ON THE OPTIMIZATION OF THE AUTOMOTIVE ENGINE WIRING PRODUCTION PROCESS BY IMPLEMENTING SOME IMPROVEMENT SOLUTIONS

PhD.Lecturer **Monica BÂLDEA**, The National University of Science and Technology POLITEHNICA Bucharest, Pitești University Centre, Faculty of Mechanics and Technology, Târgu din Vale Street, no.1, Pitești, ROMANIA, monica.baldea@upb.ro
PhD D. Lecturer **Ancuţa BĂLTEANU**, The National University of Science and Technology POLITEHNICA Bucharest, Pitești University Centre, Faculty of Mechanics and Technology, Târgu din Vale Street, no.1, Pitești, ROMANIA, ancuta.balteanu@upb.ro

***Abstract**: In the study is analyzed the implementation of improvement solutions regarding the optimization of the production process of the car engine wiring of a motor vehicle with the help of a machine, with the role of simplifying the production process of the cables*

Keywords: optimization, production, wiring, engine, vehicle

1. INTRODUCTION

The object of the study is the implementation of improvement solutions regarding the optimization of the production process of the car engine wiring of a motor vehicle with the help of a machine, with the role of simplifying the production process of the cables. This makes wiring strictly for the motor, reduces the production activities that were done manually by the operators: the insertion of the wires into the casings and at the same time the elimination of some activities from the cable cutting area and the pre-fabrication area.

The machine performs the following activities:

- cuts the threads - cuts the threads;
- trips the wires;
- crimps the wires;
- twists the threads
- insert the wires into the housings;
- check the induction: push-pull to avoid defects.

It is a fully automated machine for making cable sets, equipped at both ends. Up to 36 different types of cables can be processed. A number of up to 8 process stations allows the configuration of almost any manufacturing process and the efficient manufacture of cable sets without retooling. The machine works constantly and within the same parameters, any deviation causing a possible defect to be identified and eliminated automatically.

2. PRESENTATION OF THE WORKING MODE OF THE MACHINE

The necessary activities in the cable cutting area are the following:

- machine preparation;
- check the parameters;
- material preparation;
- debiting;

- stripping;
- crimping;
- insertions in casings;
- elimination of defects.

The operating stages of the machine are as follows:

- car preparation: scan the car and check the parameters;
- preparation of the materials, the machine is fed with wires from the warehouse;
- wire supply to the car;
- the operator must feed the machine with casings;



Fig. 1. Feeding the machine with casings

- the following operations are carried out: cutting, stripping, crimping, inserting into casings. Fig.2 shows the insertions into the casings made by the machine;

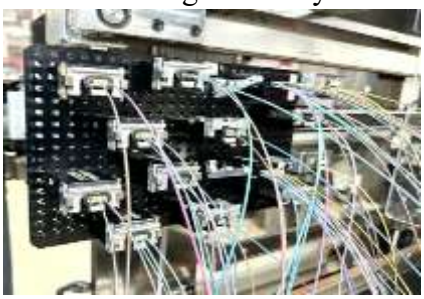


Fig. 2. The introductions made by the machine

- all the wires coming out of the machine are placed on the support and go directly to the Assembly area. In fig.3 is the final result of the operations performed by the machine. The assembly operators take them exactly as they are from the stand and lay them on the board;



Fig. 3 Placing the wires on the support

- the method of processing the cables in the cutting area is carried out on the machine as follows: the cables are cut, crimped, twisted and inserted into the casings of the machine, placed on the Support (prefabrication area) and arrive as an assembly directly in the belt where the operator on the job, he takes the assembly and lays it on the table, thus reducing an important time in the processing of the module.

3. TIME REQUIRED TO MAKE ENGINE WIRING BEFORE AND AFTER OPTIMIZATION

As a result of the analysis, it appears that the activity of inserting wires into casings from station number 1 has the longest operating time, being the busiest.

The timing of station 1 with the activities of inserting the wires into the casings by the operators and the stretching of the wires and casings on the table is carried out to find out the blocking time, an activity replaced by the machine.

Following the improvement of station number 1 in the assembly area, an activity with the help of the machine was eliminated.

Following the improvement of station number 1 in the assembly area, an activity with the help of the machine was eliminated.

Table 1 shows the actual activities performed by the operators in the workstations and the times required to perform each operation to perform a motor wiring. In the first post, the activity of inserting the wires into the casings is replaced by the machine.

