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Presentation of Content

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Application of Newton's law of cooling in production line

Aplicación de la ley de enfriamiento de Newton en Línea de producción

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Abstract

The objective of this study is to solve the problem of the packaging process when handling canned food. In the thermal process the sterilization of the food product is carried out in addition to the cooking, a thermal shock is created to eliminate 100% the microorganisms that can damage the product; in addition it must comply with the NOM-130-SSA1-1995, Goods and services. Food packed in hermetically sealed containers and subjected to heat treatment. The temperature of exit is of 75 ° C, not being pertinent for the handle of the finished product and in agreement with the internal specification of the company, the temperature for the handle and packaging must be of 40 ° C. The methodology used is Newton's Law of Cooling for heat transfer, which states that the rate of heat exchange between an object and its environment is proportional to the temperature difference between the object and the environment. The differential equation is solved and the results obtained are validated with tests in the production line. The main contribution is that science is applied to solve a problem in a production line.

Cooling law, Temperature, Thermal process

Resumen

El objetivo de este estudio es resolver la problemática que tiene el proceso de empaque al manipular alimentos enlatados. En el proceso térmico se lleva a cabo la esterilización del producto alimenticio además del cocimiento, se crea un choque térmico para lograr eliminar al 100% los microorganismos que pueden dañar al producto, además se debe cumplir con la NOM-130-SSA1-1995, Bienes y Servicios. Alimentos envasados en recipientes de cierre hermético y sometido a tratamiento térmico. La temperatura de salida es de 75°C, no siendo pertinente para el manejo del producto terminado y de acuerdo con la especificación interna de la empresa, la temperatura para el manejo y embalaje debe ser de 40°C. La metodología empleada es la Ley de enfriamiento de Newton para la transferencia de calor, la cual establece que la tasa de intercambio de calor entre un objeto y su entorno es proporcional a la diferencia de temperatura entre el objeto y el entorno. Se plantea la ecuación diferencial y los resultados obtenidos se validan con pruebas en la línea de producción. La principal contribución es que se aplica la ciencia para resolver un problema en una línea de producción.

Ley de enfriamiento, Temperatura, Proceso térmico

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Introduction

Mathematical modeling of industrial processes is an approach that allows us to study reality through algorithms. Its application occurs in different fields of knowledge such as architecture (Zappitelli, 2019), vitamin adsorption (Vélaquez Campoy, 2019), the statistical validation of virtual instruments (Herrera S., Silva J., Salazar P., & Gallardo N. , 2017), among others.

The modeling for thermodynamic processes has been used as in entropy-time relationship in an isochromic adiabatic system (Ros, 2019) with constant volume, in the transfer of heat in food (Vela P., 2013). In food, heat treatments are applied (Pérez & Sosa, 2013) with the purpose of increasing stability, cooking or heating them for consumption either for humans or domestic animals.

The heat transfer is carried out by different modes. Conduction occurs when there is a temperature gradient in a solid or fluid stationary medium. Convection is the temperature gradient between a surface and a moving fluid. Thermal radiation occurs between two surfaces in the absence of a medium.

Likewise, mathematical models provide one of the basic tools to describe physical processes and to explain and predict behavior in varied conditions. Computer science has stimulated a greater interest in the development of mathematical models of heat transfer in food processes such as sterilization, scalding, freezing, refrigeration and frying (Alvis, Caicedo, & Peña, 2010; Califano & Cálvelo, 1983; Pelegrina, Echarte, & Sherwood, 2000; Sosa, Orzuna, & Velez, 2006).

On the other hand, one of the applications of heat transfer is Newton's cooling law, which has been applied since the beginning of the 18th century (Besson, 2010), one of its applications is the simulation of the cooling system and the detection of car failures (Gupta, 2015).

In food processes, heat transfer is a key element in controlling temperature. In this case, the canning process is used for food preservation. Canning is a common technique for food preservation and commercial sterilization, this process destroys microorganisms and enzymes that harm food (Martín G., 2019).

The study was carried out in a food company, located in the State of Puebla, a problem is detected in the thermal process of a BAD production line (see figure 1), when a can of food ends its process in the autoclave immediately goes to the However, when it enters the packing area, it cannot be handled for its packaging because it has an inadequate temperature for handling. Being the problem to solve located in the area of packaging, which is linked to the maintenance area. The importance of finding a numerical value with respect to the time that a can should remain in the cooling tub for subsequent handling for its packaging. This results in delays in shipments of finished product and low productivity in the packaging area resulting in inadequate customer service.

