PROCESS SIMULATION AS SUPPORT IN LEARNING THEORETICAL-PRACTICAL WITHIN THE LEAN MANUFACTURING LABORATORY OF UTFV

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ABSTRACT

This paper presentation is a study of the application of lean manufacturing tools in a productiontraining system in an educational practice, which involves the development of single-acting pneumatic cylinders. Then the process is simulated to analyze the behavior activities and thus help improve production system modeled through alternatives and the application of lean tools. The paper begins with an overview of the areas and activities of the system, the methodology is followed by the statement of the problem and then simulation models created in the APE software and subsequent results are presented. Finally, some conclusions and suggestions for improvement are presented about system activities that can serve real systems with similar characteristics.

Keywords: lean manufacturing, productive improvement, didactic system, modeling and simulation.

1. INTRODUCTION

The productive-didactic process in which the project takes place consists of the elaboration of pneumatic cylinders of simple effect, these are made up of, a piston rod, a packing, a piston, a cover of two different diameters, a cylinder, and packages, these are elaborated in four models different under specifications from a client.



Figure 1: pneumatic cylinders models

1.1 DEVELOPMENT OF PRODUCTIVE-TRAINING SYSTEM

The practice was carried out in the University Technological Fidel Velázquez (UTFV, Mexico) in Lean Manufacturing laboratory. The objective of the practice consists of simulating the production of the pneumatic cylinders through a productivedidactic system. The Process of the manufacture of the cylinders begins after receiving order from a client, thus beginning all the internal organization of the production system to satisfy the demand of the client in specifications and certain times.

The areas involved in this production system are:

Client: should buy cylinders from the production company under certain specifications and timelines, if the received product does not meet the specifications the product should be return to the company for exchange.

Production control: get the customer purchase order and generates a work order (W.O.), send this order to warehouse.

Warehouse: responsible for supplying raw materials (R.M.) to production, assembly 1 and 2, requested R.M to suppliers and sends orders to press for punch out lids

Suppliers: provides R.M. to Warehouse for the cylinders production.

Production: receive the R.M. and only performs the thread to place the cylinder valve.

Assembly 1: assembles the stem, spring, punched out lid and cylinder

Functional Test: Test the functionality of the cylinder, if it works then it will be assembled if it doesn't work it will be sent back to the company for corrections.

Assembly 2: after being approved by functional test, the valve of the cylinder will be set.

Re-Work: to be inspected by returns or defects of manufacture, after correcting the errors gives back the product to them to the area from where it comes.

Press: it makes the perforation of covers in two diameters by warehouse orders

Packing and Quality: it makes an inspection of the finished product, to be approved places it within its packing, if it is sent to re-work is not approved.

Accounting: it makes the delivery and collection of product to the client by the product that this approves and orders of purchase of MP with warehouse.



• Display existing waste in production processes and their impact on cost, productivity, delivery times and reliability.

• Recognize the importance that plays in a company the staff participation in processes to identify opportunities for improvement.

• To generate in students the ability to identify opportunities for improvement in a company or a real production system, through educational tools

2.2 STAGES OF DEVELOPMENT AND PROCESS IMPROVEMENT

Those responsible for carrying out this study are student from The University Technological Fidel Velázquez (UTFV, Mexico) in productive systems engineering it is necessary to work with a group of 15 people on average for its development. The practical is to produce 60 cylinders in 45 minutes. Four phases are made to study and analysis the product it also help detected errors for improvement.

Phase	Description of improvements to be		
	implemented		
1	The purpose of the organization is identified,		
	roles are assigned and identify operational steps,		
	processes, work areas, anomalies and		
	opportunities for improvement		
2	Identify the 7 wastes, identify the value chain,		
	implement a redistribution of plant,		
	implementation of 5S		
3	Introduce Lean accounting		
	TPM and SMED Value Stream Mapping (VSM)		
	Just In Time (JIT)		
	Reorganize by product families		
	elimination of inventories		
4	Performing a balancing lines		
	Manufacturing cell formation.		
	Implementation of Kanban		
	7 waste reduction		
	production system PUSH to PULL		

Table 1. Phases of development of practice and implement actions for continuous improvement.

