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JOB COORDINATION THROUGH VISUALIZATION: RESOLVING OR CREATING DILEMMAS ON THE SHOP FLOOR?

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Abstract: *The purpose of this paper is to examine different dilemmas of visualization and elaborate on the topic of control versus freedom with regards to managing operators, for optimal efficiency and motivation. The paper combines theory from socio-technical systems design with operations management literature on shop floor coordination. A technology acceptance model is used to analyse different factors that influences the applicability of visualization systems for improved shop floor coordination. Results indicate that important factors to manage are trust, autonomy, job content, user interface, and employee involvement. This paper contributes to investigation of implementation of visualization tools for better management of resources on shop-floor level.*

Key Words: ***Mass Customization, Job Design, Decision support systems, Visualization***

1. INTRODUCTION

Mass Customization (MC) as a business strategy puts the customer in the center of operations, seeking to exploit the fact that every customer wants individual fitted offerings. However, "the same large number of customers can be reached as in mass markets of industrial economy, and simultaneously be treated individually as in the customized markets of pre-industrial economies" [1]. Furthermore, companies can potentially charge a premium price because of the increased value customers experience with their services [2], and hence the strategy aims at increasing customer satisfaction and company profitability. But individual offerings also add complexity to operations, and there is a danger that costs, and delivery time increases, resulting in fewer customers in the long run.

From a firm's perspective, the costs of mass customization include two factors: (i) the cost of providing high flexibility in manufacturing, and (ii) the cost of eliciting customer preferences [3]. Companies should not take on this challenging strategy if there is no need for differentiation in the market. As every single customer orders individually fitted products, the demand for components naturally differ from day to day, not only in volume, but also with respect to which products and modules to make. Employees in the pre-fabrication department must be able to commonly move their total capacity to operations with short term demand.

In this research, we have worked with FLOKK, a major European manufacturer of office furniture, to see whether visualization of daily demand in the pre-fabrication can help operators make better decisions on the shop floor during their working day. One desired capacity is to have as many as possible of the operators to be cross functional and multi skilled, to increase the possibility to take on tasks that are urgent this day. The traditional way of having a supervisor giving instructions to individuals about needed mobility is discussed against the idea of presenting information on screens as a means of participation and local decision making.

A result of high variance in the individual customer needs, is that the processing, development and delivering of the customers desired products gets more complicated. Examples of this can be design, development, production and distribution when handling a large product variety, which can adversely affect efficiency [4, 5]. In this case we will take a closer look at the challenges tied to the processing through organizing and coordination of the production.

Traditionally the coordination of people and resources has been done by middle managers. But as the number of people, resources and product variants increases, this job becomes harder to combine with the middle manager's other tasks.

The purpose of this paper is to evaluate how a change in coordination mechanism, from verbal communication to visual decision support, affects the shop floor job coordination process with regards to efficiency and motivation. More specifically the paper provides insights into how a complex production is affected when the coordination aspect of the manager role is carried out in a collaboration of tools such as information systems, visualization dashboards and decision support systems (DSS).

Figure 1 above shows how the information regarding coordination of operators in relation to demand and capacity flows at shop-floor level today. One can see that the middle manager is central in the information stream, which make it imperative he does not become a bottleneck. The middle manager has an abundance of other tasks to focus on, so the time used to walk around the shop-floor to distribute this information is in a way a waste of time. By leveraging the digital solutions in a smarter way, this waste can be eliminated, as figure 2 above illustrates. The proposed software solution will make some shortcuts, as well as giving the operators themselves more responsibility and freedom in their work.