Figure 1 Thermal process BAD line
Source: Productos Alimenticios La Morena S.A.

In general, during a heat treatment of a canned food, the heat transfer mechanisms are conductive for solids (Pérez & Sosa, 2013), convection for liquid foods, convection and conduction for liquid foods containing particles and convection followed of conduction for liquid foods that contain starch or exhibit high viscosity (Erdogdu, Uyar, & Koray, 2010).

In the production of peppers, preserves and canned sauces several processes are carried out to reach the final product, the main one is the thermal process, where sterilization of the food product is done in addition to cooking, and an adequate thermal shock is performed to achieve 100% eliminate microorganisms that can harm the product and mainly the end customer. Table 1 shows production data as operating parameters of the BAD production line.

At this time, it is not possible to force the cooling of the cans by other techniques, since technical analyzes have to be done in reference to food safety and there are no financial resources available.

Dairy produce	8,975 cans
Weekly production	62,825 cans
Ideal operating speed	200 cans per minute
Current operating speed	180 cans per minute
Rejections	350 cans
Reprocessing	250 cans

Table 1 Data from the BAD production line
Source: Own elaboration with data of the company Productos Alimenticios La Morena S.A.

Therefore, it is important to find a numerical value for the cooling temperature with respect to the surrounding temperature by Newton's cooling law and thus reduce the temperature in the cans that pass to the packing area, being the purpose of this study . On the other hand, Newton's cooling law governs (Barragán, 2009) the temporal evolution of heat transfer processes. Heat transfer is energy in transit due to a temperature difference (Incropera & De Witt, 1999).

Currently the thermal process works at an output speed of 4 minutes per can, the main problem is that the can when leaving the cooling tub does not have the proper temperature for its packaging, the temperature according to the process path of The company is 40 ° C, so claims are received from the packaging area with the argument that the can is too hot, likewise, you do not have adequate time to reach that temperature, because the temperature of the can at the exit is 75 ° C.

Figure 2 BAD Cooling Tub
Source: Productos Alimenticios La Morena S.A.

The heat convection mode is the one that is developed in the MALO production line, since there is a surface with a temperature gradient in a fluid. If we express the convection effect by Newton's cooling law, the following equation is obtained (Holman, 1999):

ή ῞Ω῞Ὑ ῞Ὑ (1)

Where the heat transfer rate is related to the gradient between the temperature of the object and the fluid, which is heat transfer rate, T_o object temperature, T_f fluid temperature and h is the heat transfer coefficient by convection.

This thermodynamic process is represented by a first-order ordinary differential equation.:

῎Ο ώὬώὬώ π (2)

Thus, Newton's Law of Cooling states that the speed with which an object cools is directly proportional to the difference between its temperature and that of the surrounding environment (Alvarado, 2019). If T = T \ left (t \ right) \ represents the temperature of an object at time t and T_mes the constant temperature of the medium, the determination of the thermodynamic function for the production line is the mathematical model of an ordinary differential equation (ODE):

῀Ω῞Υ ὸ ῞Ὑ Ὢ π (3)

Then, with the application of Newton's cooling law, a quantitative solution will be found for the BAD production line. With the application of Newton's Law of Cooling, it is expected that the can at the exit of the thermal process has the appropriate temperature for handling in the packing area and, above all, ensure that this temperature meets the appropriate thermal shock to kill microorganisms that damage to the product in accordance with the norm NOM 130-SSA1-1995, Goods and Services. Food packaged in sealed containers and subjected to heat treatment. Sanitary provisions and specifications. The specific rule that the cooling of the containers after the heat treatment must be carried out with chlorinated water, whose final concentration will be at least 0.5 mg / kg of residual chlorine, looking for an internal product temperature of approximately 40 ° C being able to effect further treatment with cold air.

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On the other hand, for the solution of this problem, another alternative is to apply the statistical method of Design of Experiments 2k having as a response variable the residence time of the can in the cooling tub and the factors will be the inlet temperature, outlet temperature and speed. The design of experiments can be considered as an evolutionary process (Napolitano, 2006) whose objective is the continuous improvement of the processes, in this case the BAD production line.

One technique that can also be used is mathematical optimization, this is a non-linear case, where decision variables are involved that form an objective function that seeks to maximize or minimize subject to structural constraints, such as the case of mathematical optimization in industrial processes (Fernández Bes, S / f).

Method

The heat transfer rate is determined by Newton's Cooling Law that represents the overall effect of convection (Pérez & Sosa, 2013). The variables involved in a thermodynamic process are the pressure, volume, temperature and structure of the food, with temperature being one of the most important variables, maintaining constant pressure and volume (Gómez Daza, 2016).

