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Improvement of the process for changing the production by using an established method. Application for S.C. COMPA S.A.

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Abstract – **The study presented in this work aims to optimise the performance of the Workshop 770 from the company SC COMPA SA - Sibiu, by reducing the time needed to perform the changes of fabrication. After having assisted in 5 changes of fabrication, the causes determining the slowing of the process were noted, but also the possible methods of improving in order to reduce the losses of time. The workshop's performance is constantly calculated with the help of indicator OEE (Overall Equipment Effectiveness).**

Keywords- change of fabrication, losses of time, OEE, improvement, process;

I. INTRODUCTION

In order to ensure a unitary approach of quality it is important to set some basic principles to take into consideration when implementing a quality management system. In order for the quality management system to be efficient, processes need to be coordinated, compatible and defined in a coherent manner together with their interfaces. [1]

Lean Manufacturing is today one of the most successful production strategies for the improvement of competitiveness and it has its roots in the production concept founded by Eiji Toyoda and Taiichi Ohno from Toyota Motor – Japan [2]. It is considered to be a set of tools or a management system according to the size, strategy and level of development of the organisation and culture where it is applied. Thus, a system of lean indicators allows taking decisions based on the analysis of the information and data obtained through observation, try and other quantifiable methods. A global indicator is used by Overall Equipment Effectiveness (OEE). [3]

A. Overall Equipment Effectiveness (OEE)

Overall Equipment Effectiveness can be defined as the relation between the theoretical production time needed to obtain the finite products and the actual time they need in order to be manufactured. It can be stated that OEE represents the best indicator to determine the percentage of planned production time which is genuinely productive.

Performance is indicated by the percentage given by OEE:

A percentage of 100 indicates perfect production namely manufacturing good products, without rejection, in a continuous manner and as rapidly as possible.

A percentage of 85 indicates a top performance for the organisation. For many companies, it represents an untouchable objective on the long term.

A percentage of 65 is common for most of the organisations, but it indicates the need to considerably improve production.

A percentage of 40 is met especially among the companies having only recently started to follow and improve their production performance. [4]

Indicator OEE (Overall Equipment Effectiveness) is used within Workshop 770 of the company SC COMPA SA to measure production performance. One of the main objectives of the workshop is to reach a performance threshold defined by a percentage of 85 of OEE and maintaining the production activity at this level.

B. Calculating general efficiency of the equipment

In order to calculate the performance percentage, and inherently the actual production time, first the losses of time from the production process must be determined. These are of 3 types:

- losses of availability;
- losses of performance;
- qualitative losses.

The actual production time in Workshop 770 is determined after the identification of losses, according to the example in figure 1.

Figure 1. Actual time resulted after losses

Thus, OEE is calculated after the following relation 1.

OEE(%)=availability rate * performance rate * quality *rate* **(1)**

The 3 rates are then calculated with the relations 2, 3, and respectively 4.

$$\textit{Availability rate} = \frac{\textit{Available time}}{\textit{Total time}} = \frac{\textit{Total time} - \textit{loss of disponibility}}{\textit{Total time}} \quad \textbf{(2)}$$

$$\textit{Performance rate} = \frac{\textit{Productive time}}{\textit{Available time}} = \frac{\textit{Available time} - \textit{Loss of performance}}{\textit{Available time}} \quad \textbf{(3)}$$

$$\textit{Quality rate} = \frac{Effective\ time}{Productive\ time} = \frac{Productive\ time - Loss\ of\ quality}{Productive\ time} \quad \textbf{(4)}$$

All losses of time slow down the production activities and must be monitored continuously by the installers of the workshop in order to obtain the percentage of performance given by OEE.

The time duration for each of these situations encountered each day is marked down in the monitoring sheet destined to achieve the OEE for Workshop 770.

Overall Equipment Effectiveness (OEE) determined after having filled in the monitoring sheet is made on a daily basis, for each cell of the workshop individually. Thus, an average of the workshop performance is determined each month. For instance, the percentage of the workshop performance for the month of September of 2015 is showed under figure 2.

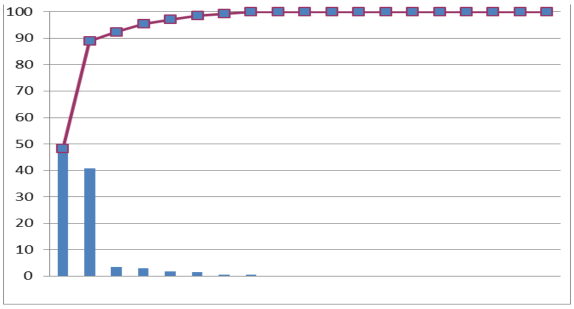
Sept	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Avg
C1	68%		71%	72%	77%	67%	83%			69%	83%	84%	84%	83%			79%	68%	65%	85%	83%	88%	**77%**
C2	90%		88%	88%	84%	90%	68%	77%		77%	70%	89%	84%	87%	89%		77%	85%	69%	90%	46%	82%	**81%**
C3	80%		79%	82%	87%	74%	85%	83%		87%	88%	81%	71%	90%	90%		88%	88%	90%	89%	87%	56%	**83%**
C4	82%		89%	88%	90%	86%	89%	90%		84%	90%	85%	88%	90%	89%		89%	89%	77%	68%	88%	90%	**86%**
C5	86%		76%	81%	88%	83%	80%	73%		88%	85%	83%	85%	88%	86%		82%	85%	51%	29%	89%	89%	**79%**
C6	88%		86%	82%	87%	82%		81%		75%	86%	89%	90%	87%	79%		78%	89%	84%	88%	88%	87%	**85%**
																						Avg	**82%**

