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AUTOMATION FROM LEAN PERSPECTIVE-POTENTIALS AND CHALLENGES

Masoud Zafarzadeh
Innovation, Design and Engineering school
Malardalen University
Sweden
Mzh10001@student.mdh.se

Mats Jackson
Innovation, Design and Engineering school
Malardalen University
Sweden
Mats.jackson@mdh.se

ABSTRACT

The competitive climate of production and high labour cost, motivate western companies to use technologies like automation as a mean to increase manufacturing competitiveness. On the other hand companies are aware about cost reductive policies like lean production which has shown noticeable achievement, consequently some manufacturers tend to follow such system. In this situation, in order to have lean enterprise, it is vital to find a clear picture of challenges and potentials of implementing automation within a lean environment. So, finding the right level and type of automation becomes vital for companies, and achieving this is not possible without a lean development of automation. The paper presents an overview of automation development from a lean perspective. The focus is on manufacturing and a case study in the automotive industry is presented. Challenges and potentials of automation are pinpointed and some suggestions regarding automation development is given.

Keywords: Lean automation, automation development, competitive manufacturing

1 INTRODUCTION

A competitive market has forced many companies towards cost saving policies such as lean manufacturing, which is a common strategy within industry initiated by Toyota. Lean manufacturing, also called Toyota Production System (TPS), is customer oriented and emphasizes on process simplicity, less human effort, less scrap, less work in process and inventory, smaller manufacturing space, lower investment in tools etc. (Womack et al., 1990). Researches show that companies which have adopted lean manufacturing often reach competitive advantages compared to competitors (Jackson et al., 2011).

Western companies are struggling to maintain their market share in competition with countries like China and India. Challenges like resource expense, high labour cost and environmental issues intensify this pressure. Among what mentioned, labor cost is an element which is more challenging for manufacturers. A study shows 33% of SMEs see human cost as an important issue and 57% mentioned that the problem with labour cost has increased in recent years (Granlund et al, 2011).
In such situation, companies need to find a way to be more efficient and reduce production cost. One way in order to manage this situation is to invest in automation (Chen, I.J. and M.H. Small, 1996).

Western companies often use technology like automation as a mean to increase manufacturing competitiveness (Jackson et al., 2011). Automation is mainly divided into two categories; mechanisation and computerisation. Mechanisation mainly relates to the physical flow of goods, and computerisation refers to the flow of information (Granlund, 2012). Based on manufacturer's opinion, expressed by Frohm (2008), automation has the following main benefits: improving working environment, possibilities for increased volume capacity, better product disturbance handling, producing with a minimum of employees, improvement of productivity, cost cuts, and improved quality.

Still, automation brings some challenges in lean environments (Frohm, 2008). Reasons for this are visualization difficulties, time consuming robot planning, complexity of maintenance and complex human machine interface (HMI) (Granlund, 2012; Frohm, 2008).

In this situation, in order to have lean enterprise, it is vital to find clear picture of challenges and potentials of implementing automation within lean environment. So, finding right level and type of automation become vital for companies and achieving this is not possible unless through lean development of automation projects. The paper presents an overview of automation development from a lean perspective.

The following research questions have been addressed:

- What are the challenges of automation development in lean organisation?
- How the automation can be developed within companies to maintain lean production?

2 METHODOLOGY

To find answer of research questions, a structured literature review is performed to figure out what potentials and challenges exist in implementation of automation in lean environment. Automation for manufacturing organisations is studied by investigating literature and a case study in the automotive industry has been conducted. The case company is located in Sweden and is active in automotive industry. The company has more than 100 robots, AGV's and other types of automation solutions. Data collection methods consist of open qualitative interview, observation and document reviewing. General information regarding production system and automation has gained and two areas are specified to have more detail practical picture. During the research, case company was in process of developing two new automated facilities within production and assembly. The challenges and potentials which have come to the system due to automation development highlighted through interview with production engineers and also board managers. It has tried to see how the case company approaches toward automation development and how it could deal with development problems. In order to analyze current automation situation, direct observation, interviews with two project managers, three project engineers and two board members have done. Also reviewing the project documents have conducted. The study of automation development process has handled to present some suggestions regarding automation development considering lean principals.

