Technical Assistance in Documentation And Instructive Updating Supported in the "S.M.E.D" - To Change of Format in the Packaging Line in the "Licorera Del Cauca" Industry

Nora Fernanda Arciniegas Sánchez
Research group on Productivity and Innovation
Industrial Engineering Program
Fundación Universitaria de Popayán
Popayán, Colombia
arciniegasfernanda@gmail.com

Ing. Diego Felipe Espinosa Erazo
Research group on Productivity and Innovation
Industrial Engineering Program
Fundación Universitaria de Popayán
Popayán, Colombia
diego.espinosa@docente.fup.edu.co

Ing. Juan Manuel Segura Mosquera
Industria Licorera del Cauca
Popayán, Colombia
mantenimiento@aguardientecaucano.com

PhD. Jaime Humberto Mendoza Chacón
Industria Licorera del Cauca &
Research group on Productivity and Innovation
Industrial Engineering Program
Fundación Universitaria de Popayán
Popayán, Colombia
jaime.mendoza@docente.fuc.edu.co

Abstract

The purpose of this work was to write the instructions to implement the methodology "SMED - Single Minute Exchange of Die" in the changes of formats of the bottling process in the "Industria Licorera del Cauca", supported by the model of the international standard of automation ISA S88; Likewise, the corresponding checklists were produced that provided information and control was made with the intention of guaranteeing the success of the project in the long term, for the development of this project involved all maintenance staff and process leaders. In addition, the 5'S technique was implemented in the mechanical maintenance area, where the ideal environmental conditions of work were created, resulting in a reduction of the time for the enlistment of work elements and parts for a more effective format change, minimizing time Unproductive for the productive process.

Keywords
Format Change, Process, Productivity, Lean Manufacturing.

1. Introduction

The Licorera del Cauca Industry, is the most important company in the department of Cauca-Colombia; it is in charge of producing and commercializing traditional and sugar-free spirits called "Caucano" in its different presentations: Gin Vicker's Gin, Cream liquor and Frosted liquor as well. All these products are made under highest standards of quality and have several international awards such as the "*Monde Selection*". This paper shows the application of the S.M.E.D. (Single Minute Exchange of Die), which was born to achieve a JIT production (Just In Time), one of the cornerstones of the Toyota Production System ("Lean Manufacturing"). This system was designed to shorten the preparation times of machines and to do smaller batches; in this case, it allows greater availability and capacity of the machines making an adequate and efficient use of them[1]. Development and updating of instructions that corresponds to the format Change was made to intend that the staff in charge follow the instructions and perform the process correctly, and to exert control and monitoring the process. All of this with the development of each one of the Contemplated stages of SMED in order to have a successful execution.

2. Objectives

2.1 Main objective

To carry out a technical advice in the documentation and instructions updating based on the S.M.E.D system to change the format in the packaging line in Licorera del Cauca Industry.

2.2 Specific objectives

• To perform a situational analysis of the current change in the packaging line of the Licorera del Cauca industry.
• To standardize operations according to the situational analysis and as is proposed in the S.M.E.D.
• To inform about S.M.E.D system and its benefits to the maintenance staff through training.
• To present the updated instructions, specifying the operations to be followed during the execution of the change in each one of the stages.

3. Context

The Licorera del Cauca industry has a packaging line, "Filling Systems" brand, 2003 model, GRVm-GP 24-24-4 type, which is composed of seven (7) production units and a compressed air system. Nowadays, three (3) presentations or formats from traditional Caucano liquour and Caucano without sugar are bottled: (1750 C.C) bottle, (750 C.C) bottle and Medium (350 C.C).

3.1 Depalletiser

The depalletiser a "Filling Systems" brand, model: 2003, model: Depal VEGA 60 is a semi-automatic machine that is composed of an extraction table for the exit of bottles. It is suitable for medium - low productions, but can be adapted with a series of accessories to achieve higher productions (max. 7000 bottles / h).

