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Lean and its impact on workplace design

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Lean analyses and following corrections of workstations are typically performed reactively, i.e. solving problems that already exist. However, there are benefits of enhanced proactivity related to the consideration of lean and human factors, as this would reduce the need for updating workstations. The approach presented here utilises a company specific, reactive lean evaluation methodology, but applied proactively, in the workstation design phase. Results gave that many assessment items in fact can be proactively addressed. This way, ergonomic and lean workstations that support quality, performance and wellbeing for a diversity of workers, can be built right the first time.

Keywords: Production, Ergonomics, Lean, Workstation, Design

Introduction

Implementation of lean manufacturing principles and associated work methodologies has reached a high point for a large number of manufacturing companies in Sweden. The first stage in a lean implementation generally focuses on establishing a common understanding of the overall lean philosophy within the company, as well as on learning and get training on using the tools associated to lean manufacturing. In lean philosophy, the importance of understanding the principle of losses is central, e.g. what types of losses that exist on workstation level. This understanding is gathered by analysing the production system in order to identify problems and opportunities related to lean principles. However, in Sweden at least, lean analyses are typically performed reactively (e.g. with a focus on solving problems that has already occurred) with shop floor activities in focus, i.e. the analysis work is directed towards the later sections of the production chain. However, coming steps in the lean implementation work in Swedish industry may very well include a wider focus, looking at the entire production chain, including production design activities. In line with this, Shukla (2005) discusses how business performance increases over time when companies go from a reactive management of process elements to a proactive management including people resources. This would lead to opportunities for a more proactive

approach towards achieving lean principles, basically by designing solutions that meet lean principles already from the start, reducing the risks for problems and corrective actions required. This would follow the Toyota Production system principles *Right first time* and *Reduction of waste* (Liker, 2004). A workstation carefully designed with lean principles in mind could likely also lead to better ergonomics, as shown by Womack et al. (2009).

However, studies carried out at the collaborating companies within the research project Lean & Green Production Navigator, as reported here, show that workstations are often just "built" rather than purposefully designed with user and task requirements in mind. This observation is also supported in Weber (2005). This indicates opportunities for enhanced proactivity in respect to workstation design.

Objectives

The objective is to better understand current work methods and understand how lean and human factors (ergonomics) can be addressed proactively and then link this understanding to the assumption that many of the issues identified and corrections made at existing workstations could, to a large degree, have been addressed at the design stage instead, i.e. employing a proactive approach. The proactive approach aims to reduce total losses in production by highlighting the benefits of designing workstations that meet lean manufacturing requirements already from the start. In general terms, losses are reduced by solving problems before they occur; thereby reducing the need for corrective measures.

Methods

In order to study the phenomena from different perspectives, the analysis work was based on two main activities: *Study 1 - Evaluation of an existing industrial process*, and *Study 2 - Evaluation of a design proposal*, i.e. representing the next generation of an industrial process. A lean maturity evaluation method, the "x Production System (xPS) Assessment", was used. This is a company specific evaluation method, developed by the Volvo Group with inspiration from the Toyota Production System (Liker, 2004) and SwePS (Harlin et al., 2008). The evaluation method covers human factors (ergonomics), material supply (internal logistics) and personnel strategies. It is used to analyse work procedures and workstations to see that they follow, for example, ergonomics guidelines and lean production principles. Each assessment item is given a maturity level score, from L0 (poor) to L5 (excellent), with well-defined descriptions for each level (Table 1).

Table 1: Example of level L0-L5 of assessment item "Station Design: Handling of heavy parts".

L5	No lifting of heavy parts.
L4	Use of horizontal and vertical lifting equipment is minimised through low cost, fixturing and ergonomic assistance devices.
L3	Use of lifting/carrying is minimised through efficient station layout.

L2	Lifting equipment/ergonomic assistance if provided, is used by operators.
L1	Lifting equipment/ ergonomic assistance equipment has been installed where necessary, but it may not be used.
L0	No standard has been defined for use of lifting/manual handling of heavy parts.

A part of a production site at one of the collaborating companies was studied and evaluated from a lean manufacturing maturity level perspective. This evaluation was performed mainly due to three reasons:

1. To gain a better understanding of the specific industrial process and its maturity level. (The production line is a pre-assembly line containing eight stations, including manual assembly stations as well as hydraulic press stations. It is a part of a production system consisting of, among others, casting and machining processes.)
2. To identify which problems that could have been found and solved at the design stage.
3. To identify which assessment items that can be addressed already at the design stage to prevent these issues.

These studies were conducted in the basic steps shown in Table 2:

Table 2: A comparison of methods for the two studies.