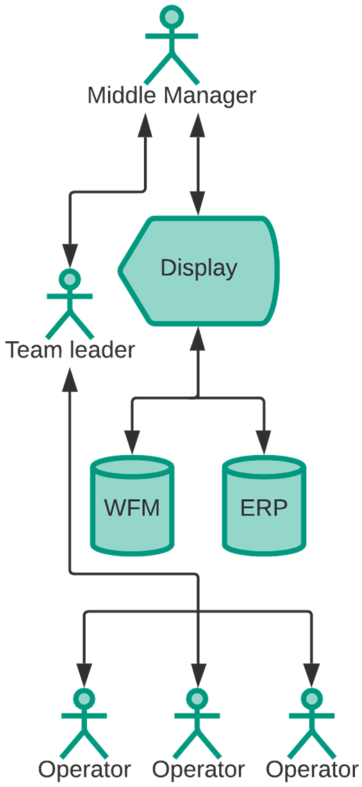

Fig. 1. A simplified representation of how the job coordination is organized today. WFM = Workforce management.

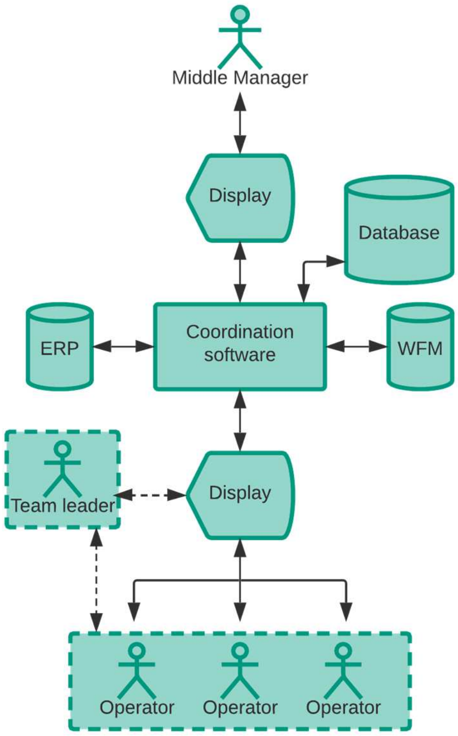

Fig. 2. A representation of how the job coordination software will communicate

The rest of the paper is structured as follows. First, we elaborate previous work on two main topics, job coordination and visualization. Then, the research context is described, which includes an introduction to the case company producing customer designed chairs. Then we discuss how visualization tools can support shop floor job coordination, and which challenges it can introduce. Last, we conclude by looking at implications for managers and further research.

2. THEORETICAL BACKGROUND

2.1 Job coordination

2.1.1. Job design

Job design, also called work design, emerged from studies of alienating and meaningless jobs, psychological research on the subject has motivation at its core [6]. Furthermore [7] proposed that work should be designed to have five core job characteristics, namely: Job variety, job autonomy, job feedback, job significance, and job identity. These core characteristics is further elaborated on by [8].

Time pressure and situational constraints-which are typically considered to be stressors in work settings-can also generate a reason to be proactive. From a control theory perspective, these stressors signal a mismatch between a desired and an actual situation which stimulates employees to want to proactively rectify the situation [9]. Finally, enriched jobs can promote "energized to" states, such as feelings of enthusiasm and vigor [10].

[11] argued that when jobs are structured such that incumbents have contact with those who benefit from their work (i.e., beneficiaries, such as clients, customers, and patients), job incumbents empathize with the beneficiaries, which encourages incumbents' effort, persistence, and helping behavior.

This is also supported through the research done by Lacueva-Pérez, et al. [12] who states as follows "user-centered assistance systems in order to demonstrate their impact and applicability at the shop floor". That the operators are left with a real sense of influence and usefulness in their daily work, may pave the way for a stronger ownership towards their work. This sense is strengthened by the fact that many of these assistance systems lead to “more job security due to the emergence of new jobs, reduction of monotonous work, and increased employee satisfaction on shop-floors" [12].

2.1.2 The Scandinavian model

Trust and the tripartite cooperation are two characteristics with the Scandinavian labor life. In general people show a relatively high degree of trust to each other and are treated as the main component the various bi- and tripartite efforts discussed by Gustavsen

[13]. From all the models described and discussed in this important article, Gustavsen [13] phrased that the models do have "some elements in common, in particular the function of building trust between management and workers on the local level." Trust should be treated as the main ingredient or the basis for the Scandinavian way to organize the everyday life at work. Employees do trust their managers, and the leaders do trust their personnel.