3.2 Triblock module

The Triblock consists of 3 machines (Rinsing, Filling, Capping), "Filling Systems" brand, model: 2003, type GRVm-GP 24-24-4; The rinsing machine is in charge of the washing of the bottles before the fill phase, then the bottles pass by the filling machine, where the product (traditional liquor or sugar-free liquor) is bottled, finally the bottles goes to the capping machine.

3.3 Closures feeder

The Feeder, "Filling Systems" brand, model: 2003, type ALM - 02, is designed to raise the plastic lids by a blind type conveyor belt. The lids rise uniformly from the inside of the hopper with a rate of approximately 9,000 plugs / h, and finally the lids fall through the channel to be placed in the bottle. Hopper's capacity is approximately 3,500 caps.

3.4 Labeling

The labeling machine "P.E. LABELLERS" brand, model PROGRESS S 9T / 540 / 2S-2E with registration number M. 00884, is responsible for placing the labels on each of the bottles that enter into the machine.

[1] (Paredes Rodríguez, 2007)

3.5 Marking or Videojet inkjet

The VIDEOJET EXCEL 273SE Inkjet is composed with two basic sets: the first is the control unit and the other is the print heads. The control unit is made up of electronic, hydraulic and pneumatic compartments. The hydraulic compartment or Hydraulic System Cabinet is where the ink and the diluents are stored and maintained to ensure the correct thickness of the fluid, also the pressure is applied to the ink to ensure the correct speed for the ink drops to reach the Print head. In the pneumatic compartment the inlet air pressure is regulated, controlled and distributed. Finally, in the electronic compartment are all the electronic and electrical signals to generate and control the printing on the label and the cap of each of the bottles with the production date.

3.6 Devider

The Devider "Filling Systems" brand, model 3710650061, year: 2003 with registration number 2558. The machine handles the distribution of bottles, which arrive in a row through the channels that make up the bottle matrix, where they are separated according to the number and the presentation that is being made, from this point bottles come ready to pack.

3.7 The Packing machine

The Wrap-Around packaging machine consists in:

- One stretch of 4/6-way blind conveyor belt or Intralox reticulated belt.
- Separators and a distributor which prevents that the bottles get stuck during the process, they also group them correctly on a suitable reticulated conveyor belt to separate them and to form the groups that are going to be packed according to the specifications given.
- A fixing system that is in charge of holding the bottles in the back at the moment when the separation is made.

In the process, the box is collected from the warehouse with suction cups powered by Venturi generators, during this time it is folded in an L shape and is moved at a 90 ° angle to the loading zone where it coincides with the product. The product and the box continue to the next closure phase. The front side is fold and the glue is apply on the upper inner flap, the box is stopped, the back flaps are raised and is fold the inner side. Finally, in the next phase glue is applied and the four (4) outer covers are folded. The integrated compression system ensures that the box is perfectly attached.

3.8 Transport system

The transport system "Filling Systems" brand, model 03.11.206, year 2003, is in charge of the synchronization of all the machines that are part of the packaging line, it is here where the speeds of the transport chains are controlled, and also controls the entire communication network between PLC's (PROFIBUS).

3.9 Compressed air system

"INGERSOLL RAND" brand, Model SSR-UP6-30-150, series 09m-008203. The compressed air system is responsible to generate the air pressure in order to the machines operate; the system has filters at the exit of the tank to ensure clean and dry air.