Figure 2. Percentage of OEE for the workshop in the month of September

II. PARETO ANALYSIS OF THE DATA

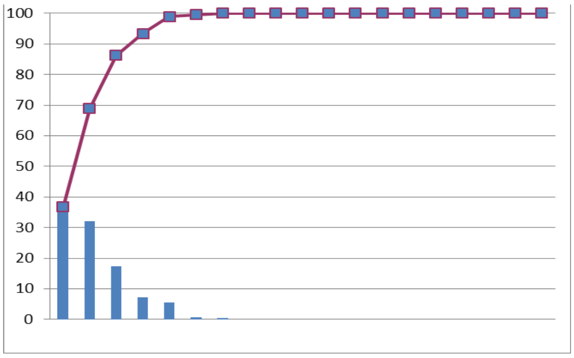
After having collected the data and generated the percentage of OEE, a Pareto analysis is carried out for each cell of the workshop. With the help of this method, the weight of the main situations determining pauses in the process of production is determined.

Therefore, for each of the 6 cells of the Workshop 770 we made a Pareto analysis with the purpose of identifying the main situations where time is being lost, according to figures 3, 4, 5, 6, 7 and 8.



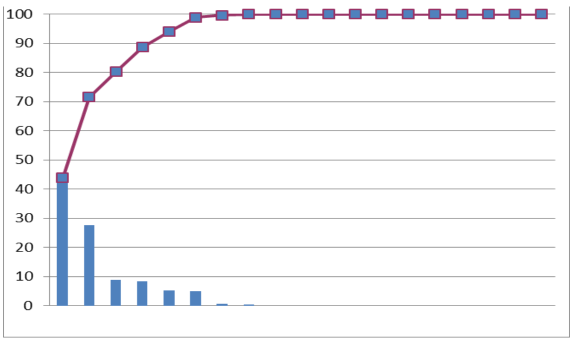
Machine failure	48,3 %
Change and pre-setting tools	40,7 %
Others	3,5 %
Waste	3,0 %
Adjustments	1,7 %

Figure 3. Pareto for cell 1



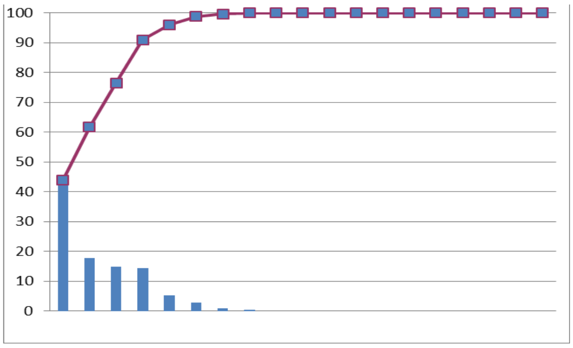
Machine failure	36,7 %
Tools change and pre-setting	32,1 %
Change of fabrication	17,4 %
Measurements	7,1 %
Adjustments	5,6 %

Figure 4. Pareto for cell 2



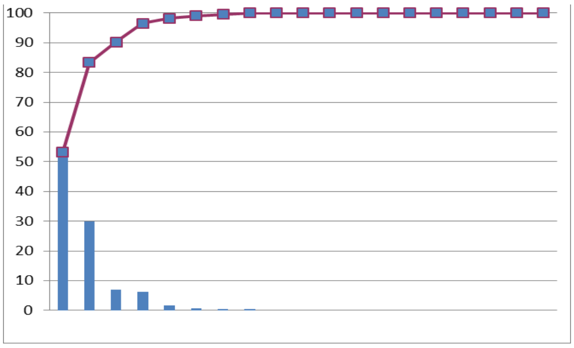
Change of fabrication	43,8 %
Machine failure	27,7 %
Tools change and pre-setting	8,8 %
Measurements	8,4%
Others	5,3 %

Figure 5. Pareto for cell 3



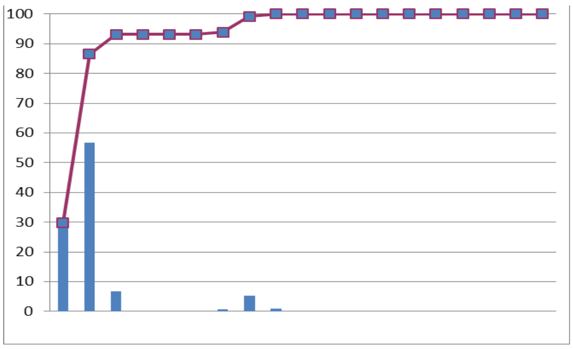
Tools change and pre-setting	44,0 %
Change of fabrication	17,8 %
Measurements	14,8 %
Machine failure	14,4 %
Adjustments	5,1 %

Figure 6. Pareto for cell 4



Machine failure	53,3 %
Tools change and pre-setting	30,0 %
Others	6,9 %
Measurements	6,3 %
Adjustments	1,8 %

Figure 7. Pareto for cell 5



Tools change and pre-setting	56,6 %
Change of fabrication	29,8 %
Others	6,7 %
Measurements	5,2 %
Meetings	0,8 %

Figure 8. Pareto for cell 6

Thus, in the top of the main causes determining losses of time within the workshop are the following situations:

- tools change and pre-setting;
- change of fabrication;
- machine failure.