On the other hand, the purpose of differential equations is to analyze the process of change in reality, for this study in an industrial process. In the analysis of natural phenomena, whether physical or chemical, variables related to exchange rates appear through the general laws of nature that regulate these phenomena (Molero, Salvador, Menarquez, & Garmendía, 2019).

In our study it is a chemical phenomenon related to thermodynamics and heat transfer and a mathematical analysis is applied. The focus of the study is analytical for Newton's Law of Cooling as a separable first order differential equation. The assumptions of the model are:

- It is assumed that the ambient temperature remains constant T_m
- That the temperature of the can is the same as its surface, that is, a constant cooling.

The current conditions are as follows: The 200 gram jalapeno cans leave the thermal process at a temperature of 75 deg and enter a 35 deg water cooling tub when running the tub for 2 minutes, the can has a average temperature of 60 ° C, finally obtaining a production rate of 4 cans per minute.

With a temperature of the cooling tub of T_m = 35 deg, ODE remains as:

[illegible] (4)

Solving the separable ODE

[illegible] (5)

Finding the value of C with the initial temperature T_0 = 75 deg in the time 0 minutes of band travel in the cooling tub.

[illegible] (6)

The ODE is:

[illegible] (7)

Defining the value of the convection heat transfer mode constant with a can temperature of [illegible]

[illegible] (8)

The final ODE is

[illegible] (9)

Results

Currently, the time it takes for a can to pass through the cooling tub is 4 minutes. When we substitute time t = 4 minutes in equation 9, the following temperature is obtained.

[illegible] (10)

If the desired final temperature is T = 40 \ degc, we substitute in equation 9 and obtain the time value:

[illegible] (11)

The time required to obtain a temperature of 40 deg for handling the can in the packing area is about 8.85 minutes.

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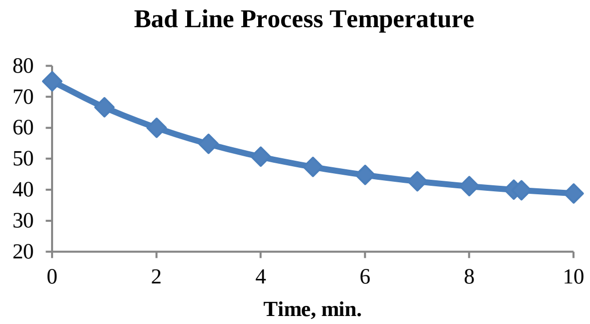
Comparing the current conditions with those proposed by means of the cooling law: an output temperature of 50.63 deg is obtained on the BAD line with a time of 4 minutes, which does not comply with the requirements of NOM 130-SSA1-1995 . On the other hand, applying the Newton cooling equation with a time of 8.85 minutes will obtain an outlet temperature 40 deg for the jalapeno can of 200 grams complying with the provisions of NOM 130-SSA1-1995.

In graph 1, it is observed how the temperature is inversely proportional to the cooling time, that is, if the time increases, the temperature decreases. When the can is submerged in the cooling tub of the production line, reaching the temperature of 40 deg approximately 8.85 minutes.

With the application of the results with Newton's law of cooling, tests are performed to reduce the speed of the band in the cooling tub (20 speed reductions), each speed is changed per minute.



Graphic 1 Equation 4 τ Å٩ي8 ١ ٣ ڠ σ 8
Source: Own Elaboration

In table 2, the different values for temperature with respect to time are observed by equation 9.

Time, minutes	Temperature, °
0	75.00
1	66.62
2	60.00
3	54.76
4	50.62
5	47.35
6	44.76
7	42.72
8	41.10
8.85	39.99
9	39.82

Table 2 Temperature behavior in the production line with the cooling law
Source: Own Elaboration

With these results, the estimated time of the cans in the cooling tub is 8 minutes to achieve a temperature of 41,103 ° C, see table 3. Consequently, decisions have to be made regarding this since the daily and weekly production will be affected in a matter of its quantity.

Values	Time	Temperature ° C
Initials	0	75
Current	4	50.625
Ideal	8	41.103

Table 3 Temperature behavior in the production line with the modifications according to the conditions of the BAD production line
Source: Own elaboration with company data Productos Alimenticios La Morena S.A.

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Conclusions

The time required to comply with the pasteurization process and the operating temperature required by NOM 130-SSA1-1995 has been determined by studying heat transfer and Newton's cooling law. Consequently, an improvement in the handling of cans in the packed process has been achieved.