A presumption for this practice is that the workers are not only "competent to handle whatever challenges emerge, but strongly motivated to do so. They need to involve themselves deeply in their work, they need to continuously acquire new knowledge and they need to face difficult decisions and associated risks" [13]. Personal freedom in daily work is treated as crucial for establishing trust in a workforce. Trust is thus treated as being closely linked to the learning organization in which "it is recognized that all actors have to learn and that this, in turn, demands a certain degree of freedom in their work role" [13].

Implicit in this section we see what we can refer to as "work authority" (Davis and Wacker [14], Cherns [15]). This term underlines the duality in the operator's job performance - a combination of responsibility and authority. Cherns illustrates this works authority this way: "Those who need equipment, materials, or other resources to carry out their responsibilities should have access to them and authority to command them. In return, they accept responsibility for them and for their prudent and economical use." Cherns [15].

Work authority is one attempt to translate the Norwegian "Ansvarskompetanse", a term that is based on a broad set of references within in the field of workplace studies. Many references could have been chosen, but some of the most important one’s are Ravn [16] and Øyum, et al. [17]. After an in-depth discussion we have chosen to use the Davis and Wacker’s term and Chern's definition / description as the basis for translating it into English as Work authority.

Work authority should be treated as a core value in the Scandinavian model, and once again as we see trust as crucial. I.e. a high level of trust presupposes a relatively high level of skills and competence in the workforce, and a willingness and ability to handle a variety of situations that may occur in the daily work.

2.2 Visualization

Most computer programs today work in connection with an information system. But what is an information system? "Information systems are combinations of hardware, software and telecommunications networks that people build and use to collect, create, and distribute useful data, typically in organized settings [18].

One of the more popular forms of information systems these days are called "Dashboards", which is continuously being introduced to new areas to simplify work for the human mind.

2.2.1 Dashboards, data analysis and decision support systems

Take for example an airplane pilot, he has a *dashboard* covered with information in different visualized forms. The truth is that without all these different, customized visualizations, he would be much more inefficient at the job he is doing. Dashboards needs to be specified, designed, and implemented, necessarily including some aspects at the expense of others, also placing some aspects at the forefront of users’ attention, while pushing others further away [19]. “Data is prolific but usually poorly digested, often irrelevant and some issues entirely lack the illumination of measurement” - [20]. Although promising, a dashboard's value is inextricably linked to its features and the way they are utilized in organizations [21]. However, several success stories has been reported in professional journals on actual dashboard implementations, i.e. Schulte [22] found that the use of IBM's Business Objects Dashboard Manager at Edward Hospital improved its cashflow through better management of account receivables.

Yigitbasioglu and Velcu [21] define a dashboard as "a visual and interactive performance management tool that displays on a single screen the most important information to achieve one or several individual and/or organizational objectives, allowing the user to identify, explore, and communicate problem areas that need corrective action." Today dashboards and other information screens are getting more advanced and interactive, which again may introduce this technology to new settings and challenges, like job coordination on shop-floor level at a manufacturing company.

One clear advantage of using information systems like dashboards is the possibility for the system to collect and analyze large amounts of data, before it introduces it in an easy digestible presentation, tailored to the described needs of the user.

Data is in general a collection of information. For example, your mobile phone number, street address, personal identification number and postal code are all pieces of information, or data. Like software, data is also intangible. A simple piece of data can be useful and valuable, but the degree of value and usefulness increases when data is aggregated, indexed, and organized together in a database. Massive collection and processing of the quantitative, or structured, data, as well as of the textual data often gathered on the web, has developed into a broad initiative known as “big data”. The term "big data" has evolved so fast that a real definition has been missing, however [23] suggest using Big Data as a standalone term when referring to those "Information assets characterized by such a high volume, velocity and variety to require specific technology and analytical methods for its transformation into value."