4. Phase 1: situational analysis

A situation analysis of the format change process is carried out in order to establish the failures presented during the execution of each one of the stages by the personnel, to document in detail the process and to identify the opportunities of improvement according to SMED approach. The flowchart of the changed format is next (figure 1), focused to the order of execution as is performed by maintenance staff

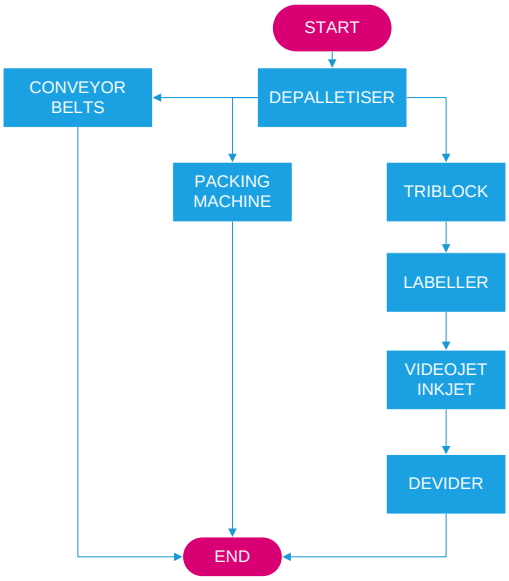

Figure 1. Format changeover

Several tools were used to gather information, which provided all the details about the process and its execution. Some of these were: observation, opinion surveys, standard time calculation, reviews of existing process documentation, HACCP matrix and a SWOT matrix. Through these tools the following problems of the process have been identified:

- First, maintenance staff do not follow the instructions and manuals that indicate how to carry out a good process; current problems were identify, for example: there is a large number of damaged parts, Incorrect dimensions written in the instructions, waste of raw material, waste of time and reprocessing.
- There are no manuals that explain in detail the step-by-step of the Change in each of the stages. The formats are outdated.
- Work Absenteeism, which implies that the change is made by people who do not have the experience and knowledge of the process.
- Disruption of the workshop where the necessary parts and tools for change are stored

These problems have a significant impact on the productive efficiency of the packaging line, it generates losses and dissatisfaction in the fulfillment of the production schedule; therefore, it is considered that the S.M.E.D. provides the most appropriate solutions to solve the existing problem, important tools previously listed for the success of the practice are proposed.

4.1 Observation

Each of the executed operations during the Change of format carried out by maintenance personnel was identified and documented. This allows to define improvement opportunities such as the implementation in packaging workshop the 5'S technique which belongs to Lean Manufacturing, this will guarantee the application of the 5 Japanese's principles: Classification, Order, Cleaning, Standardization and Discipline to have an efficient tools storage, in addition there is an optimal and fast reach of objects.
It was also defined as an improvement mechanism the updating of instructions and checklists which are necessary for the Change process as a control and follow-up mechanism.

4.2 Survey opinion

A survey of 11 questions was fulfilled by personnel (2 mechanics, 2 electricians and auxiliaries), it was divided into: knowledge, opinion about the current execution of the process and it willingness to participate actively in the development of the SMED system phases. As a result: for the questions about knowledge, 60% of the survey respondents said that they do not know the SMED and 5'S concepts; in terms of the current process, they consider that some aspects such as tools access is appropriate, and 100% agree that workers must be trained and participate in the process as a method to reduce the time of change. Also, 100% of the respondents confirm they would like to participate actively in the development of the S.M.E.D system to improve the current format change process.

4.3 Taking times and calculating current standard time

To complement the observation process of change, a time register was made, to verify how long it takes to make the format change. It is important to note that the calculations and records are held to schedule the change by the Production and Maintenance chief, therefore, only five changes were made:

- Half bottle – bottle
- Half bottle – decanter
- Bottle - half bottle
- Bottle – decanter
- Decanter- half bottle
- Decanter – bottle

Record time was carried out the cumulative timing method, which consists in starting the stopwatch from the moment the change starts, until the end of it; then the standard time for each change is calculated as follows:

Table 1. Standard Time

CHANGE	STANDARD TIME (MIN)
Half bottle – bottle	**224**
Bottle – decanter	**363**
Decanter – half bottle	**332**

Table 1 shows the last phase, it is possible to establish a time projection and resources distribution (maintenance personnel) applying for the different changes the S.M.E.D. methodology.

