attendants talk at length about their experiences from working in a factory after leader asks "What did you think about working in a factory?". Attendants have different opinions on the topic. • Many attendants answer with right answers and ideas on question "What is a robot better at than a human?"
"Ask questions unrequested"	• Some attendants give own examples on where they have encountered data collection. This is discussed among the whole group afterwards. • Attendants ask "How can we store data and how can we get the data when we are interested in it? How hard is that?" • Attendants ask "How much of this technique is used today?"	• Some teachers ask unrequested questions after discussions. • Pupils doesn't ask questions unrequested.

IV. Answers Survey 1

Station 3: Attractive workplace

The question to the participants was "What did you learn at this station?". The answers of the participants are presented in the following.

- Vikten för oss människor att digitalisera, hur mycket bättre det blir även för oss
- Hur viktigt det är med digitalisering
- Jag har lärt mig att digitaliseringen är framtiden
- Förstått lite mer av hur digitaliseringen kan hjälpa industrin och tillverkningen, samt risker och möjligheter med nya tekniker.
- Den viktiga transformation som industrin just nu genomgår, och som den kommer genomgå åren som komma skall. Och problemet som det kan innebära om äldre arbetare säger ifrån för rädsla att förlora jobbet
- Att den yngre generationen förstår digitaliseringen medan den äldre är mer skeptisk.
- Hur digitaliseringen kan hjälpa att utveckla industrin och arbetena inom industrin. Att digitaliseringen kommer att hjälpa till att skapa en bättre arbetsplats för alla.
- Hur man kan effektivisera produktionen i fabriker. Industrilisering i fabriker.
- Hur framtidens företag kan se ut
- Return of invest
- Den här stationen har varit väldigt lärorikt, jag har lärt mig allt från ergonomi till risker som finns ute i fabriker och i arbetslivet .
- Fördelar med att ha robotar vid ett arbetsplats
- Nya arbetsättet
- Nya arbetssätt med digitalisering, andra typer av jobb när robotar gör enklare arbeten
- Digitalisering av industrin leder till effektivare och bättre produktioner. Robotar kan hjälpa människan med monotona arbeten och samtidigt skapar nya jobb för människan
- att det är viktigt för företagen att veta om robotarna att de inte tr jobb utan ger möjligheter för nya jobb

- Att digitaliseringen inte gör att jobb försvinner utan snarare möjliggör nya jobb.
- Några nya sätt att tänka kring produktionsutveckling
- För och nackdelar med digitalisering och robot i företaget.
- Om att arbetsmiljön och arbetarna kommer bli bättre med digitaliseringen
- Digitaliseringen skapar nya jobb, samt eliminerar jobb som kanske inte är så uppskattade då de kanske inte är ergonomiskt optimerade.
- kommer skapa en fantastisk möjlighet för digitaliseringen

Station 4: The connected factory

- The question to the participants was "What did you learn at this station?". The answers of the participants are presented in the following.
- Att med visualering kan man spara information för produktion förbättring
- Spårbarhet, Varför man ska digitalisera
- Spårbarhet och dess viktiga och lönsamma påverkan. Insamling av information hjälper produktiviteten och lönsamheten
- Att spårbarhet är en stor fördel och gynnar företag tidsmässigt och ekonomiskt.
- Spårbarhetens olika funktioner samt användningar
- Att spårbarhet kan vara oerhört lönsamt. Lagring av data är ett bra sätt för företag att se över/ ha koll på sin produktion för att kunna implementera effektiva lösningar på problem.
- Att spårbarheten på produkten man tillverkar kan kosta lite extra i början men kan eventuellt spara företaget väldigt mycket pengar
- Hur sårbarheten kan förenkla problem och hur viktigt fara är för industrin.
- Spårbarhet och varför det är viktigt för att kunna följa upp och slippa stora kostnader. Samt att data är den nya oljan
- Det var intressant genom bra exempel från lastbilsindustrin, samt nyttig information angående vikten av att lagra data. Speciellt för företag
- Att data är mer värdefullt än olja
- Att information är viktigt
- Vikten av att spara information från tillverkningen för att kunna spåra och felsöka.

- Felsökning m h a datainsamling
- Hur viktig data är
- Data är bra till att spara eftersom om ett fel uppstår i produkt till verkning kan man ta fram gamla data för att se hur felet uppstår
- tydligare hur spårbarhet har en viktig påverkan
- hur viktigt uppkoppling är när det kommer till företag
- Att spårbarhet kommer vara viktig i framtiden
- Spårbarhet är användbar i förhindring och förbättring
- att få möjlighet att säkerställa på ett betydligt enklare sätt

V. Questions and Participants' Answers Survey 3

Vad gör fabriken där du tillverkar 3D-glasögon smart?

- QR koden som bär på all information.
- Vet inte.
- att du använder dig av en app?
- återanvänder material kanske?
- Det är kollaborativ applikation till som är enkel att använda.
- Man kan beställa i appen och sedan scanna en QR-kod.
- Det går att beställa glasögon som är individanpassade.
- Alla dess sensorer, målnanvändningen som gör att fabriken kan lagra information utan stora minnesbanker.
- Den är uppkopplad till en databas dit information om systemet skickas.

