

LEAN MANUFACTURING - PROCESS AUTOMATION AND ELIMINATION OF PRODUCTION LOSSES IN ROMANIAN AUTOMOTIVE INDUSTRY

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ABSTRACT

Lean Manufacturing is currently the most important management method for manufacturing companies. The method, used in conjunction with the quality tool called "six sigma", is based on Toyota Production System and has been adapted by Womack and Jones, in 1995, for Western companies, referring to the real basic capabilities. Lean Manufacturing means flexible assembly cells or lines, more complex works, highly skilled workers, well manufactured products, a much larger variety of interchangeable parts, compulsorily an excellent quality, reduced costs by improving the production process, international markets and global competition [2].

TRW is an example of the practical application of these concepts, in the leather product preparation sector.

KEYWORDS: lean manufactory, automotive industry, process automation

1. Introduction

LEAN manufacturing or lean production is a systematic method for the elimination of waste ("Muda") within a manufacturing system. Lean also takes into account waste created through overburden ("Muri") and waste created through unevenness in workloads ("Mura"). Working from the perspective of the client who consumes a product or service, "value" is any action or process that a customer would be willing to pay for. Manufacturing, or *production at minimum costs*, is a production philosophy which reduces the time period between the customer's order and the product delivery, by *eliminating losses*. Implementation of LEAN principles has become a survival strategy in a production environment where COST reduction is a fact on the market. If you are not content with the current results of your company, you can find answers to many of your problems, by coming into Lean world.

Lean manufacturing pillars may be simply explained by Figure 1.

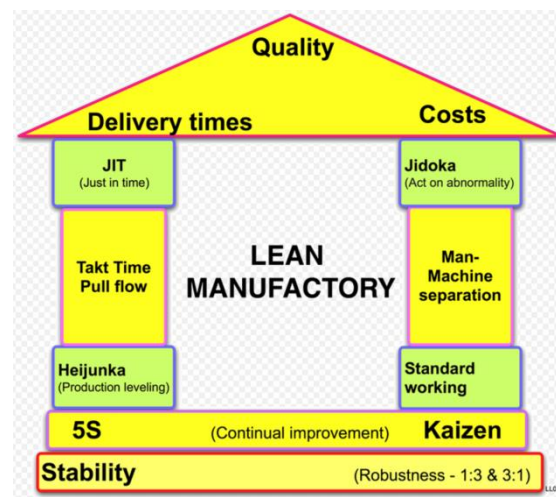


Fig. 1. Lean Manufacturing pillars [1]

If you want to introduce long-term production management improvement methods, to help identify losses in the company and increase the productive capacity while reducing production costs, by following this module you can get familiar with some of the Lean Manufacturing concepts, which, after implementation, will lead to:

1) Reducing by half the human effort in the production workshop.

- 2) Reducing by half the defects of the finished products.
- 3) Reducing to one-third the time of production preparation.
- 4) Reducing by half the production space in order to obtain the same results.
- 5) Reducing to one tenth or less the unfinished production.

2. Terminology used

The 7 losses in production are, according to Taiichi Ohno's classification, as follows [3]:

- Overproduction: making too much compared to the downstream/customer process need. It is the most serious form of waste, because it directly determines the other 6 types of losses.
- Waiting: operators interrupt their work due to machinery or equipment failures or delay of materials/drawings/parts required for processing.
- Transport: moving parts and products unnecessarily, such as from the processing line to the warehouse and from here back in the section - to the next processing phase, when it would be more rational for the next process to be located in the close proximity of the first processing station.
- Processing: carrying out unnecessary or incorrect operations because of poor quality equipment or carelessness.
- Inventory: owning an inventory higher than the minimum required for the operation of the pull-type production system.
- Motion: operators make unnecessary movements - like finding parts, equipment, documents, repeatedly moving tools, etc.
- Corrections: inspection, rework, scrap.

Overall, there is a limit of introducing human driven improvements: there is a "barrier" over even extremely skilled operators will not deliver consistent results in terms of efficiency. There is an accepted 10-15% failure ration related to all visual inspection capabilities. Also, there is a natural tendency for operators to "adapt" the process according to their own comfort or the other way around. It is not always possible to design a process/layout/flow in such a way that is comfortable for all operators. There is an answer to all these, called automation.

Automation is the usage of computers or equipment driven/controlled by computers to drive a particular process in order to increase reliability and efficiency, often through the replacement of employees. For a manufacturer, this could entail using robotic assembly lines to manufacture a product.

Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices and computers, usually

in combination. Complicated systems, such as modern factories, airplanes and ships typically use all these combined techniques. The benefit of automation includes labor savings, savings in electricity costs, savings in material costs, and improvements to quality, accuracy and precision.

3. Case study: implementation of automation and benefits to be considered by TRW Automotive

Project description:

The TRW Automotive factory in Timisoara is producing steering wheels for several customers of TRW. For this task, the company is using 7 die casting machines with 1 cavity or 2-cavity tools.

a) Current situation:

At present, the production is performed using operators. The process steps can change, depending on the steering wheel type. The process steps are [4, 5]:

1. Positioning of the inlay for die casting process (Optional).
 2. Armature check.
 3. Laser marking.
 4. Armature cooling.
 5. Positioning of the armature in the trimming press.
 6. Positioning of the rim inlays (Optional).
 7. Armature hand over to transport buggy.
- b) Future state/Project objectives:

The casting process will be changed from a manual to an automatic process. Each of the existing die casting machines will be automated step by step. Each of the sub-processes will be evaluated and the best automation solution will be decided upon:

1. Positioning of the inlay for die casting process will be ensured by a robotic arm.
2. Armature check-gauging (automatic process) and weighting (also automatic).
3. Laser marking.
4. Armature cooling-changed, will introduce a second robot collecting the armatures from the oven.
5. Positioning of the armature in the trimming press - automatic process.
6. Positioning of the rim inlays (Optional) - automatic process.
7. Armature hand over to transport buggy - automatic.

The new process steps will be the following [4]:

1. Armature extraction.
2. Mold lubrication (spraying robot or spraying machine).
3. Part integrity check.
4. NIO armature discard in scrap box (not shown in the picture below).

5. IO armature laser marking.
6. Armature cooling.
7. Positioning of the armature in the trimming press.
8. Place rim inlay in the trimming press (rim inlay robot or linear axis).

9. Pick up inlay for the die casting process (rim inlay robot or linear axis).
10. Return to die casting machine.

Overall changes implemented into each process step, concluded as being most suitable ones, are presented in Figure 7.



Fig. 1. The 7 process steps of die casting, performed manually or semi-automatically at TRW Automotive, before the implementation of automation