4.4 Documentation

Currently, the maintenance area has the following instructions to Format Change:

- INDP05 operation instruction machine Depalletizer.
- INPD06 operation instruction machine Triblock
- INPD07 operation instruction machine Labeling machine.
- INPD08 operation instruction machine Devider machines and Cartwright.
- INMA06 operation instruction machine Line Filling Systems.

However, these are totally outdated, due to the line has undergone several changes such as the new presentation of the bottle that used to be 1500cc and now it is 1750cc. For this it was necessary to adjust the machines (pieces, tools and others) for its correct operation. The evidence of the outdated instructions is shown (Figure 2):

INDUSTRIA LICORERA DEL CAUCA
INSTRUCTIVO PARA CAMBIOS DE PRESENTACIÓN LINEA FILLING SISTEMS

Código	Versión	Fecha vigencia	Página
INMA06	01	Julio 9 de 2004	2 de 8

CONTENIDO

Figure 2. Instructions to Change Presentation e - INMA 06

Upgrading as a mechanism for increasing the capacity and improve machines operation during the changeover process is extremely important for the SMED purpose.

4.5 HACCP Matrix (Critical Control Point Analysis).

Nowadays, Licorera del Cauca Industry, is in a certification process in GMP (Good Manufacturing Practices), it is considered important to accomplish an analysis of the existing dangers during the execution of the format change process that can affect the safety of the product in Its elaboration[2]. Therefore, it is considered important to perform a Critical Control Point Analysis (HACCP), understood as a system of logical and direct control based on the prevention of problems in the production of safe food. To identify the causes and effects of these hazards on the Change process affect the quality of the product, a HACCP matrix was elaborated.

4.6 SWOT Matrix (Weaknesses, Opportunities, Strengths and Threats).

Finally, a SWOT matrix was developed, which summarizes the entire diagnostic process, highlighting the strengths, opportunities, weaknesses and threats in the current format change, this process validates the importance of SMED and 5'S technique as continuous improvement tools to achieve a positive impact in productivity, customers' demand and satisfaction from the "Licorera del Cauca" Industry.

5. Phase 2: identification, classification and perfection of internal and external operations.

In this phase, each of the carried out operations during the format change is identified, classified into internal or external operations. Internal operations are those that must be done with the stopped machine and the external operations are the ones that can be done with the running machine[3]. Then the analysis and reclassification is completed, seeking to reduce the time needed to carry out the Change.
Through a checklist and using the information collected during Phase 1, the identification and classification of each of the operations of the current change is performed. It can be seen in Table 2 that all operations of the current process are performed internally.

Tools and parts enlistment, was scheduled when the change was notified by the Chief of Maintenance and the Chief of Production, in order that the mechanic shift initiated the development of the Change even though the line Is producing the last units of the batch corresponding to the presentation to be changed; On the other hand, an ideal way to perform adjustment operations is to perform them every time a Change is completed at each stage. The other operations must be performed with the machine stopped because of the manufacturer's technical specifications, for the protection and safety of the personnel in charge of the process.

Table 2. Internal and External operations of the actual format change

STAGES	OPERATIONS	INTERNAL	EXTERNAL
Tools and parts enlistment	. Setting all needed tools and parts to perform the format change.	X	
Depalletiser	-Head Adjustment	X	
Triblock	- Change of the set parts - Sensors adjustment	X	
Labeller	- Change of the set parts - Sensors adjustment - measures adjustment	X	
Videojet Inkjet	- Head Adjustment	X	
Devider	- measures adjustment	X	
Packing machine	- Glue gun adjusment. - measures adjustment	X	
Adjustments	Without starting the machine introduce bottles to rectify the change	X	

The reclassification and conversion of operations (internal to external) is performed as shown in Table 3. In addition, it was possible to analyze that it is important that the process is done in parallel stop, this guarantees that the change is realized in several machines at the same time, that is a considerable reduction of time and the team work is improved.

[2] (Salas Choque, 2006)
[3] (Espin Carbonell, 2013)

However, it must be taken into account that the staff is very small, they work in 2 different moments (Morning and Afternoon), which makes it necessary to consider the possibility that operators be included in the Change process.