The production line currently has a production rate of 180 cans per minute and its standard is 200 cans per minute. Then, other variables such as the temperature of the tub water at 35 deg have to be analyzed if it can be increased without affecting the specifications of the thermal process, as well as the capacity of the cooling tub.

It is important to consider Newton's cooling law with a fractional derivative approach (Gómez Aguilar & Razo Hernández, No. 61 January - April 2014) to have a greater precision of the thermal shock process and compare the results obtained.

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In terms of food there are also studies of the application of fractional derivatives (Mondol, Gupta, Das, & Dutta, 2018), so for the future it is convenient to apply this technique to compare its results. On the other hand, there are also other forms of pasteurization of thermal processes such as the electric field technique (Pulsed Electric Field, PEF processing) as an alternative to change the pasteurization process with temperature as the main factor (Fernández Bes, S / f). PEF technology involves the application of electrical impulses to liquid or semi-liquid foods located between two electrodes. This technique can be used for non-thermal pasteurization of food at low or moderate temperatures.

Also, High Intensity Electric Pulses is a non-thermal food preservation technology is another alternative to conventional heat-based conservation technologies (Rivas Soler, 2012). This technology is characterized by allowing a microbiologically safe product to be obtained, with greater respect for nutritional components than conventional heat treatment. These alternatives will have to comply with NOM 130-SSA1-1995, as well as other international standards such as ISO 22000: 2005 and the Hazard Analysis and Critical Control Points system; (Hazard Analysis and Critical Control Points; for its acronym in English).

However, with the current conditions of the company's BAD production line, the best option is the application of Newton's Cooling Law. The cost - benefit will have to be studied so that in the future, changing the current thermal technique to a non-thermal technique such as those mentioned above.

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Elaboration of a production planning system for a snack manufacturing company

Elaboración de un sistema de la planeación de la producción en una empresa manufacturera de botanas

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Abstract

A Production Planning System was developed for a snacks' production Company by the development of a MRP system in order to increase the present production and to meet the demand. The methodology used was Material Requirement Planning (MRP) that basically consists in a logic system able to manage and control material requirement planning based on a number of pieces, components and material needed for manufacturing, in other words, it is a production planning system. The outcome of the Project has been an application with MRP features, with complements such as line balance, purchasing Budget of raw materials, among other things. The application relies on protection of information and backup by the same. The executable application of MRP system has contributed to reduce 50% the production breach at the company, as well as reducing waste in a 40%, idle time in a 50% and raw material costs in a 25%, achieving the stated goal.

Material requirement planning (MRP), Supplies, Waste

Resumen

Se elaboró un sistema de planeación de la producción para una empresa productora de botanas, mediante el desarrollo de un sistema MRP con el objetivo de incrementar la producción actual y dar cumplimiento a la demanda. La metodología empleada fue Material Requirement Planning (MRP) que básicamente consiste en un sistema lógico capaz de gestionar y controlar la planeación de requerimientos de material con base al número de piezas, componentes y materiales necesarios para la manufactura, es decir, es un sistema de planeación de la producción. El resultado del proyecto ha sido una aplicación con funciones de un sistema de planeación de la producción MRP, con complementos como el balanceo de línea, presupuesto de materia prima, nivelado de la producción, entre otros. La aplicación cuenta con protección a la información y respaldo de la misma. La aplicación ejecutable de sistema MRP ha contribuido a reducir en un 50% el incumplimiento de la producción en la empresa, así como, reducir merma generada en un 40%, tiempos muertos en un 50% y gastos de materia prima en un 25%, logrando el objetivo planteado.

Planeación de Requerimientos de material (MRP), Insumos, Merma

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Introduction

Microenterprises in Mexico present a series of deficiencies derived from the lack of methodologies, techniques and tools that optimize the operation of their processes. Studies have been conducted where it was obtained that innovation, technology and strategic planning, are determining factors in their competitiveness (Hirsch, J., *et al*, 2015).

While it is true that there is software on the market that facilitates the planning and control of inputs and processes (Poma, J. M. R., Pernia, E. O., & Quiroz, J. P., 2014). , many of these companies do not have the economic capacity to acquire them and there is little clarity about the advantages that these can bring (Cisneros, M. A. I., *et al*, 2016). That is why, within the objectives of this work, a production planning system was developed for a Mexican microenterprise, dedicated to the elaboration of snacks, which does not have a planning and control system for raw materials that requires for the elaboration of your product. The foregoing causes non-compliance with the demand for input deficits or overproduction due to lack of planning.