Vad ger det för fördelar att man kan identifiera montören genom en RFID-tagg i exempelvis en arbetsjacka?

- vet ej
- För att få en spårbarhet.
- Vet inte.
- Att kunna förbättra produkten
- Man kan få reda på arbetstempo på montören, och se statistik på hur produktiv montören är.
- Att du kan se vem som gjort vad och kunna spåra om det skett fel vid ett tillfälle.
- För att kunna spara inställningar vad gäller bordshöjd osv. Sedan vet man även vem som har gjort vad och får högre spårbarhet.
- Personen kan fortsätta sitt arbete som de höll på med.
- För att enkelt kunna gå tillbaka och felsöka eller återblicka på en tidigare produktion
- Man kan spåra vem som gjort vad vid vilken tid.

Vad är fördelarna med 3D-printning jämfört med andra tillverkningsmetoder?

- Att man kan på ett snabbt sätt få fram prototyper med även reservdelar
- Mindre fel, lättare att tillverka flera saker
- Vet inte.
- minimisera onödiga fel
- billigare och snabbare
- Man kan anpassa detaljerna till specifika ändamål
- Det går åt precis så mycket material som behövs. Det går snabbare att få produkten istället för att beställa, Kan specialdesigna
- Billigt och relativt snabbt att framställa prototyper och reservdelar.
- Det är enklare att göra specifika delar till maskiner.
- 3D-printning är väldigt flexibelt tillverkningssätt.
- Det går snabbt och det är billigt.#

Vid produktion av våra 3D-glasögonen i fabriken, vad är det som har den största miljöpåverkan?

- Kartongen
- Kartongen
- Vet inte.
- användningen av kardboard
- Kartongen och linserna
- Papperssvinnet
- Kartongen följt av glasögonen.
- Det är transporterna till fanriken.

Varför använder man sig av virtual commissioning/virtuell driftsättning?

- För att slippa transportera sig till den plats som skall driftsättas
- vet ej
- Vet inte.

- lättare och smidig
- för att snabbt kunna lära nya arbetare
- För att man kan få en plan på hur det kommer se ut vid nya ideér.
- För att se så att delarna får plats i fabriken och att de fungerar i praktiken.
- Det blir enklare att se problem i produktionen innan man börjar att driftsätta den.
- För att kunna förkorta time-to-market tiden. Vilket ger en effektivare produktion
- Det är billigt eftersom man kan uppräcka och åtgärda fel innan man ens byggt fabriken.

En AR-applikation var fjärrstyrd vägledning, också kallad "remote guidance". Vad kan du se för användning av denna teknik?

- Det kan vägleda montören på ett enklare sätt. Minimerar felmontering
- mindre misstag
- Vet inte.
- lära flera personer samtidigt på ett smidigt sätt
- När en vanlig montör behöver expertis hjälp, då kan man via AR få det utan att flyga ut en expert.
- få upp sprängskisser samtidigt på delar som du reparerar/servar. Få hjälp genom att någon annan kan se vad du ser och säga vad du ska göra.
- Att en expert kan stå någon annanstans, i en annan stad eller land och hjälpa en montör tex.
- Enklare montering och kommunikation för arbetare.
- Inom många områden. T.ex vägledning mellan doktorer under operation, även om de inte båda befinner sig i samma rum. Ett annat alternativ kan vara i produktionen för att montören utan förkunskaper inte ska kunna göra fel.
- Två personer som befinner sig på olika sidor av jorden kan på ett smidigt sätt arbeta tillsammans.

Vad betyder uttrycket "Data är den nya oljan" ?

- Att data kommer att bli lika värdefull som olja är.

- data är värdefullt

- Fabriken var beroende av oljan förut, nu är fabriken beroende av data

- att datorn håller på att ta över världen. Att det är framtidsrik

- att data kommer vara det mest värdefulla i framtiden

- Att en ny industri har möjlighet att växa omkring datan.

- Att data är det som kommer generera pengar i framtiden.

- Att datan och digitaliseringen kommer att komma med nya oanade fördelar och grejer som kommer hjälpa oss i vardagen, precis som oljan gjorde när den upptäcktes.

- Företag vill ha data för då är det enklare att visa den till rätt grupp av personer och då har det ett stort värde som olja hade när de först hittades.

- Data är värdefullt och bör bevaras så gott det går. Genom att värdesätta datan kan du snabbt och enkelt återanvända den för felsökning med mera.

- Att data är mycket värdefullt och den nya "guldkällan" för de som utvecklar detta.

Hur kan en kollaborativ arbetsstation skapa ett attraktivt arbete för montören?

- Montören behöver mer fortbildning i det tekniska som ger mer utmanande arbete.

- det blir lättare att arbeta

- vet inte

- samarbete mellan människa och roboten

- det förenklar arbetsprocessen och gör det mer ergonomiskt

- Roboten kan lösa de tyngre uppgifterna åt montören.

- Det blir mer ergonomiskt och minder slitsamt arbete för montören.

- Arbetet blir lättare.

- Det blir enklare att montera.

- Den kollaborativa arbetsstationen tar bort många oergonomiska lyft och ställningar för montören.

- Roboten kan lyfta tunga lyft och sträcka sig efter saker vid obekväma positioner.