Table 3. New classification of format change operations.

STAGES	OPERATIONS	INTERNAL	EXTERNAL
Tools and parts enlistment	. Setting all needed tools and parts to perform the format change.		X
Depalletiser	-Head Adjustment	X	
Triblock	- Change of the set parts -sensors adjustment	X	
Labeling	- Change of the set parts - Sensors adjustment - measures adjustment	X	
Videojet	- Head Adjustment	X	
Devider	- measures adjustment	X	
Packing machine	- Glue gun adjusment. - measures adjustment	X	
Adjustments	Without starting the machine introduce bottles to rectify the change	X	

6. Phase 3: Standardization of operations

With all the method defined for the accomplishment of the change, assigned responsibilities and operating times, this information is consigned in the new process instructions. To get standard operations, the process model of ISA S88 for a Batch production process is taken as a reference, those processes whose output is given in the form of quantities or material, batches for example the Pharmaceutical products or beer production[4]. According to ISA S88, the structure model is given as follows:

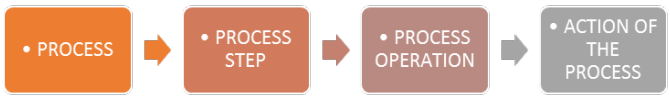

Figure 3. Process model according to ISA S88

For example, in the instructive, the structure for the Format Change of the Depalletiser, is represented as follows:
PROCESS: Format change
STAGE OF THE PROCESS: Depalletiser

Table 4. Format Change: Depalletiser

OPERATION	ACTION	TIME (MIN)	RESPONSIBLE
Tool Enlistment	Key number 10 is ready (2) NOTE: Remember to fill out the checklist (Tool Enlistment).	8	Mechanical
Head and Sensor Mechanic	Adjustments made with key number 10 loosen the level locking the screw.		Mechanical
	Adjust the height of the head using a bottle of the presentation that will be change as a guide to achieve its perfect fit.		
	Use the key number 10 to screw the head locking screw until it is firm.		

(Ortega Erazo & Paz Cordoba, 2015)[4]

The time and responsible boxes are included in order to establish the time the Stage Change must take and who should execute it, this time and responsibilities are establish according to the projection (See Figure 7).

7. Implementation of the 5's technique in the packaging workshop

As an added value, it is proposed to make use of the 5'S technique in the Packaging Workshop as a complement process to the S.M.E.D, in order to reduce the times of parts and tools enlistment.

7.1 Initial diagnosis

Previously in the Packaging Workshop and in the Spare Parts Workshop an implementation process had been carried out in, were the maintenance area is responsible for. At first, all the requirements and provisions of the 5'S technique were complied, which is defined as the Methodology that integrates 5 fundamental concepts, which workers and the company itself can achieve adequate conditions to develop and offer quality products and / or services[5]. However, the implemented program did not have a follow-up and control that allowed its long-term success, causing storage problems, dirt, loss of objects, and deterioration of the goods.

It is important to resume this process (5'S principles) especially in the packaging workshop to reduce the times in the format change, and the search for tooling and parts. These principles provide a proper, cleaning and order rules mainly to make a successful process. It should be noted that all the staff in the maintenance area, received very positive response and collaboration throughout the steps. Next, the development of the implementation of the 5'S in the Packaging Workshop is shown.