Sometimes we must evaluate and act from big sets of data, and this is where information systems of different sorts come to shine. Information systems can make sense of big data sets we as humans will not see any correlation in, in a matter of seconds. For example, you could feed a driving computer in a car with a target destination. What the computer then does is calculate the quickest route to get there by looking at its available data. Examples of such data can be speed limits, estimated traffic, on-going construction work and so forth. In a matter of seconds, the driving computer have calculated something you as a person would need different tools such as pen and paper, calculator and maybe most important, time, to do.

If you have a system which basically collects, analyses, and presents the desired information for you, the only tasks remaining is to decide, and see it through. This is where the decision support systems come into play.

A *Decision Support System (DSS)* is basically an information system that supports decision-making activities. Typically, they are used for unstructured and semi-structured decision problems, to help people make decisions about problems that may be rapidly changing and not easily specified in advance.

DSS have traditionally been used in companies at the strategic management level to make non-routine decisions. But as technologies and company structures change, so does both the structure and use of DSS.

An information system collects and processes data, a lot of data. Then a selection of this data will be presented in a form which is appropriate for an assignment or position. This could be done in the form of a dashboard. Then again, a decision support system can analyze the appropriate data and suggest actions to take from this, to better reach the parent goal.

DSS and other technologies mentioned above can give huge efficiency bonuses for all functions in an organization, however, these tools are just one element in a complex equation with regards to efficiency. Another less technical, but even more important factor in this complex equation is the motivation of the workers using the above tools.

2.2.2 Benefits of visualization

The working mind is constantly influenced by the signals and impressions of the outside world. Card [24] list six groups of ways visualization can help the mind to process information. Visualization amplifies cognition by (a) increasing the memory and processing resources available to the users, (b) reducing search for information, (c) using visual representations to enhance the detection of patterns, (d) enabling perceptual inference operations, (e) using perceptual attention mechanisms for monitoring, and (f) by encoding information in a manipulable medium. Examples of ways we help our mind to process information could be a conversation to share information, a grocery list to aid memory, a speedometer to gauge velocity, a calculator to compute advanced calculations. All these tools make us more efficient in some way or another. However, there are still many ways to expand on our own cognition by inventing new representations, models and visual elements to make us even more efficient.

A common tool used in businesses all over the world today, which make us more efficient are information systems, which today exists in many different forms and on many different platforms.

2.2.3 Technology

The technology acceptance model is an information systems theory that models how users come to accept and use technologies.

A short explanation of the different dimensions of the model follows:

- **Perceived usefullnes:** The degree to which a person believes that using a particular system would enhance efficiency and improve performance [26].
- **Perceived ease of use:** Shows that people believe that the use of technology won't require hard work and exerting too much effort to handle.
- **Attitude towards using:** Positive or negative feelings about the evaluation of an action or a behaviour is called attitude [27].
- **Actual use:** Is the amount of time that people interact with technology and use it and its frequency ([26], [28]).
- **Performance expectancy:** Expectation that the acting person expects to improve his performance.

Social influence: Any impact of the development projects lifestyle, work, social relationships, and the organization.

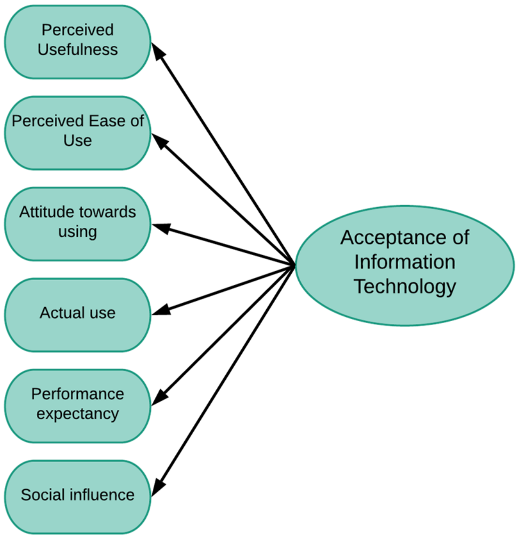

Fig. 3. A replica of the technology acceptance model created by Teimouri and Ansari [25].