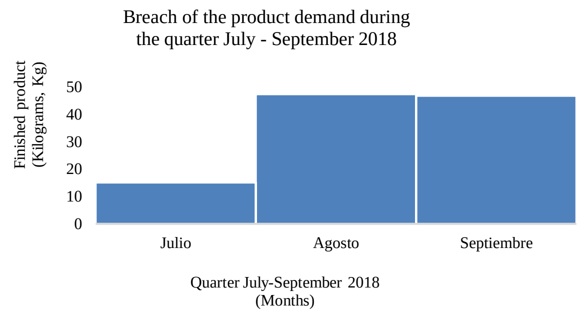
Among the advantages and disadvantages of the Planning of the Resources of the Company, the integration of supply chain, production and production process stand out, as well as its purchase is very expensive and its customization even more (Heizer, J. H. y Render, B., 2014). To address this problem, the methodology used was a Production Planning System, by its acronym known as MRP (Material Requirement Planning). Subsequently, as part of the objectives of this work, an application for Personal Computer and Tablet was developed based on the MRP and the specific requirements of the company, capable of determining the net demand of raw material, determining material costs, among other functions.

Methodology

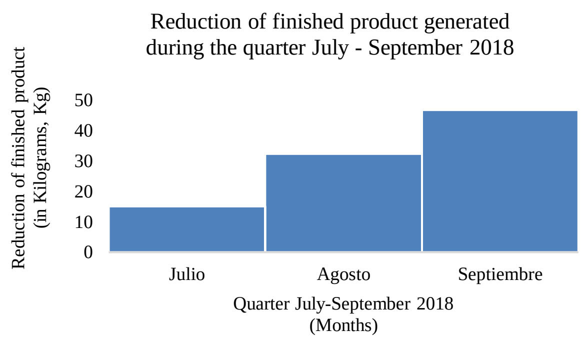
During the diagnostic phase of the present work, it was detected that the record of historical data that evidenced the aforementioned problem was lacking, therefore, it began with the acquisition of data and the following graphs of the indicators were prepared:

A. Breach of the demand product
B. Reduction of finished
C. Days not worked

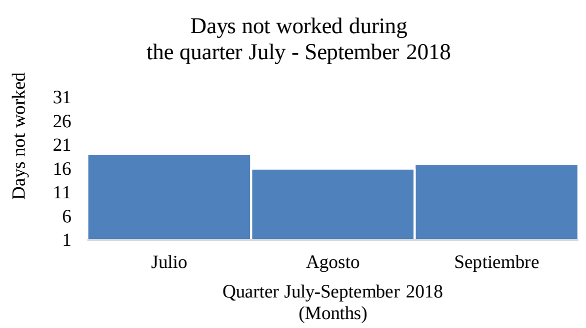
In Figures 1 and 2 there is an increase in non-compliance in demand and in losses in a quarter, respectively. Figure 3 shows more than 40% of unused working time.



Graphic 1 Breach of the demand for finished product in the quarter July - September 2018



Graphic 2 Waste of finished product in the quarter July - September 2018



Graphic 3 Days not worked in the quarter July - September 2018

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MRP General

MRP is a dependent demand technique that uses a structured list of materials, inventory, expected billing and a master production schedule to determine material requirements (Heizer, J. H. and Render, B., 2014). The MRP also provides a program to specify when these materials, parts and components must be produced or ordered..

MRP structure

The structure of a production planning system with the MRP methodology consists of different data obtained from different departments and simple formulas, Figure 1 shows the basic components of the structure of an MRP (Chase, RB, Jacobs, FR, Aquilano, NJ, 2018).

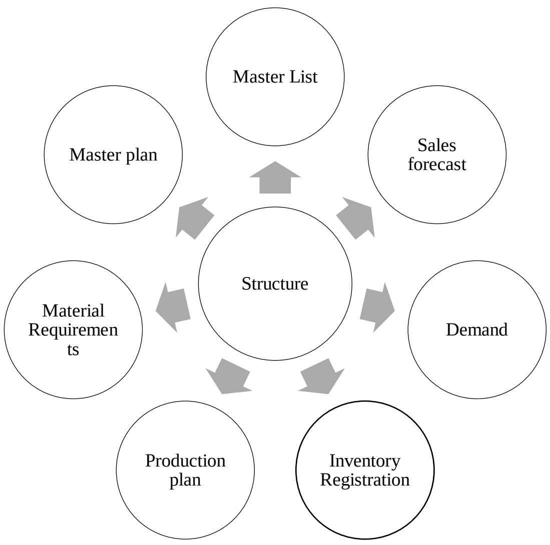

Figure 1 Main components of an MRP

Master list

It contains the complete description of the products and notes materials, parts and components, in addition to the sequence in which the products are made (Cuatrecasas Arbós, L., 2011). Indicates the components that enter a complete product unit (Hopeman, R. J., 2006).