Figure. 2 Flow diagram of the production process in the development of a cylinder.

2. METHODOLOGY OF THE DEVELOPMENT OF PRACTICE

2.1 OBJECTIVES THEORETICAL PRACTICAL OF THE SYSTEM

• Learn the techniques of lean manufacturing and applying them.

2.3 EXPECTED RESULTS AFTER EACH PHASE

Two main results of the implementation of improvements in practice development is expected after each phase:

• A decline in the use of materials, constantly the levels of raw material inventory in warehouse and product in process are levels above the capacity of customer satisfaction, that is to say, you have more raw material to make products that really sell this, what generates that at the end of the practice and perform the analysis of economic, this point is one of the most part that affects the finances of the organization that produced the cylinders.

• Improvement of the indicators of productivity, economic and quality: each practice will pass through four stages of improvement, at the end of each of these phrase, it will be evaluated by the indicators mentioned above, and compared with each previous stage. The last stage of each practice is the one that shows the best performance for the application of different Lean tool methodologies.



Figure 3. Expected results after applying lean tools in each of the phases. "Waste is anything that adds cost, but not value, to a product" (Wang, 2008)

3. IMPLEMENTATION OF SIMULATION IN THE STUDY AND DEVELOPMENT OF PRACTICE

3.1 OBJECTIVE

Introduce simulation in the process of teaching and learning within academic activities in the workshop lean manufacturing by designing the model with simulation software SIMIO to assist students in achieving the objectives of the practice. *"Simulation is an effective method to recognize these problems with consuming least cost and time" Hafezalkotob* (2014)

3.2 SPECIFIC OBJECTIVES

Simulation is a technique to model a real-life or hypothetical situation on a computer so that it can be used for analyzing the behavior of system (Senem, B., 2011.)

- Modeling and Simulation of the production process of pneumatic cylinders based on each phase of the system.
- Analysis of behavior of the production system for enhancement the learn process, decisionmaking and improvement proposals skills on students
- Compare and evaluate the results in groups which will use the simulation whit respect to those who have not made use of it.

3.3 JUSTIFICATION

"The first step of applying simulation in the real industrial problem is recognition of the simulation parameters" Hafezalkotob (2014).

This study on the implementation of simulation in conjunction with lean manufacturing in the learning process of students in Engineering Production Systems, will reveal the impact of both tools as complementary elements in their education, else helping at the same time to strengthen skills of study and understanding of processes, analysis of causes and effects, identifying variables and above all generate in them a technique oriented systems approach.

In terms of development of the practice as a production process, we also seeks the performance improvement of the metrics of historical data of practices realized previously in which both instruments simultaneously not intervene. Proving as this way, that simulation is a powerful tool with different guidelines for finding solutions and improvement.

4. MODELS AND SIMULATION OF DEVELOPMENT PHASES

Then we introduce four scene corresponding to each of the four phases involved in the development of practical and production metric analysis is performed.

4.1 PHASE 1 MODEL



Figure 4. Layout phase 1



Figure 4.1 Model phase 1

	Phase 1	
Results	Results obtained	Desired results
Produced cylinders	13	60
Cylinders delivered time	0	60
Average delivery time	900 s	45 s
Earnings	64	960
Rework coefficient	12%	0%

Table 2. Results of Phase 1

During the first phase the students form a group and they choose a leader to start a teamwork and produce 60 cylinders in 45 minutes to deliver them to the consumer on a specific time and in due time which is the main objective. At this stage roles are assigned to participants to manage the workspace in which he or she will be responsible and should work in the respective processes to meet the target. After the implementation, the objectives will be measured and placed in a format called "summary of results" where the number of produced and delivered on time cylinders will be shown, also will be shown the profits, if the <u>objectives</u> have been produced in time and the coefficient labor. Thus the quality and productivity is measured.