For more in depth information regarding this model, see [25].

Summary. Although there is much research on benefits of visualization, there are few studies on the effects this has on job coordination. There is a need for further empirical studies that investigates how visualization contributes to job coordination on the shop floor level. Furthermore, there seems to be a gap in the literature with regards to the control versus freedom paradigm when implementing information systems on the shop floor level. This is also tightly knitted to the aspects of building trust between the system and its users. This embraces not only the issue of trusting the information from such systems, but also with regards to if the information is up to date, that all the users understand the visual models in the same way and the dilemma of control versus freedom such system may add to an already demanding workday. A modified version of the extended technology acceptance model will serve as a basis for the case analysis, looking at the following elements:

- Job relevance
- Voluntariness
- Interpretation
- Transition and perceived ease of use

3. RESEARCH METHOD

The empirical data have been collected through a case study of the Norwegian office furniture manufacturer, FLOKK Røros, who has been working with their mass customization approach for more than two decades. One project they are involved in is the CustomR project, funded by the Research Council of Norway. The project is founded in action research as methodological framework. Researchers and the problem holder (in this case the Norwegian enterprise) collaborate in solving highly relevant real-life challenges. Through this work, new knowledge is acquired for both parties and fed back to the body of knowledge within research [29]. In this project, four companies collaborate to strengthen their abilities within mass customization, at several specific points. Each of the four different companies have production facilities, with highly skilled operators who handle a varying degree of complex tasks on the shop floor level. One of the challenges with regards to the shop floor level is the organizing of people. There are many people, many different competences, many different tasks, which so far, the middle manager is organizing in between all the other tasks he/she has. One of things the project group is looking at is how to make this process smoother, more effective, and more objective with regards to who should be doing what. So far, the middle manager has been handling the responsibility of this task, while the operators themselves have been a considerable helping party in the process. However, one of the dilemmas with letting the operators handle parts of the organizing, is the fact that people are different. More specifically, they like different tasks, they make decisions based on different basis, and hence, the same basic context and challenge can, and most likely will, result in different solutions. Therefore, the thought of adding a more objective third party into the decision making struck their minds. This idea was then concretized in the form of a visualized information system, which will confront this challenge in cooperation with the operators on the shop floor.

FLOKK Røros was selected as case company due to their ambition of increasing the efficiency with regards to coordination of people on the shop floor, through software solutions, while still preserving or bettering the feeling of freedom, and motivation tied to the operators work. This is done by putting more trust in the operators and letting them control more of the organizing within the department, based on information presented by the developed software. The software solution is described in chapter 4.2.

The case data have been gathered from a series of workshops, meetings, and interviews at the company, over a period of about 12 months.

4. RESULTS

4.1. Case Company FLOKK, Røros

This research is done together with the office furniture manufacturer FLOKK at Røros, following the principles of a case study. FLOKK design, produce, and deliver workplace furniture by principles of mass customization.

Products are modularized, allowing an automated final assembly line to serve several chair models efficiently. The line moves products to the next assembly stage, providing efficient internal logistics. Most assembly operations are executed manually alongside the line, keeping the most interesting jobs for operators. After years of development, the line now can be described as a series-of-one installation, allowing different models and product configurations to enter the final assembly in a random sequence. Capacity is approximately 1000 chairs a day, whilst the delivery time to central Europe is 5 days from receival of customer orders.

Production of components and modules is done the day before the final assembly. Of course, all based on registered customer orders. This implies that the demand for different parts differ from day to day, in accordance with the natural variety in customer orders. To meet this ever-changing situation, with respect to volume and type of pre-assembly, people need to move several times a day over to work-stations with a short-term demand of today. And once the needed amount of a components is produced, further movement is necessary again. The situation can be demanding for operators, but also more satisfying in terms of variety and involvement.