Sales forecast

It is an estimate of short or medium-term sales, this, with the help of quantitative and qualitative sales forecasting methods.

Demand

Demand comes mainly from two sources. The first are known customers who make specific orders, such as those generated by sales staff. These orders usually have a promised delivery date. The second source is the forecasted demand, which covers independent demand orders. The demand of known customers and the forecasted demand combine and become the basis for the master production program.

In the case of the second source, demand is calculated from the sales forecast. For this, it is necessary to calculate the balance for each period (demand balance calculation) (Chase, R.B., Jacobs, F.R., Aquilano, N.J., 2018):

$$Balance_n = \text{Sales Forecast} - \text{Inventory} \quad (1)$$

Subsequently, the net demand or corrected plan in a period n is obtained as follows (demand calculation) in equation 2:

[illegible]

balance > zero (2)

Whereas, if there is excess of inventory, it is calculated as Corrected Balance of a period n (SC_n), as follows, as shown in equation 3:

$$SC_n = \text{Demand} + \text{Inventory} - \text{Sales Forecast} \quad (3)$$

Inventory Registration

The MRP program opens the status segment of the registry according to specific periods. These records are consulted as needed during program execution. Since, the MRP program performs its analysis of the product structure in descending order and calculates the needs level by level.

Computer-based systems for managing inventories and scheduling the delivery of raw materials and tools are called material requirements planning systems. The MRP is also considered as an inventory control method and involves keeping complete records (Kalpakjian, S., Schmid, S.R., 2014)

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Master Production Program (MPS) or production plan

Specify the exact quantities and production times of each finished item in a production system (Nahmias, S., 2014), establishing the net needs of the finished product, this, after considering the sales forecast, demand and coverage It gives production. The term coverage refers to the extra production of finished product in order to advance the production of the following period.

Material requirement

It lets you know the needs you have regarding the components of each product. Its obtaining is with a simple multiplication (requirement per period of time), which is shown in equation 4:

$$Request_n = Demand_n * \text{No. pieces in product} \quad (4)$$

The number of parts in product refers to how many equal components are used for a common product, that is, in the case of a car, four equal tires are needed.

In this way, for each quantity of finished products, it is possible to obtain the requirements by stages for each level (Chase, R.B., Jacobs, F.R., Aquilano, N.J., 2018).

Net needs

The volume of components or materials that will have to be obtained to dispose of gross needs at the end of a period (Cuatrecasas Arbós, L., 2011).

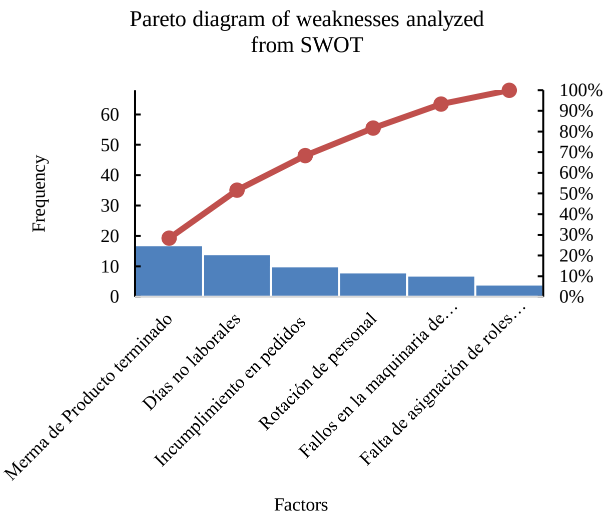
Master program

It is the net material requirement for the elaboration of different products in the short or medium term, in which the equal components of all the products are added, taking into consideration, the previous calculations of forecasts, inventories, demand and material requirements.

This mechanism enables the translation of actual and projected customer orders into specific production orders. (Chapman, S.N., 2006).

Pareto diagram of the i… compliance with producti…

A Pareto Diagram was made … data obtained from the … area (Graphic 4).



Graphic 4 Pareto diagram of the co… problems

The diagram allowed to … and the cumulative perce… and to identify that th… incidence were:

– Breach of orders.
– Days not worked.
– Final product decline…

These indicators are … company's production. Wh… orders constitutes the m… with 28%, worked days and the … final product, with an a… 16%, respectively.

