NEXT GENERATION REAR AXLE ASSEMBLY

Richard Andrae & William Bergmark - Faculty of Engineering, Lund University, July 2021

The shift in demand towards electric vehicles combined with the rapid development of industrial and manufacturing technology has created both the need and the necessary means to take the automotive sector through a fourth industrial revolution.

1. Introduction

The rapid development of technology and its industrial appliances, often referred to as Industry 4.0, is changing the way manufacturing companies operate. With Industry 4.0, it is possible to automate complex tasks and manufacture products at higher speed with a lower cost.

At the same time, the electrification of vehicles is driving a shift in the automotive industry. Truck manufacturer Scania CV AB is in a position where its rear axis assembly line in Södertälje will require substantial investments to keep the production speed at the needed levels to meet demand. To add to this, electrification is likely to cause changes on the product design of Scania's rear axles in the near future.

This has led to the need to perform a pilot study on how Industry 4.0 and automation can be leveraged to create a new assembly line which is both more efficient and allows for more flexibility in the design of future rear axles.

2. Method & Empirical knowledge

In order to solve the issue of optimizing the productivity, flexibility and ergonomics at the Scania assembly line, both internal and external sources of knowledge were used. Initially, a literature study was conducted were multiple topics relevant to Industry 4.0 and automation were investigated.

Afterwards, resources at Scania served a critical function in obtaining information. Firstly, multiple site visit was conducted at the Assembly Line in order to gain an understanding of the working processes. Secondly, internal training programs and documents were utilized in order to deepen the knowledge within relevant topic areas. Thirdly, interviews were conducted with experts at Scania to get a good understanding of the practical uses as well as pitfalls of certain technologies.

In order to find weak links and improvement areas at the current assembly line every station was graded from the perspective of ergonomics, production efficiency, flexibility and possibility for automation. Furthermore, all tasks currently being performed at the assembly line were put in a sequencing chart to get an overview of which tasks could be completed in a specific relative chronological order.

Multiple ideas were generated through the identification of improvement areas, and the feasibility of all the generated solutions were evaluated by Scania experts. The ideas that were considered to be feasible were sent to suppliers for an estimation of the price. Finally, the ideas that were considered to be feasible by both experts and suppliers were combined and a new assembly line was created.

3. New assembly line – key results

Through combining current methods and practices with new automated workstations a new assembly line is proposed.

By rearranging the sequence of assembly tasks, automating 4 out of 10 (previously manual) workstations, the following improvements have been identified:

Efficiency improvements
of needed employees during full takt (100%) time reduced by 50%, from 8 to 4 employees.
of needed employees during double takt (200%) time reduced by 50%, from 8 to 4 employees.
Required takt time reduced by roughly 2%.

Ergonomic improvements
Reduction by 57% of "*Medium/high risk for strain injuries*" markings, from 58 to 25, in Scania's internal ergonomic rating system.
Reduction by 46% of "*Potential risk for strain injuries*" markings, from 52 to 28, in Scania's internal ergonomic rating system.
Flexibility improvements
Several changes to layout and material flow to facilitate assembly line logistics, resulting in reduced cost and increased storage space.
Number of needed workstations reduced from 10 to 8.

The proposed assembly line is estimated to have a payback time between 2 – 8 years depending on final prices and future production takt.

4. Designing an assembly line

The Master's Thesis proved there are many imperfect solutions currently at the Scania Zone 1 assembly line, and that Scania can improve its flexibility, productivity and ergonomics by implementing more automation.

Furthermore, through utilizing the same method and framework companies similar to Scania may improve their processes for designing new assembly lines.

5. Contribution

A framework was developed as a tool and basis for companies planning to renovate or design a new assembly line.
The framework is divided into three chronological parts; The *Prephase*, the *Main study* and the *Proposal & Evaluation.* An overview of the framework is presented in the following column:

I. Prephase

- System definition
- Background & problem definition
- Objective & identification of key variables
- Context & delimitations

II. Main study

- Knowledge acquisition
- Identification & sequencing of activities
- Identification of challenges
- Generation of conceptual solutions
- Estimation of feasibility
- Requirement's engineering
- Request for quotas
- Creation of balance sheet & layout

III. Proposal & Evaluation

- Workshop with focus group
- Presentation of final proposal
- Project evaluation

6. A final note on automation

Initial results of the assembly line design indicate that significant improvements can be made in terms of efficiency, ergonomics and flexibility compared to the current line.

These improvements can be materialized by mainly automating work stations at the assembly line. While the case for automation is strong, there are many pitfalls and risks related to automating tasks.

Stop time, which is made up by the number of stops and the time required to resolve a stop during production takt is one key risk to consider. Scania employees are today highly efficient and reliable, setting the bar high. Often, an operational reliability of well over 99,5% is needed to secure profitable automation.

The carrier/conveyor system, which in this case transports the rear axle throughout the line, is a hugely important factor for overall line performance. The flexibility of an AGV system needs to be weighed against the rigidness and precision of a fixed rail based system.

Finally, partly automating an assembly line while keeping manual workstations will change the operators work environment, for better or worse. Understanding and mitigating the effects that automation will have on the operators is crucial at every assembly line.