Operators needs to orient themselves on the instant needs of the factory, since tomorrow certainly consist of a mix of orders never seen before.

On the production floor, the situation calls for structure and organization of people and tasks, for optimal efficiency. A visualization tool is being developed to help operators make decisions on the fly.

4.2. Development of visualization tool

The purpose of the visualization tool is to help the operators and managers on shop floor level get the information they need, when they need it, without getting the feeling of being controlled from above, while maintaining or increasing motivation. More specifically there will be screens placed around key-points on the shop-floor, which will contain a continually updated status for each work area and the underlying workstations. This is visualized through color-coded graphs for workload and work-capacity. When the capacity is lower than the workload this will be visualized through a red color which signals that there is a need for more operators on this workstation. The exact need is also quantified as numbers in the same picture. So, if a workstation has a heightened workload, let's say because of a rushed order, operators on every workstation can see that this workstation is colored red, if there is more workload than capacity. They can also see which other workstations has an overcapacity. This should then result in the workstation with the highest over-capacity moves one or more operators to the workstation in need. However, one also need to prevent that too many operators from different workstations moves to this station at the same time, only to generate a high overcapacity, for further distribution of operators. The solution to this challenge is simply implementing a form of registration at each workstation. For example, if an operator leaves workstation A to assist at workstation B, before physically moving, the operators registers a leave, through their terminal, from workstation A and entry to workstation B". If workstation B already has gotten the same message from enough operators to cover its capacity-need, every operator in abundance will get a message like "Already received enough operators", which will lead to the excess operators to stay at their original workstation and continually monitoring if the visualization tool signalizes a new need for assistance there or at other work stations.

Through this solution we believe that the information flow through the shop floor will be more efficient since all the necessary information is collected from connected software systems, and then distributed directly into the visualized tool, which is easily accessible for all operators and managers through information screens placed strategically around the shop floor. This basically frees up more time for everyone, but especially for the manager and the team leaders who else would use some time to organize and make sure each workstation is sufficiently manned to meet the demand. Much of this time would previously be used to simply walking in between the operators to give the individual messages regarding coordination of workloads. With regards to motivation we believe that it is positive for the operators to be able to, some degree, control their own workday rather than always being told what to do, one could call it a responsibility for own work.

Our research suggest to take the best from both worlds in form of software systems which will inform and visualize important information with regards to manning the right processes with the optimal competence from available operators, without giving the operators a feeling of being controlled from above. By implementing such as system the management will ensure that the operators get the necessary information to complete their tasks, and that every person always helps maintain optimal efficiency on the shop floor level. Several articles have underlined the need for more information on the shop floor, but these are particularly relevant [30] and [12].

An overall goal in this activity is to strengthen the position to the individual operator or team of operators, so they can choose to do the correct choice voluntarily and without another individual, in this case a Team leader, directing them where to go. FLOKK tries to solve a dilemma the team leaders experiences during a typical working day, namely the discontent some operators can express when moved to their least favorite workstation. The information screens are not personal and a message to the operators from one of these may be easier to accept and act on, since the operators have been included in the development and implementation process, and therefore have influenced the rule-set which the system is based on.

5. DISCUSSION

This part of the paper aims to discuss the different dilemmas one can encounter or avoid by introducing a visual coordination tool, instead of relying on other ways to do the same thing. The purpose is to identify dilemmas relevant to implementing a visual coordination tool on shop-floor level, instead of using traditional well-established routines like physical face-to-face interaction. That way, readers of this paper can be prepared and perhaps avoid possible dilemmas altogether.

5.1. Building trust in the system

When developing and implementing a software tool, it is imperative that the users of the system trust the data and information they get from it. If they do not the system will potentially create more challenges and dilemmas than it solves. In a case like this, trust is built best through transparency and inclusion of the users in the development process. Transparency in the form of being clear and open on why this system is being implemented, and how it works. When implementing software systems, the future users of the system can worry about surveillance and logging and how this may affect their work, both now and in the future, outside of what has been told by the ones implementing it.