3 AUTOMATION FROM LEAN PERSPECTIVE

Historically, automation has been used in early 1960's with ergonomics reasons. Working in difficult situation and lifting heavy parts are two examples of this. Afterward, industries see automation as a mean to improve quality, performance and efficiency. Automation is often regarded as the main solution to improve efficiency in manufacturing (Winroth et al., 2006). Consequently it became a key technology in manufacturing industries. According to Granlund (2012) adopted from Groover (2008), automation benefits can be presented as follow: labour productivity, reduce labour cost, mitigate the effects of labour shortages, reduce or eliminate routine manual and clerical tasks, improve worker safety, improve product quality, reduce lead time, accomplish processes that cannot be done manually and avoid the high cost of not automating.

Despite what has been mentioned before, some companies that are interested to follow lean manufacturing believe that more automation brings more complexity and even has contradict with lean principals. Some companies and specially SMED's have lack of confident to deal with automation problems and automation facilities. As a result, they are highly dependent on their automation suppliers and integrators. They also see automation with high initial cot, difficult to maintain and also with complicated interface (Granlund et al., 2011). Based on previous studies (Delkhosh, 2012; Hedelined and Jackson, 2011; Orr 1997; Haris and Haris, 2008) some automation challenges that may come to lean environment are listed as follow: high investment cost, product and process adaption and customization for the automatic manufacturing, robot programming modification for new product, human-Cell interface , human-Machine Interfaces, installation complexity, training of operators and personnel, quality issue and the ability to detect defected products, maintenance, space occupation, visualisation, competence issue and supply issue. Some of these elements can be rephrased as complexity. For instance, problems regarding Human interface with cell and robots, maintenance, visualisation etc. A survey handled by Hedelind and Jackson (2011) reveals that operators often mention that they do not really perceive what is happening inside a

robotized cell but they see it like a "black-box". As a suggestion to deal with complexity in production, Hedelined and Jackson (2011) have suggested three strategies:

- The development and implementation of maintenance strategies. Total productive maintenance (TPM) has been identified as a means for improving maintenance performance

- Standardize the solutions in each plant. This leads to fewer spare parts. It also reduces the need for a wide variety of special training and expertise in different technical solutions. When companies build their own automation solutions, this can easily be maintained by the production engineers themselves

- Reduce the perceived complexity of system for operators. For example, develop a user interface with the ability to sort and show the information that is really needed to handle the operation. This system collects information from other parts of system and displays them in coherent way.

On the other hand as Sambasivarao and Deshmukh (1995) discussed, before investment in automation, companies must review their strengths and weakness and develop a strategy for effective implementation. Under such circumstances it is vital to find right level and type of automation that can serve lean requirements. As Haris and Haris (2008,p1) mentioned "it is not a question that lean is manual or not- effective lean production systems use both manual and automated process-the task is to determine appropriate type of automation." But finding the right level and type of automation is not possible unless by defining clear automation strategy (Granlund, 2012). Researches show, most of automation development projects follow ad hoc strategy and are dependent on project situation. Additionally, it is surprising that many companies still are not aware about the effects of automation strategy on their overall business trend (Granlund and Friedler, 2012). Skinner (1969) defines strategy as a set of plans and policies by which a company aims to gain advantages over its competitors and points out the importance of having a strategy and to make active choices in approach. Some researchers have published some methods to define automation strategy. For instance, Lindstrom and Winroth (2010), Safsten et al. (2007) and typical warehouse automation project steps by Baker and Halim (2007). Also Granlund and Friedler (2012) have proposed a model regarding automation development, represented in figure 2.