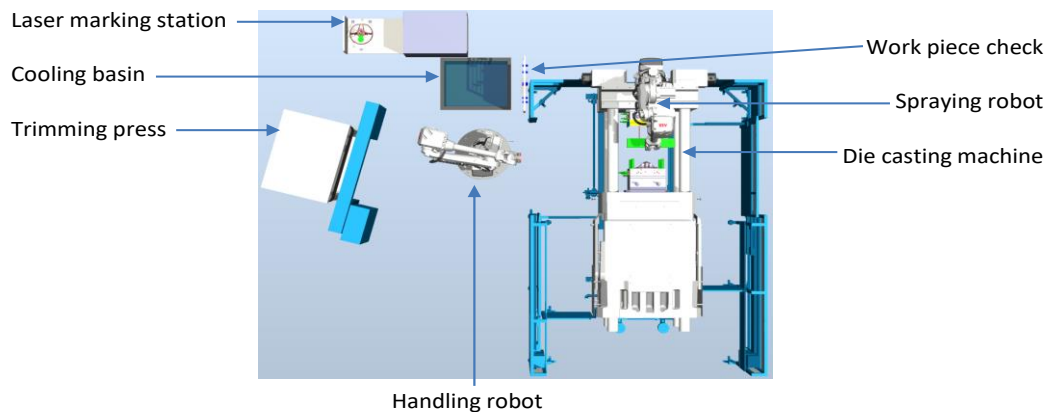


Fig. 2. New process steps schematics - introduction of the first handling robot

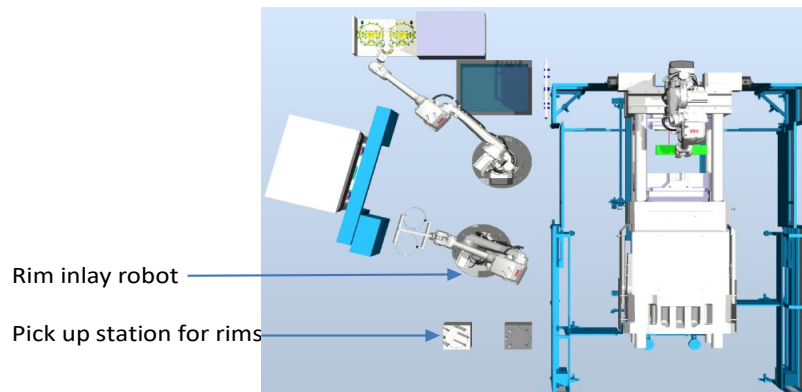


Fig. 3. New process steps schematics- introduction of the second handling robot

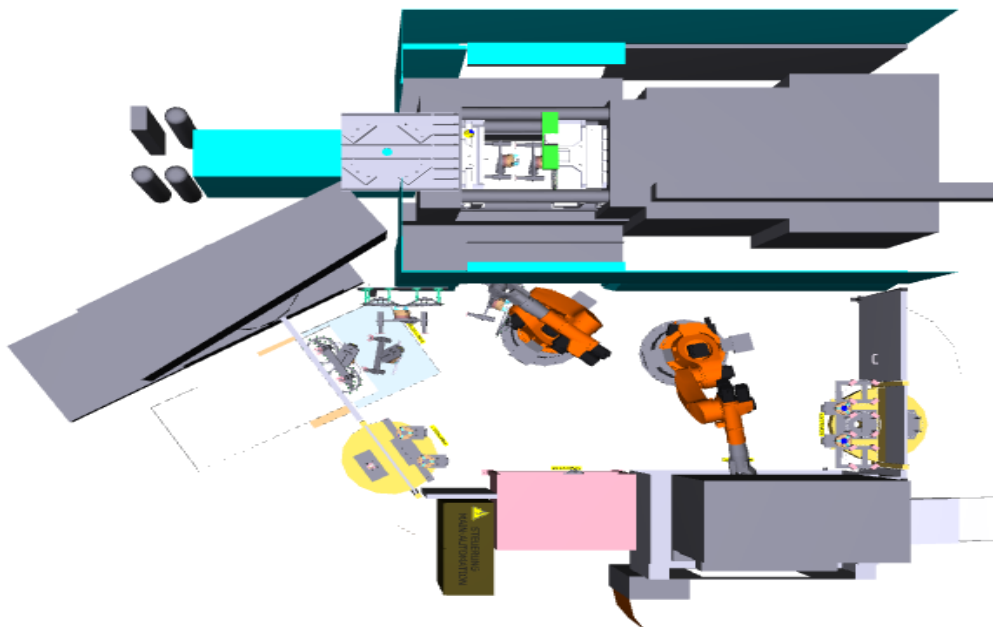


Fig. 4. New layout of the die casting machine- after the implementation of automation



Fig. 5. Activities related to the automation process implementation at first/prototype cell at TRW Automotive



Fig. 6. Activities related to the automation process implementation at first/prototype cell at TRW Automotive

Changes	From	To	Why	effect to product
release agent method	manual	automated	constant/Standard	+
release agent media	Oil	Micro spray (HERA)	Environment/Safety/Standard	0
feeding of inserts	manual	automated	constant/Standard	0
overflow check	manual	automated	constant/Standard	++
cooling	dip into water per elevator	dip into water per robot	standard	0
metal insert verification	manual at weight station	automatic check at overflow detection	constant/Standard	++
weight control	in line shot by shot	First Off/Last Off	no shot to shot variance	0
laser marking	not implemented	single unit traceability	traceability/standard	0
trimm press cleaning	manual	automated	constant/Standard	+

Fig. 7. Table of changes and benefits on product by the implementation of the automation process on die casting prototype cell

4. Results and diagnosis

As today's status is running the prototype cell, results are not final and cannot be considered definitive for the entire production. However, so far, several conclusions are totally clear:

- A 30% increase of productivity (output) expected on double cavity machines.
- A 10% improvement of quality - by elimination of human/visual check.
- A reduction by 40% of human operator time; therefore, payment will also decrease for this process.
- A significant improvement in terms of human safety, magnesium being one of the most difficult to control substances in the case of uncontrolled ignition.

Based on all the above-mentioned results, this program could be already considered as extremely successful.

5. Conclusions

Production becomes more flexible because the members of the work brigades "correlate" the pace of

advance among them without the need for complex time studies for the workload or other laborious analyses for balancing work in workstations.

TRW company improved the quality and the entire manufacturing process at its products (it is one of the largest manufacturers of automotive wheels), where one important sector is the leather product preparation. Here the quality standards are extremely severe, and the production losses and rejected products are also important.

But by using the above mentioned new ideas from the lean manufacturing philosophy, combined with technological improvements, the quality level has reached the desired standards.

References

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