So, when introducing a software tool like this in a Scandinavian company, several enabling factors are in favor for us with regards to the high trust and inclusion documented through the Scandinavian model. It is reason to believe that companies located in other regions in Europe, with other arrangements and regulations of the working life - i.e. not necessarily characterized by the same degree of trust and egalitarianism - may differ from what is going on in the Scandinavian model. Also, the discussion above about work authority emphasis some of the differences that appear in Northern Europe, compared to other regions in Europe. An employee in the Scandinavian countries may be more autonomous compared to other parts of the world and will thus have a comparative advantage in the competitive marked.

5.2. Process transition – From manual to digitally supported job coordination

When trying to replace face-to-face interaction with software systems, we must be sure we are refining the right aspects and leaving the wrong ones behind. This is often more complex than one would think. When digitalizing the coordination of operators, with regards to capacity and demand, are we sure we are not leaving some important functions and or interactions, etc. behind? When replacing old solutions with new, it is easy to focus solely on the one documented procedure and forget about other effects both the previous solution and the new one brings along outside of what is written on paper. In this case we are removing an interaction point between operators and replacing it with a streamlined software tool. When doing so it is imperative to research and see if there are other important aspects tied to the old solution. In this specific case one important aspect tied to the old solution is the actual contact between operators, between the one constructing something, and the recipient. When implementing the new software tool there can arise a new need for communication between operators since we have removed the old meeting points for exactly such interaction. This could be done through for example implementing a communication channel in the software-tool dedicated to quality and improvement or by establishing a forum and time for the operators to have improvement conversations about quality and production-aspects which contributes to raising the competence on the shop floor.

[30] wrote an article about a similar case. The article introduces a mobile dashboard for shop floor workers, i.e. Operational Process Dashboard for Manufacturing (OPDM). This concept will pave the way for "shop floor workers providing information on process context, process performance, process knowledge and process communication" [30]. With this dashboard the "workers can grasp at a glance the current situation of the entire manufacturing process beyond their local work places, act proactively based on metric predictions, communicate with all participating workers using audio and video" [30].

As we see this dashboard do have some similarities with the aim in the ongoing project with FLOKK.

This may suggest a dilemma when replacing human interaction with an information system, on the shop floor. Since a system will not be better than the rules it is based on, this may get better or worse than the original procedure. If the system embeds a communication channel for giving feedback to the previous process and operators on the line, regarding the quality, etc. the communication and cooperation between operators and processes may get better, and result in a higher efficiency as well as operators which care and like their job even more than before. If the implemented system takes away the interaction between processes and operators, it can lead to operators which care less about the process and result of own work, simply because they never interact with the recipient of their own work.

5.3. Interpretation of visual elements

One dilemma we encountered in the early stage of developing conceptual sketches was how we as individuals interpret the same model/figure/picture in different ways. The specific case we encountered were with regards to the use of colors on the graphs which are meant to visualize capacity and demand.

As an effect of the wide inclusion of participants when developing the software tool, this was addressed early in the process which again enabled us to adjust and agree on visualization form which everyone seems to agree upon. Not only this, but it also made us aware of the need to look at the tool and agree on a standardized form of interpreting and reacting to the information absorbed through the screens around the shop-floor.

5.4. Up-to-date information

A software system will never function better than the ruleset it is based on. If for some reason one or several persons do not use the system, but rather uses other methods or means to solve the same challenges, it will undermine the entire system and its effects. An important aspect to mitigate this is involvement of the users in the development of the system.

Therefore, it is important that the information presented through the system is regarded as correct, and up to date. If one of these two factors are missing, it could result in the operators turning to the old solution and turning a blind eye to the information screens tied to the software solution.

There is no silver bullet answer to how often information on such screens should be updated, but one could say that every significant event should be represented in due time to act on it, if possible. The dream-scenario would be a real-time update interval, but this is not always possible due to complex interactions between information systems. So, one should look at what the information need is in each unique case.