Figure 4. Packaging workshop

7.1.1 Classification (SEIRI)

At this stage, the separation of the elements in the Packaging Workshop was carried out with the maintenance staff, taking into account the following criteria:

- Are the elements arranged in the Workshop necessary?
- Can the elements that are not needed be used in another area?
- If some items are not needed in another area, are they thrown or sold?
- Once the arrangement in the elements of the Workshop is made, they are classified as follows:
- Obsolete parts and parts used for the current Change.
- The pieces that belong to the presentation of Decanter 2000 c.c.
- The pieces that belong to the PET presentation.
- Spare parts.
- Tools and screws.
- Unnecessary items

For items that are useful in other areas are placed in boxes and are taken to a new place to classify and mark them with a Red Card, as is shown below:

[5] (Vargas Rodríguez, 2007)

7.1.2 Cleaning (SEISO)

Cleaning, painting and marking of the stands, table, lockers, was done for a more effective identification of all the elements present in the Workshop, everything can be evidenced:

7.1.3 Order (SEITON)

At this stage the organization of all the elements was performed, it is taken into account that people's time should be minimized and the time reduction in the Change process according to the SMED should be considered. Then stands were organized as follows.

- Storage: Deprecated parts
- Labeller: Set of parts and change elements, ordered according to the presentation.
- Triblock: Set of parts and elements of change, ordered according to the presentation.
- Spare parts.
- Decanter Presentation 2000 cc.
- PET Presentation

Figure 5. Order - Packaging Workshop

7.1.4 Standardization (SEIKETSU)

The rules of procedure are established, formats were created in order to establish a control and follow-up of the process to guarantee its long-term success, in addition, its application eliminate excessive time in the enlistment of tools and parts contemplated in S.M.E.D.

7.1.5 Discipline (SHITSUKE)

At this stage, maintenance staff was trained to explained them the concepts, procedures done in the Workshop, the control and follow-up that will be done to appropriate the process, to know it and to establish the norms for the success of the project and its long-term duration.

8. Phase 4: presentation of instructives for the process of format change.

This is the last stage that includes the practice period, the elaboration and updating of instructions for the format change process based on the system, in addition the checklists will allow the control and monitoring of the correct development of the project.

A general format change was created to compile the information about the changes that must be made in the different presentations: Media (375 cc), Bottle (750 cc), Bottle (1750 cc) in a single document based on the ISA Standard 88, incorporating standards that must be taken into account before, during and after the process, focused on controlling the critical points of the process, identifying in the HACCP matrix. Checklists were also developed for Tools and Format change process.

The purpose of the SMED is the reduction of times, a projection of the total expected time for the format change is made using the instructions, the conversion of operations, 5'S in the packaging workshop and the training of the maintenance staff. The checklists were developed in order to monitor and follow the process to evaluate their effectiveness and make the adjustments to improve it.

Table 5. Projection of Format

ACTIVITY / TIME	-30	-15	0	15	30	45	60	75	90	105	120	135
Tool Enlistment												
Enrollment of format pieces												
Transportation systems	-	-										
Depalletiser	-	-										
Triblock	-	-										
	-	-										
Labeller	-	-										
Videojet inkjet	-	-										
Devider	-	-										
Packing machine	-	-										
Settings	-	-										

Recursos		
1		Maintenance Assistant
2		Mechanical 1
3		Mechanical 2
4		Electrician 1
5		Electrician 2

The projection was performed taking into account the steps, giving them an average time, this average time was calculated according to the initial observations per stage and its subsequent record is shown:

Table 6. Average time of the stages. Source: authors

STAGE	AVERAGE TIME
CONVEYOR BELTS	52
DEPALLETISER	8
TRIBLOCK	129
LABELLER	47
DEVIDER	7
PACKING MACHINE	122
TRANSPORT SYSTEM	88

9. Conclusions

With the implementation of the 5'S, the development of the SMED system achieves an average reduction of 20% of the time in the "Format Change" process; it demonstrates that this component of the production process is decisive for the Productivity.

Table 7. Expected time with 20% reduction.

PRESENTACIÓN	CURRENT CHANGE (MIN)	EXPECTED TIME (MIN) – REDUCTION 20%
Half botlle	**224**	**179**
Decanter	**363**	**290**
Half decanter	**332**	**266**

The instructions updating, the control and follow-up checklists of the process of format change and the fulfillment of the 5'S, facilitate the interaction of the personnel and the commitment to the process were carried out. The saved time, can be used in the execution of other operations included in the process of " Format Change". The process model of the ISA S88 standard for the standardization of operations in the second phase of the S.M.E.D was used. providing an appropriate structure to the final instruction of "Change of format", it's also integrates the nomenclature of the process that allows to unify criteria and terms. The use of different concepts and tools of Industrial Engineering, such as: standard time calculation, 5'S and S.M.E.D as a complement that allowed to identify improvement in the process.