4.2 PHASE 2 MODEL



Figure 5. Layout phase 2



Figure 5.1 Model phase 2

	Phase 2	
Results	Results obtained	Desired results
Produced cylinders	27	60
Cylinders delivered time	1	60
Average delivery time	400 s	45 s
Earnings	380	960
Rework coefficient	10%	0%
Table 3. Results of	Phase 2	

In the second phase an analysis will be prepared to identify the seven wastes and the value chain, the students propose strategies to redistribute plant to help waste disposal, they begin by ordering the work area and standardize the process through the application of 5 S's methodology.

4.3 PHASE 3 MODEL



Figure 6. Layout phase 3.



Figure 6.1. Model phase 3.

	Phase 3	
Results	Results obtained	Desired results
Produced cylinders	42	60
Cylinders delivered in time	11	60
Average delivery time	82 s	45 s
Earnings	629	960
Rework coefficient	5%	0%

Table 4. Results of the phase 3

In this phase, participants begin to introduce the Lean accounting, reducing inventory levels; They begin to apply kanban cards to identify the merchandise and the processes; apply the TPM, then reduce tooling change through the SMED and begin to meet the objectives of JIT, this phase may take between two and three production runs.

4.4 PHASE 4 MODEL



Figure 7 Layout phase 4.



Figure 7.1 Model phase 4.

Results	Phase 4	
	Results obtained	Desired results
Produced cylinders	67	60
Cylinders delivered in time	51	60
Average delivery time	47 s	45 s
Earnings	960	960
Rework coefficient	0%	0%

Table 5. Results of the phase 4

Kaizen is a cyclical methodology is continuous improvement, once the methodology of "small big improvements results" is adopted, at this stage make a value stream mapping to observe the status quo, and identify areas of opportunity to observe accurately and numerical results, time in the value chain and continues with the JIT and design manufacturing cells to meet the objective: to produce 60 cylinders 45 minutes, delivering on time, obtaining the necessary profits and 0% in the rate of re work, 100% quality. Being a 100% dependable enterprise.

4.5 CONTINUOUS IMPROVEMENT IN THE FOUR STAGES



Figure 9. Cylinder production

Cylinder productión in fhase 4, the goal is met.



Figure 10. Cylinder production and delivered in time required.

Give on time of cylinder in phase 4, it has not met the target, but the result was close



Figure 11. Increased earnings.

The earnings were sificientes and business investment recovered and got the 100% gain for each pneumatic cylinder sold.



Figure 12. Quality of the finished products

Quality is measured by the coefficient of Rework obtained by counting defective cylinders. The graph shows that in the last phase no defective cylinders, thereby complying with the principle of " zero defects " lean work accomplished team.

5. CONCLUSIONS

Finally, we present some conclusions and proposals for improvement about the activities of the system which is just one of the objectives of the simulation processes. The improvements that we propose can serve for real systems with similar characteristics.

• Simulation is a very valuable tool that allows us to see the changes that we can make without working with the real system, avoiding stoppages in the processes and delays in the production, making more optimal the optimization process proposed by the continuous improvement or the philosophy of lean manufacturing.

• Include a simulation software in the workshop of Lean Manufacturing of the UTFV helped the students learn a little about the benefits and applications of this tool within a training practice and also within a production system, these benefits and activities, students can propose them once they begin their professional career, and initiating continuous improvement in the companies where they work.

5.1 RECOMMENDATIONS

• The students that participated in this project have not yet work with a simulator, so it is recommended to have an introduction to the simulator in the same area where they practice.

• Standardize and document through a manual of procedures all the characteristics of the process such as: the times, the movements of each one of the operations in the stages of the system, so that no matter who performs the operation, the times are similar and thus to achieve a line-balancing, which is a step subsequent to the application of lean manufacturing with success.

• Analyze those activities that could be integrated in a same stage of the process, and simplify operations. (p. e. The packing of the parts in practice may be made by the area assembly II).

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