A dilemma with regards to update-interval is the uncertainty one can experience if there is a long interval between updates. With a five-minute interval, it is possible that the delay of information is as much as four minutes and 59 seconds, which in some cases could be devastating. One could compare it to the speedometer in our cars, if the speedometer had a delay of one minute, it would be almost useless for the driver, so the interval of updating information should be looked in context with the case and situation.

5.5. Freedom vs. control

One of the big dilemmas in this paper, and this case, is the relationship between freedom and control. The company, FLOKK, has since the beginning of the project been clear on one thing, namely that it is important that the users of the system feel a sense of freedom, rather than feeling monitored and controlled from above. This fits exceptional good with how business is done in Scandinavia, and Norway, since we encourage a work relationship based on trust, rather than a rigid hierarchy where you do what you are told, and only that.

However, there is a need to some degree, to have control over the situation at the shop floor. This becomes increasingly true as one implements potentially complex production logistics through the business model mass customization, where every product is unique, which again entails that the operators need to evaluate and adapt their handling of the products in a one-piece-flow aspect. This demands more of the operators and the equipment than when producing by the traditional mass production business model where you set up the equipment for producing large batches of the same products.

The solution ended up being a system based on "volunteering". This basically gives a message to the operators that "we trust that you can organize yourselves to meet the demand at every workstation". However, there can be a situation where there are not enough volunteers, if so, the team leader will have to step in and manually get people to move in accordance with the demand. So, the system is basically an opportunity for the operators to take more control of their own work conditions. If this does not work, the system could theoretically be altered to not be based on volunteering, but rather giving direct orders, about job coordination.

6. CONCLUSION

The purpose of this paper has been to gain a wider understanding of the dilemma's visualization tools can avoid or introduce on shop floor level in a manufacturing setting, both from workers and managers perspective. More specifically, the paper has shown a specific case, in progress, of how implementation of such a system affects some dilemmas tied, especially to the freedom/control paradigm.

Five main aspects of implementing a visualized software tool for organization of operators on shop floor level were found in this case:

- Establishing trust in new solutions through transparency and inclusion in the process of development and implementation.
- Making sure that all elements of importance tied to the process, which is altered, is safeguarded, or further developed.
- People are different and can understand the same picture in as many ways as there are people, make sure to address this and find a solution which works for everyone.
- Information update interval must be seen in context with the case and situation. Do not let the users of the system be in doubt whether the information they see are up-to-date or not.
- When changing something in relation to the control/freedom aspect, consider the context of the working culture.

However, the paper aims to show how a well implemented software tool with weight on easily digestible and visualized information can contribute to better information flow while maintaining or increasing motivation of the users of the system.

The paper aims to show how a visualized software system efficiently can communicate necessary information to the operators on the shop floor to motivate the operators to make a well-informed decision regarding job-coordination, without the need for several people to meet. However, we also shine a light on the complexity of altering procedures, and that it is not always straight forward to replace a "manual" procedure with software.

While this paper does not aim to conclude with the one or the other, but simply to enlighten the dilemma of introducing new technology, and perhaps, replacing old procedures and traditions, on the shop floor level of manufacturing companies.

Limitations. This paper is based on a single case study, having its drawbacks of limited ground for generalization. Further, the authors of the paper have been actively involved in the concept development of the software system in question, perhaps influencing the objectivity of the research. However, the research strategy of action research provides the benefits of mutual learning between practitioners and researchers and have provided the access to a highly interesting case with future potential.

Future work. The visualization tool now moves into a phase of more in-depth testing and exchange of experience at the shop floor. Also, it is possible the same process and system will be integrated at other factory shop-floors when there is more information and experience to learn on from this case.

While technologies advance in lightning speed, and we humans must adapt, we still need to be motivated for the job. So, there is a need to focus on the motivational aspects of being in an increasingly more complex working situation.

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