Acknowledgements

We thank the active participation of all the maintenance staff, the commitment of the maintenance chief and the head of the production division in the development of the entire process proposed in the S.M.E.D.

References

Paredes R. F. (2007). Preparación rápida de máquinas: El sistema SMED. [Online]. http://www.mantenimientomundial.com/sites/mm/notas/SMED.pdf

Salas, Ch. W. A. (2006). Aplicación del sistema HACCP en e proceso de elaboración de alimentos de reconstitución instantanea a base de cereales extruidos. [Online]. http://www.revistavirtualpro.com/biblioteca/aplicacion-del-sistema-haccp-en-el-proceso-de-elaboracion-de-alimentos-de-reconstitucion-instantanea-a-base-de-cereales-extruidos.

Espin Carbonell, F. (2013). Técnica SMED. Reducción del tiempo de preparación. [Online]. http://www.3ciencias.com/wp-content/uploads/2013/05/TECNICA-SMED.pdf

Ortega Erazo, J. C., & Paz Cordoba, J. M. Estandarización y simulación industrial del proceso soxhlet para obtención de extracto etanolico total de Bardana. Popayán, (2015), 95 h. Trabajo de grado (Ingenieros en Automática Industrial). Universidad del Cauca. Facultad de Ingeniería electrónica y telecomunicaciones. Departamento de Electrónica, instrumentación y control.

Vargas Rodríguez, H. (2007). Manual de implementación de un programa 5S un sistema de gestión de calidad. [Online]. http://www.revistavirtualpro.com/biblioteca/manual-de-implementacion-de-un-programa-5s-un-sistema-de-gestion-de-calidad-

Rojas, O. Estándares ISA S88 S95 [diapositivas]. Popayán: Grupo AI, (s.f). 16 diapositivas.

Niebel W. B & Freivalds A. Ingeniería industrial, métodos, estándares y diseño de trabajo (12 Ed.). México: MC GRAW HILL, (2009).

OIT. Introducción al estudio del trabajo. (4 Ed.). GINEBRA: (1996). (págs. 317-318).

LOPEZ S., B. (2016). ESTUDIO DE TIEMPO ESTÁNDAR. [Online]. http://www.ingenieriaindustrialonline.com/herramientas-para-el-ingeniero-industrial/estudio-de-tiempos/c%C3%A1lculo-del-tiempo-est%C3%A1ndar-o-tipo/

Shingo, Shigeo, (2001), El Sistema SMED. Productivito Press. México: (2001). (pág. 86).

Biography

Nora F. Arciniegas. Industrial engineering student from Fundación Universitaria de Popayán. Young researcher of the Industrial Engineering program

Diego F. Espinosa. Industrial engineering, is currently a fulltime teacher of the program of industrial engineering of the Fundación Universitaria de Popayán. Belongs to the investigation group IP (Innovation and productivity) with 5 years of experience in working with times and methods and movements, production, logistics.

Juan M. Segura. Automation Engineer, Maintenance chief of the Industria Licorera del Cauca. With 5 years of experience in working with processes of production. Industrial Engineering Master Student.

Jaime H. Mendoza. PhD. Engineering from Universidad del Valle, Magister in microbiology from Universidad del Valle, specialist in industrial engineering from Universidad del Valle, degree in biology and chemistry from Universidad del Valle, full time teacher from Fundación Universitaria de Popayán, He

was part time teacher from Universidad del Valle, Universidad Cooperativa de Colombia, belongs to the investigation group IP (Innovation and productivity) with 25 years of experience in working with productivity processes and investigation.