Study 1:	**Study 2:**
1. Shop floor evaluation and data gathering, 2. Unstructured interviews with production personnel and senior industrial process project managers, 3. Walkthrough of the results with experts on the x Production System.	1. Unstructured interviews with production personnel and senior industrial process project managers, 2. Assessment of 3D CAD models of the workstation design proposal, 3. Walkthrough of the results with experts on the x Production System.

Results

Study 1 gave that there is a problem with the connection between the reactive work, i.e. work performed on an existing industrial process (lean evaluation, countermeasures eliminating losses and wastes) and a proactive work that could be performed in the design stage of workstation creation. The study presented in this paper, together with results from the company's own assessments of their production sites (approximately 50 production sites are parts of the company), show that working with ergonomics and lean evaluation on existing production processes has little or no effect on the proactive work that should be addressed during the design stages of a workstation creation. A result from the shop floor evaluations is that it seems that experience on its own is not enough for successful workstation

design processes. Some of the 57 assessment items from the xPS Assessment used to evaluate the workstation focused on work procedures in up and running production, and these were considered not applicable for proactive use in the design process. However, the fulfilment of 21 items concerning both lean production and human factors were found possible to address through workstation design: Health & Safety Risks, Noise level, How to handle and reduce waste and packaging, Station layout flexibility, Facade design, Tool/equipment handleability, Movement, Handling of heavy parts or tools, Assembly ergonomics, Space utilisation, Changeover time and Ratio of Value-adding work.

In Study 2, a new design proposal that was not yet implemented/built, was evaluated using the 21 identified items. Only 4 of these items were found to meet the company standards, aiming to achieve a maturity level score of at least L4 (a highly competitive result). None of the identified items reached L5 (excellent) (Figure 1).

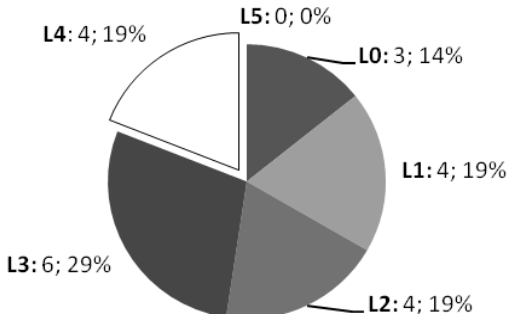

Figure 1: Out of the 21 evaluated items, only 4 (19%) met the company standards (L4 and up).

A conclusion is that the evaluation method may well be an aid during the workstation design process. It can be argued that there would be clear benefits from performing this kind of evaluation already in the design phase. This conclusion is drawn since the study shows that many deficiencies can be identified even at early design stages, thereby making it possible to eliminate them before workstations are built. This should provide a good opportunity to design workstations where the built in losses and ergonomics problems are minimized.

Discussion

By utilising evaluation methods proactively, it is believed that companies will improve their workstation development processes. To be able to address lean principles as well as human factors it is important that a product developer/industrial process engineer has a support during this process. This support can take different forms and can for example be in terms of human factors experts. Within the research project the focus is however set on the opportunities for supporting workstation design by

offering a support tool rather than, or a supplement to, direct access to experts (physical person/-s). The goal with this approach is that workstations are designed that live up to human factors demands as well as to the goals that the lean implementation process initiate.

It is important to see ergonomics/human factors as a part of lean practices. Injuries and difficulties to perform tasks, e.g. in manual assembly, due to poorly designed workstations are examples of losses connected to human factors and are therefore parts of lean practices. All too often these human factors issues are revealed when the problem is a fact, and the work to address the problems is primarily a reaction on the losses that already exist in the production process, i.e. a reactive work process. When adopting a problem solving approach rather than a problem preventing approach, losses/wastes are built into the workstation and the industrial process. To be able to prevent lean losses connected to human factors issues, these factors need to be a part of the evaluation system used in the workstation design process.

The study indicates that senior product developers use some human factors/ergonomics and lean parameters during the design process, but not in a structured way. During interviews with senior product developers it was made clear that their experiences from previous design projects had made them aware of problems that could occur in later stages of the product's (the workstation's) life cycle. This awareness has led to a situation where they developed their own process that exists parallel to the development/ design process that the company uses. This awareness also includes the knowledge regarding the company design process. This company process, as used today, has in its nature a focus on project management rather than design. A conclusion drawn from previous experience within the research project and the described studies presented here is that it is common that, when lean is discussed and/or implemented, the principles often describes *what* needs to be done, but *when* (from a design perspective and not from a project management perspective) and *how* is not, i.e. that the process is a project management process in its nature. For an organization that addresses waste thinking from a lean perspective, especially for the first time, a workplace development process lacking of lean and human factors issues can create a situation where activities are of a reactive nature.

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