4 CASE STUDY RESULT

The case company develops all projects based on seven steps guideline which automation projects follow same procedure. These steps are represented as below:

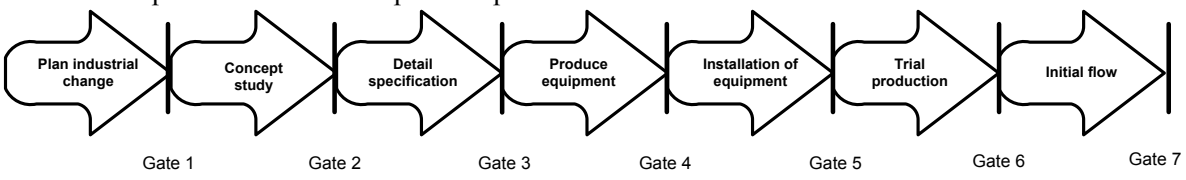

Figure 1: Project development process in case company

As it can be seen in figure 1 the project team should deliver specific tasks at the end of each phase to be able to pass the gate and enter to next step. Project development guideline starts with plan industrial change with the aim of determining policies and it continues to last step with the aim of controlling the initial flow and find the breakdowns. Each phase includes: main objective of the phase, deliverables, way of working, decisions requirements and tools and templates might be needed in time of completing the phase. This process has started to be implemented since 2010 and the two project managers that have interviewed mentioned that despite positive effect of such steps, still there are some problems with the clarification and deliverables. In some cases deliverables are not so clear to understand and project leaders do not know what exactly they should deliver to be able to pass the gates.

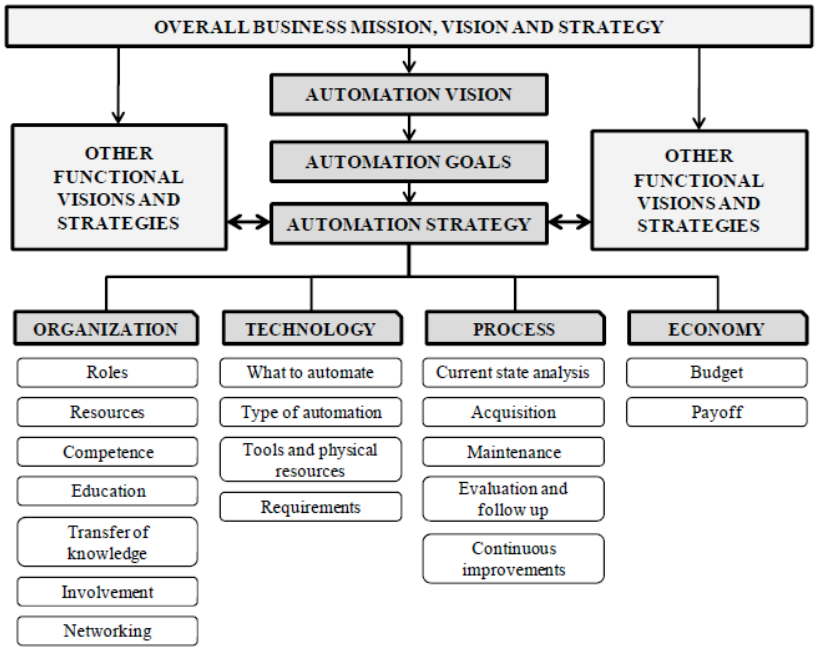

Figure 2: Automation strategy model (Source: Granlund and Friedler, 2012, p6)

Regarding automation projects, the case company follows the same process but the last four phases are handling by the supplier(s) and case company only control the process. As a result, the company asks different suppliers to present their proposals with attention to detail of specification which prepared by the company and the best proposal will be accepted considering different criteria such as cost, availability, reliability and attention to waste reduction etc. Considering the development process table1 presents automation problems which challenges the lean principals. Additionally it has found that there is a problem with automation interfaces variations. Each supplier might use his own HMI and this cause some problem with operator training and also bring some complexities to the system regarding integrating.