Cause-Effect Diagram of the delay … compliance in company or…

Based on the previous i… Effect Diagram was made … the company's historica… records to determine the … affect the frequency (Figure …

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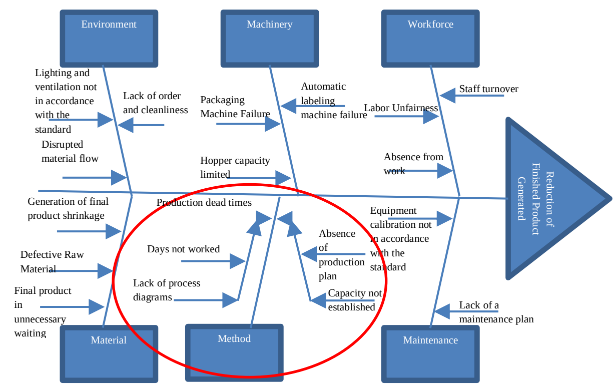


Figure 2 Cause-effect Diagram of non-compliance in production

From Figure 2, the lack of a production planning in the company is highlighted so, the proposal of this project will be based on offer an alternative solution to these incidents.

Preparation of a proposal for improvement to reduce delays and non compliance with orders and decrease downtime

Description of the snack production process

All the tasks that make up the company's snack production process were defined. Process that is roughly broken down below in Figure 3:

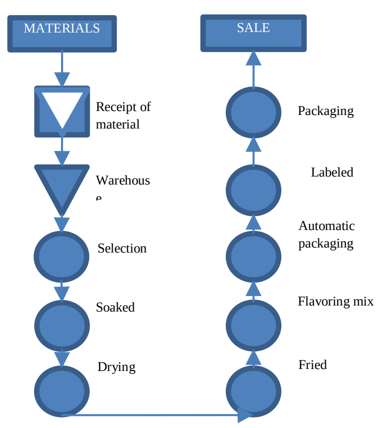


Figure 3 Process Flow Diagram of snack making

Selected from the raw material

Its objective is the separation of the seed from stones, soil, seeds in poor condition or any trash and, it is weighed again to obtain the actual weight of the selected raw material. After selecting the seed, the soaking task is performed.

Soaked

The purpose of soaking is to soften the seed to facilitate its separation and add components that allow conservation; In some cases, like peas, a portion of dye is also added.

Washed

After the task of soaking, the seed is washed, peeled and separated; in the case of the bean or peanut they are separated by halves.

Centrifuged

After soaking, washing, peeling and separating, it is centrifuged to dry the seed; in some cases, it is transported once dry to a cooler.

Fried

This process is used in most of the company's products, where the product is submerged in deep fryers with a capacity ranging from one hundred to one hundred fifty kilograms.

Seasoned or mixed flavors

Once the previous process has been completed, the seed is transported to a dragee drum where the relevant mixture of flavorings is added according to each product.

Automatic packaging

Once the seed is seasoned, it is transported to a packaging machine, where the seed is placed in a hopper. The team distributes the product in proportions of similar weight and packages it.

Labeled

During the labeling process, each of the packaging is inspected verifying that it meets the company's quality standards, that is, that the envelope is not broken, that each bag has the right amount of product and that the expiration date it is not printed in any incorrect section of the packaging, once the envelopes have been inspected, each one is stamped.

Packaging

Finally, the finished product is packaged in boxes of two hundred units, then transported to the warehouse of finished product and delivered to the customer.

Flowchart of the botanical production process

After knowing each of the tasks of the process, as well as, routes and distances for the preparation of snacks, a Process Flow Diagram was made. The diagram gathers important information about the process of making snacks, such as operations, inspections, transport, delay, storage, distances traveled in transport, times, among other information. This information was obtained from the company's historical records.

In Figure 4, the summary chart of the Process Flow Diagram is highlighted, which provides information to the MRP system.

