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IMPROVING THE PERFORMANCE OF AN ASSEMBLY LINE OF THE CAR AIR CONDITIONING SYSTEM

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Rezumat. Lucrarea *are ca obieectiv îmbunătățirea unei linii de asamblare, constând mai întâi în analiza inițială a acesteia și ulterior în aplicarea unor soluții de îmbunătățire și dezvoltare a liniei prin reorganizare spațială.*

Abstract. *The aim of the study is the improvement of an assembly line, consisting first in its initial analysis and later in the application of solutions for the improvement and development of the line through spatial reorganization.*

Keywords: Assembly line, Warehouse, Process, Production

1. Introduction

The study focuses on the improvement of an assembly line, consisting first of its initial analysis and later of the development, analysis and application of improvement solutions.

The work addresses the following issues:

- Defining the technological process of assembling the air conditioning system;
- Presentation and analysis of the initial situation of the assembly line;
- Identification of problems on the analyzed assembly line;
- Presentation of solutions to improve the assembly process of this air conditioning system, by modifying certain aspects of the technological system;
- Presentation of the final situation of the assembly line (after improvement);
- Comparative analysis of the 2 situations, the initial line, and the final line (improved).

In order to be able to identify the main shortcomings, it was necessary to analyze the assembly line, both in terms of the way the workstations are carried out and in terms of time and performance indicators [1], [2], [3]. After the implementation of the improvement measures, a comparative analysis of the 2 situations was performed.

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2. The production process and the production line

The production process is defined as a complex of conscious actions of the employees of the company, carried out through various machines, installations or equipment on raw materials, materials or components, with the aim of transforming them into products, which have a certain value of market [5].

The production process consists of:

- The technological process;
- The work process.

The technological process is a set of technological operations, through which a certain product or its components are made. The technological process intervenes both in the modification of the shape and structure, as well as in the chemical composition of the different raw materials it processes.

The work process is that process through which the human factor acts on the objects of work, using a multitude of means of work.

Technological processes carried out in industrial engineering are grouped into three categories, which are associated with three different stages of manufacture, namely, as can be seen in the Figure 1:

• Technological processes of semi-finished products;

• Technological processing processes;

• Technological assembly processes.

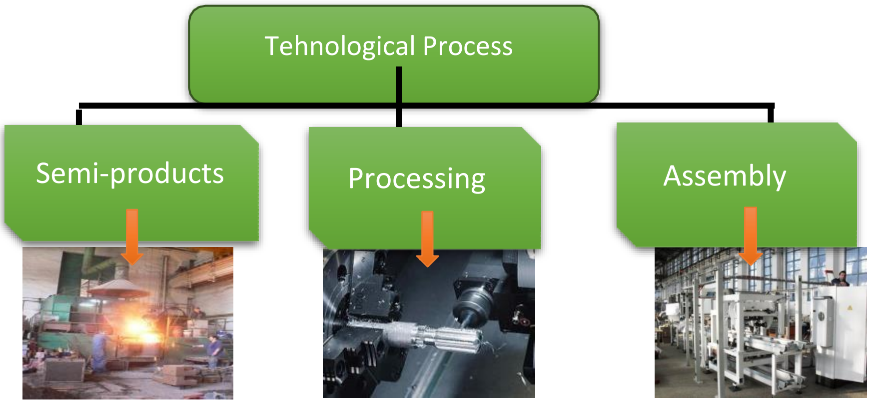

Fig. 1. Grouping of technological process.

The production line is the set of machines that are located in the past by the sequence of operations of a technological process within a given product or several other types of products (Fig. 2). The production lines are also called technological lines, presenting a small number of products, with similar manufacturing technologies.

Fig. 2. Production lines.
a. Automatic line; **b.** Stream line

Characteristics of the production line [6]:

- Dividing the technological process into equal / multiple operations, from the point of view of two notions: workload and time;
- Carrying out an operation on each job;
- Exercising the operations continuously or discontinuously, with or without interruption, having a certain imposed or free time, this rhythm depending on the degree to which the execution works of the technological operations are synchronized;
- Placing workstations in a successive order of technological operations, to ensure one-way movement;
- Within the form of organization of the production line it is possible to execute a single kind of part / product;
- The movement of the object of work from one workplace to another is ensured by adequate means of transport.
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3. Functional and quality indicators of the assembly line

The efficiency of the production line could be determined by measuring its characteristic indicators. The calculation of the indicators can be done on the basis of several variables, such as the working time of the machines and equipment, the available time, the number of operators, the stops, the preparation-closing time, etc., having distinct calculation methods [7], [8].

Table 1 describes the most commonly used functional indicators of an assembly line, listed in the following order [4]:

- Cost;

- The degree of load of the line;

- Execution time of a product;

- The number of jobs involved in each operation.

- The cadence of the line, also known as the production tact.

The cost is defined as the totality of the expenses generated by the realization of the goods / products, respectively of the expenses determined by the activities of supply - production - sale.

The degree of load of the line represents the capacity at which the respective production line is used, depending on the time given to each product / part.

The execution time of a product can be defined as the time resulting from the totality of the processes through which the respective product passes from the semi-finished stage (in some cases raw material) to the finished product stage.

The number of jobs that each operation entails is in fact the number of existing jobs in a production line.

The cadence of the line or the tact of the production represents the time interval between two technological operations that are executed successively, in short, the time interval between two outputs of product units that are consecutive [9], [10].

Table 1. Functional indicators of an assembly line.