Table 1: Automation challenges

Automation integrating issue	Integrating different types of automation suppliers with different programming approach is a challenge for case company.
High initial cost	Robot purchasing is costly and in addition to robots it makes marginal cost like programming modification, maintenance etc.
Quality issue	Robots are not able to detect defected parts and scraps.
Visualisation	Operators and observers do not have clear picture that what is going on inside robots.
Maintenance	High mean time to repair (MTTR) is a result of complex maintenance of robots and their tools. Finding suitable spare parts, contact supplier etc.
Supplier-customer relationship	Supplier is not aware about his customer needs. Mostly suppliers due to vast range of their customers are not familiar with their customers' production strategy and situation.
Dependency on third party	Maintaining automated facilities, robot program modification and integrating the facilities are some examples of dependency to third party due to lack of competence for the company.
Training	Training the operators and involved people in automated area takes longer time and needs more complicated training.

Also programming of robot cells is a problem that the case company is dealing with. For instance, it is so common to have a problem with robot visualisation system and this needs supplier(s) to modify the programming and in some cases even the vision system needs to be replaced with new system. Further

to this, it has found that in automated cells, operators do not tend to find the cause of stops and prefer to restart the cell as a solution. Regarding this, in time of break downs, if the operator cannot solve the problem, will ask the maintenance team for help and sometimes operator cannot detect the right cause of the problem and maintenance team need to spend extra time and effort to find the cause. On the other hand, automation level is an issue that varies from one project to the other one and almost there is no determined method to define automation level in case company. This depends on project team decision and their experience and also supplier(s) suggestions. Also, automation type is highly depends on supplier(s) and there are some examples of simple solutions offered by integrators which these solutions could be existed in whole factory but due to suppliers variations, the offered solutions are different. Investigating the layout of one automated cell shows current situation is not optimized and even robot movement analysis reveals that there are some non-value added movements in the robots.

On the other side of extreme, automation potentials from interviewee's point of view are presented in table 2.

Table 2: Automation potentials

Reducing production and human resource cost	Robots can continue working nonstop. Concerning high human cost in Sweden and working rules which let all operators to have 5 weeks holiday during a year, automation is cost reductive.
Ergonomics	Weight and size of many products, need lifting help tools. In such situation robots can handle the handling process much easier than operators with less ergonomic risk.
Availability	Comparing to human source, robots do not need vacation, rest or changing shifts. As managers express, almost all robots have the availability more than 90%.
Production capacity improvement	As mentioned earlier, the high availability rate of robots will end to production capacity improvement.

5 ANALYSIS AND SUGGESTIONS

The research result shows that it is vital to see automation through holistic view. Based on the empirical findings, the case company has lack of long term and holistic view toward automation. There is no published strategy toward automation and project managers -despite the existing of project development guideline- follow ad hoc strategy regarding automation. As a result of this situation, the case company has not enough automation competence and is highly depends on the suppliers and system integrators. For instance, cell interfaces are different and are designed based on supplier's opinion and also automation solutions do not guaranty to follow lean principals and avoid losses. According to paper aim, some suggestions regarding problems and challenges found in the case company has given as follow: As mentioned in literature review, the case company should have clear automation strategy driven from overall business vision. In this respect, it is vital to pinpoint strengths and weaknesses regarding automation competence. The observations in the case study confirm that there is a need to increase the automation competence especially in robotic as well as designing simple automation solution. This can be represented as in-house development of solutions which would help the case company to decrease the level of dependency to suppliers and system integrators and also decrease the initial costs of developing automation projects. In-house development and increasing competence level would be helpful to deal with maintenance issue. Complicated automation facilities need more complicated and expensive expertise to maintain the system (Hedelind and Jackson, 2011). In order to overcome the challenge of supply, it is recommended to define clear scope of supply and also reduce the number of suppliers and integrators. Training issue needs knowledge sharing around organisation. In the case company, sometimes it is difficult to find the data regarding automation history, robots and so on. In order to understanding the historical data it is necessary to meet the project manager and ask for declaration. Cooperation with different system integrators and suppliers cause problem in HMI's. It is suggested to publish internal standard regarding HMI design and ask suppliers to follow the internal standard. This will also help to

have easier training and reduce the complexity. Regarding quality issue, increasing the level of human touch in automated cells can be helpful.

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