From the top of the identified causes, next an analysis of the change of fabrication is carried out and then finding and implementing improvement methods.

III. CHANGE OF FABRICATION IN WORKSHOP 770 - COMPA

The time of change of fabrication represents the time interval between the last good piece made in the previous series and the first good piece made in the following series. Meanwhile, one or two installers from the section reconfigure the machines, the work place and the environment through an ensemble of activities and operations.

In Workshop 770 from the company SC COMPA SA we monitored 5 whole changes of fabrication in order to determine the time needed to complete them, causes which led to delay in the process but could also optimise it. Thus, each operation destined for the process of change of fabrication from the production cells was timed individually.

In order to make an analysis of the losses of time, we centralised the data related to the 5 changes of fabrication, according to table 1.

TABLE I. TIMES RELATED TO OPERATIONS OF THE 5 CHANGES OF FABRICATION

Date	3.02.16 Shift 1 Cell 3	09.03.16 Shift 1 Cell 2	23.03.16 Shift 1 Cell 2	11.04.16 Shift 1 Cell 2	22.04.16 Shift 1 Cell 3
Operation	3838→ 3842	3846→ 3727	3846→ 3727	3846→ 3727	3851→ 3838
Marking	4 min 25s	11 min 40s	10 min 15s	5 min 30 s	10 min
Change of Chiron device	92 min 50s	81 min 45s	41 min+5min change screws	32 min 29s	50 min 24s
Change of Chiron device	30 min	12 min	26 min	8 min 46s	34 min
Change of Chiron machine	46 min 21s	38 min 10s	33 min 40s	40 min 10s	36 min
Mollart	10 min	13 min	3 min	3 min 35s	30 min
Deburring	30s	unchanged	5 min	2 min	unchanged
Documents	un-fulfilled	un-fulfilled	un-fulfilled	un-fulfilled	un-fulfilled
Settings	26 min	7 min	6 min	11 min	12 min
TOTAL	213 min	163 min 35s	130 min	103 min 30s	172 min 24s

A. Main causes of losses of time

The main causes we have identified and which can produce considerable delay in the process of change of fabrication are the following:

- A part of the installers who make the change of fabrication is in training (for instance, a larger time interval is noted for the change on the 3.02.16 compared to the rest of the changes);
- The instructions and related lists of the necessary metal removing tools have not been updated;
- Failure to comply with the prescribed instructions (for instance, driving with a force higher than the prescribed one for fixating the fastening screw of the device determined its breakage and the need to replace the component);
- Un-provisioned failure of the Mollart machine for the operation 20;
- Missing semi-fabricated, which was not noticed in due time, has determined extra waiting time;
- Lack of measuring and control devices determined taking the necessary tools from other cells of the workshop;
- Failure of the sensor on the stand for marking the pieces;
- Blocking of the Poka-Yoke pistons of the Chiron machine;
- Accumulation of a significant quantity of chip in the "T" gutters of the tables on the Chiron machine;

IV. Improvement of the Process of Change of Fabrication

After having determined the causes which provoke a long time interval to complete a change of fabrication we established a series of possible improvements regarding optimisation of this process.

The actions which should be carried out in order to reduce the time necessary to complete the change of fabrication are the following:

- Change of speed and advancement of the piston moving the motherboard into the work position for the marking operation;
- Existence of some change screws available for each change of fabrication;
- Supplying the Chiron machine with new metal cutting tools in order to reduce the time allocated to the transfer of tools from the new fabrication into the old one, but also the appropriate information related on service life, geometry of the tools which should have been introduced in the system of the equipment;
- Performing the operation of setting the marking in the time where pieces are in the 3D validation department and contour tracing apparatus;
- Performing the type 0 maintenance for every change of fabrication;
- Equipment with a new tool kit destined exclusively to the production because the tool kit currently used belongs to the Maintenance Department of the Workshop;
- Positioning the instructions with magnets closer to the working area;
- Positioning the tools closer to the working area;
- Introducing the system Balluf chip, an automated system through which all the data of the metal cutting tools is stocked and entered into the system;

V. Conclusions

According to the Pareto analysis made for the 6 cells existing inside the Workshop 770 from SC COMPA SA, one of the main situations where a lot of time is wasted is the change of fabrication.

After a brainstorming process with the Fabrication Department and the installers who perform the change of fabrication, we determined the possible causes for time losses as well as an action plan to reduce them as much as possible.

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