Table 1. Activities performed by operators after optimization

Post	Operations	Time (min)
1	Stretching the threads on the board	11
2	Continuous shading	3,9
	Fixing cable element	1,4
3	Discontinuous shading	3,1
	Fixing cable channel	1,5
4	Continuous shading	3,9
	Application of supporting elements (necklaces)	2,4
5	Continuous shading	3,9
	Application of supporting elements (necklaces)	2,4
6	Continuous shading	3,9
	Discontinuous shading	3,1
7	Electrical check	5,5
	Wrapping	2
Total		48

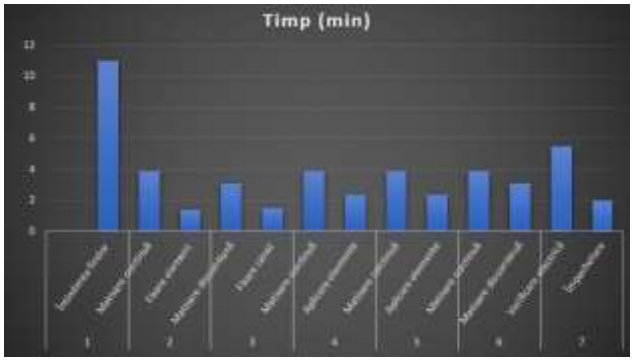


Fig.4. Graphical representation of the operators' activities on the stations after optimization

After the introduction of the machine into the production process, the activity of inserting the casings by the assembly line operators was eliminated. The time diagram of the activities in fig. 4 of the workstations was made.

As a result of this analysis, it emerges that the activity of inserting wires into casings in station number 1 is removed from the assembly and replaced in the cable cutting area by the machine, thus resulting in a shorter operating time in the assembly, an increase in productivity.

4. CONCLUSIONS ON THE OPTIMIZATION OF THE PRODUCTION PROCESS

In the factory, work is based on starters, as follows:

- the orders that need to be worked on are sent. All these orders have activities that are standardized, so for each order the time required to perform that order is known.

➢ All orders started must be ready within a time frame (24 hours – the production group is daily).

➢ The need for people and equipment is calculated through the prism of starters (which are already known from the beginning of the project).

Automotive engine wiring is produced on the dynamic assembly line containing 7 workstations with a number of 13 operators. It is carried out in 3 shifts, with an efficiency of 100%. For 100% efficiency, 450 minutes are worked to which 30 minutes break is added.

• The time to create a wiring harness before optimizing the station is 60 minutes.

• The tape beat is the ratio between the time of making a wiring and the number of operators.

Clock = min/wiring: no. by operators = 60 : 13 = 4.6 min

• The number of cables per shift is the ratio between the maximum working time of the operators per shift and the tape clock.

N = maximum time / tape beat = wiring/change = 450 : 4.6 = 97.8 cables/exchange

• The completion time of a wiring harness after job optimization is 48 min.

• The tact of the tape is the ratio between the time of making a wiring and the number of operators.

Clock = min/wiring: no. by operators = 48 : 13 = 3.7 min

• The number of wirings per shift is the ratio of the maximum working time of the operators per shift and the tape beat.

N = maximum time / tape beat = wiring/change = 450 : 3.2 = 121.6 cables/exchange

• Working time per shift is 450 minutes. A engine wiring was done before in 60 minutes and i97.8 wirings were done in one shift.

• Working time per shift is 450 minutes. An engine wiring after the introduction of the work machine is done in 48 minutes and in one shift are done 121.6 wirings.

In fig.4 the realization of the number of wiring per shift after optimization.

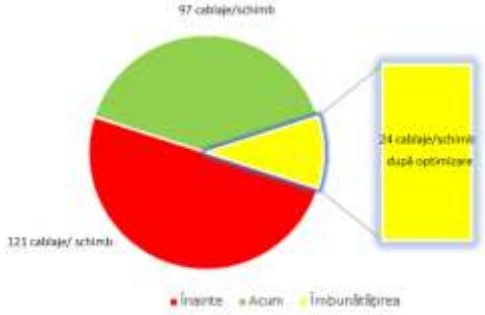


Fig.5. Realization of the number of wirings per shift after optimization per shift after optimization

In the production process, the working machine saves time, space and operators in the area of assembly, cable cutting and prefabrication.

In the assembly area, the activity of inserting the wires into the casings has been eliminated, thus it can be seen that the wiring time has decreased by 12 minutes, which means a time saving, an increase in productivity, the number of wirings has increased by 24 more per exchange. In fig.6 the duration of the automotive engine wiring harness production cycle after optimization. In the production process, the working machine saves time, space and operators in the area of assembly, cable cutting and prefabrication.