Functional indicators of the production line							
Labors no.	*Td- Available time*	*Q- Quantity*	*T-tact*	*KOSU- Cycle time*	*CP - Line capacity*	*Gil – Level of loading*	*P-jobs*
[pers.]	*[min/sch]*	*[buc/shift]*	*[min/buc]*	*[min/buc]*	*[buc/year]*	%	-
-	450	Q=Tf/T	Tf= working time	(Nrop*td)/ Q	CP=	Gil=	Available jobs

From the point of view of quality, Table 2 highlights the most important indicators of an assembly line [4].

- Total scrap on the line;
- Number of customer complaints.

Table 2. Quality indicators

Quality indicators	
Rc- customer complaints	*TLR* - total scrap from the line
[rec/year]	*[piese/shift]*
Rc=In/Zc	Rejected parts in line

A good solution to improve a process is MUDA analysis.

Muda means wastefulness, uselessness and futility, which is contradicting value-addition. Value-added work is a process that adds value to the product or service that the customer is willing to pay for.

Which of the 7 types of MUDA is considered to have the greatest impact?

All types of Muda have a negative impact on production, but Over Production is considered to have the greatest impact, because it is the "Mother of all MUDA", generating all the other 6 MUDA.

Where do we find the 7 MUDA?

Wherever we have a process, whether it is in administration, design, production, supply chain, etc.

How do I remove MUDA?

We must first detect them by observing the genba and apply the adapted VPS (Valeo Production System) tools.

Why fight MUDA?

The elimination of MUDA leads to the prevention of defects, and the reduction of costs, with the main purpose of simplifying costs (Fig. 3).

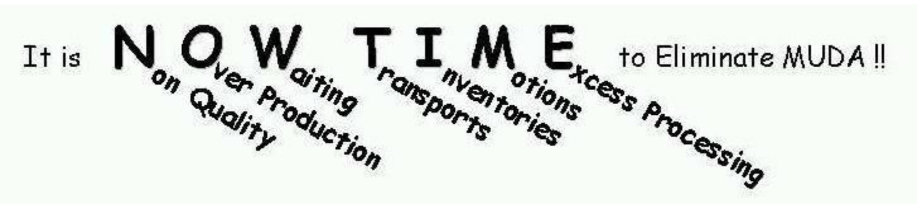

Fig. 3. Elimination the components of MUDA.

4. Product details

When we refer to the air conditioning system of a car, the interest is projected towards the degree of comfort that it must ensure in the passenger compartment regardless of the season, generating the feeling of cold in hot seasons and warm air in wet seasons. The efficiency of the air conditioning system depends on the ability of the air to travel a route in a pleasant environment and safe for all members of the vehicle.

Therefore, the air conditioning system of a car can be considered both a comfort system and an active safety system.

In more precise terms, the air conditioning system is a combination of all the elements (Fig. 4) that are necessary to ensure a form of air supply, and through which the temperature can be controlled, either raised or lowered to certain comfort levels, particular from one person to another.

Fig. 4. Air conditioning system.

5. Comparative analysis of two different production lines

The proposal to change the configuration of the assembly line (from I to U) has a positive impact on the production flow, as this can be demonstrated by the number of finished parts made per shift, before and after the change.

Number of parts / spare parts - original version: 293 pieces Number of parts / spare parts - improved version: 307 pieces

307 pieces / spare - 293 pieces / spare = 14 pieces / spare (will be produced with 14 more pieces in the second variant)

The characteristics of the assembly line are:

- dividing the assembly process into 6 positions plus approximately equal final control in terms of time and workload, respectively;

- the grouping of operations by stations was not carried out according to the rhythm of the line

- specialization of jobs by training operators;

- execution of multiple operations at each station;

- the placement of the workstations in the order imposed by the execution of the assembly operations, ensuring a one-way movement for the air conditioning system: lubrication, component assembly, screwing, verification and final control;

- the assembly is moved from one station to another with the help of sledges, which move on the guide of the line.

The ‘U’ shape of the line gives the operators the possibility to simultaneously operate several machines that represent distinct operations: assembly, verification, movement, etc.

One of the major disadvantages of this type of line is the impossibility of maintaining the continuity of the production process, when certain machines fail or certain materials are missing.

The basic element of the line is the workstation. The line is delimited by 6 workstations plus the final control. The typology used on this type of line is 'one piece in flow', because the advantages are multiple: the movement of the piece from one station to another by a single operator, there is no stock between workstations, the downtime between stations is very small, the number of operators may vary depending on the desired capacity.

From the point of view of the number of operators, this may vary depending on the desired capacity on the line at that time, this being another advantage of the flow typology so that we can have a minimum of 1 operator or a maximum of 6 operators. The capacity of the line differs depending on the number of operators, this being influenced by the station with the longest time, namely the one consumed in station 3 (54 "), so we can have a line capacity of at least 85 pieces (with 1 operator) up to a maximum of 307 pieces (with 6 operators).

6. Conclusions

From the initial analysis, it was found that unnecessary movements are made on this line, by covering the same distance by the operators, who, in order to return to workstation 1, must perform the same distance, proportional to the entire length of all workstations, on this line. Their return to workstation 1 does not add value to the process, because the return is made without the operator having to go through an assembly process, so no addition is made to the production.

As a solution, a new spatial configuration of the line was proposed to change the line shape, by moving the workstations, from the initial shape they constituted - the shape of the letter "I", to the shape of the letter "U".

Following the application of this measure, all the indicators that were analyzed in the initial phase were determined, precisely in order to ascertain the extent to which this change can be considered a real proposal for improvement.

The effects of applying this measure to improve the assembly process on the HVAC line can be listed as follows:

- increase in the number of parts made per shift: from 307 pieces / shift, it went to 293 pieces / shift, which means that production increased by 1 piece / shift
- continuity of the assembly process without bottlenecks;
- a good synchronization of the assembly process;
- balancing the line.

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