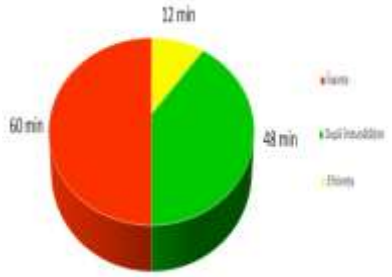


Fig.6. Cycle time for wiring after optimization

In the cutting and pre-fabrication area, approximately 30 square meters of space is saved. Table 2 shows each section with the space saved.

Table 2 . Space saving

Space saving	
In the cable cutting area, remove:	Remain
2 machines Alpha 488 S	64.5975 sqm (of which 45.8642 sqm ≈ 46 sqm Omega) => 18.7332 ≈ 19 sqm
In the pre-fabrication area, remove:	
Twisted wires Pro-Twist machine	7,736 sqm ≈ 8 sqm
Bow-knots making activity	2,5 sqm
Crimping activity	1 sqm
Total	29,9692 sqm≈ 30 sqm

In fig.7 the space is saved after optimization, ≈ 30 sqm of space was saved.

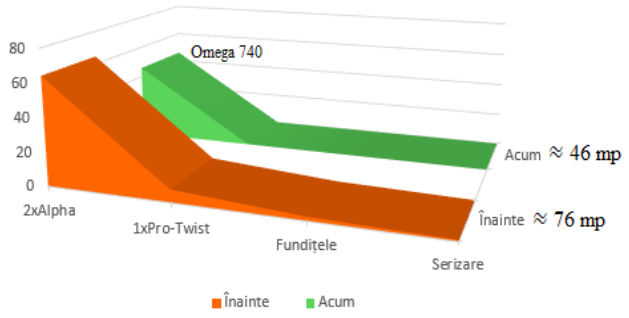


Fig. 7. Space saving

In the area of cable cutting and prefabrication, the number of operators is reduced. Table 3 shows each area with the number of reduced operators

Table 3 Reducing the number of operators

Reducing operators	
In the cable cutting area, there are reducing:	Remain
2 operators at the Alpha 488 S machines	1 operator for Omega 740
1 operator was pulling the threads from cutting and pre-fabrication	-
1 operator takes the wires to the assembly area and places them on the support	1 operator who takes the wires to the mounting area, already arranged on the support
In the pre-fabrication area, the there are reduced:	
1 operator crimping activity	-
1 operator in the activity of making bow-knots	-
1 operator at Pro-Twist machine	-
7 operators	2 operators

Fig. 8 shows the number of operators after optimization; 5 operators were reduced from the cable cutting and prefabrication area.

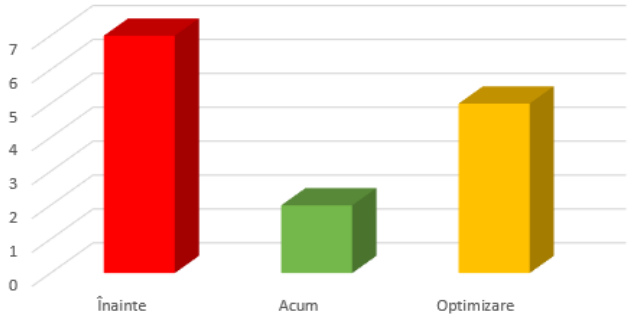


Fig. 8. Number of operators after optimization

The work machine manages to combine activities from cable cutting, pre-fabrication and assembly. In cable cutting, this machine cuts and crimps the cables (something that all the machines in the cable cutting area do), at the same time activities that used to be done in pre-fabrication (winding wires, manual crimping, wire loops) or assembly (inserting wires into cases) is now also done on the machine.

5. REFERENCES

[1]. **Misiurek,B**.,*Standardized Work with TWI: Eliminating Human Errors in Production and Service Processes*. New York: Productivity Press. ISBN 9781498737548,2016
[2]. **Grote K-H,.AntonssonE.K., editors** - *Handbook of mechanical engineering*, Springer, 2015;
[3]. **Durgesh S., Singholi A., Mohammad A., Chitra S.,** *Feedback Based Framework for Flexibility Management & Control*, VIVECHAN IJR, Vol.1, 2010
[4]. **Mitonneau,H.,** *O nouă orientare în managementul calităţii*,Editura Tehnică, Bucureşti,2009.
[5]. **Ungureanu,I**., *Analiză funcţională*, Editura Universităţii din Piteşti, 2007