Summary			
	Number	**Time**	**Distance (Meters)**
Operations	10	11.56.00	123.5
Transportation	10	01.59.07	
Inspections	2	00.20.00	
Delays	2	Indeterminate	
Storage	1	00.10.00	
Total	25	14.25.07	

Figure 4 Summary of the flowchart of micro enterprise processes

Snack production process information flowchart

Based on the tasks of developing snacks and the Process Flow Diagram, an Information Flow Diagram was prepared, which is shown in Figure 5:

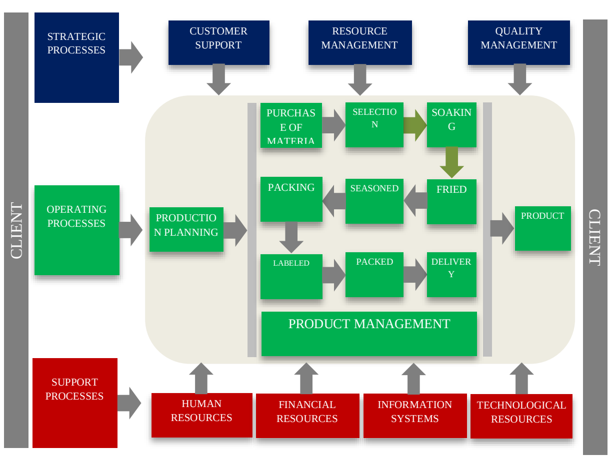


Figure 5 Diagram of Information Flow of the micro enterprise. Oct. 2018

Figure 5 highlights the Support Processes, Strategic Processes and Logistics items, which contribute to the flow and establishment of information sources for the preparation of the MRP.

As well as a value added diagram (Value Stream Mapping, VSP), which is shown in Figure 6:

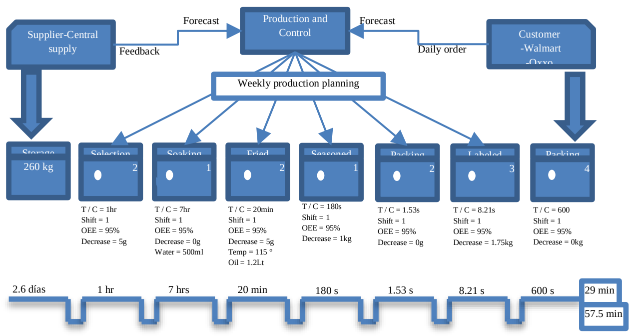


Figure 6 Value-added diagram of the process snack making Oct. 2018

Master list for snack production

The master list that was made (also called catalog) contains all the products and components of each of them (See Figure 7):

Catalogue											
Code	**Description**	**Level**	**Description**	**Quantity**	**Unity**	**Inventory**	**Coverage**	**Tam Lot**	**Expiration (Months)**	**Cost**
1	Roasted Peanut with Lemon	PT	With lemon	1	Kg	20	0	1	6	$ 34.00
2	Spicy peanut	PT	Spicy	1	Kg	0	0	1	6	$ 33.00
7	Lentils with lemon	PT	With lemon	1	Kg	0	0	1	6	$ 55.44
8	Chipotle Lentils	PT	With chipotle	1	Kg	0	0	1	6	$ 60.00
11	Chicharitos with lemon	PT	With lemon	1	Kg	0	0	1	6	$ 96.00
12	Chicharitos with chipotle	PT	With chipotle	1	Kg	0	0	1	6	$ 110.00
13	Salt maicitos	PT	With salt	1	Kg	0	0	1	11	$ 115.00
14	Maicitos Chile	PT	With Chile	1	Kg	0	0	1	11	$ 124.00
15	Peas with lemon	PT	With lemon	1	Kg	0	0	1	6	$ 53.04
16	Chipotle teddies	PT	With chipotle	1	Kg	0	0	1	6	$ 45.00
17	Spanish peanut with lemon	PT	With lemon	1	Kg	0	0	1	6	$ 45.00

Figure 7 Master list or catalog. O

It has the items of Mother Code, Level, Unit and Price of the master list. The mother code is the finished product code, which has a number between one and fifty-seven. The unit and manufacturing price of the products are also mentioned.

The master list contains a record of the inventory and coverage of the company, which specifies the quantity of finished products currently available.

The master list sends information to the inventory MRP, coverage level, product composition and product units.

Product levels called snack

In the product levels, the finished products in their components have been separated with their respective quantity in kilograms used to produce a kilogram of finished product, which is presented in Figure 8:

Son Code	Product name	Mother code	Code Description	TIME	Quantity	Unity
A101	Roasted Peanut with Lemon	1	Peanut Halves	0	0.980	Kg
A102	Roasted Peanut with Lemon	1	Lemon mix	0	0.020	Kg
A101	Spicy peanut	2	Peanut Halves	0	0.963	Kg
A103	Spicy peanut	2	Chipotle mix	0	0.015	Kg
A102	Spicy peanut	2	Lemon mix	0	0.007	Kg
A104	Spicy peanut	2	Chile Wide	0	0.015	Kg
A105	Lentils with lemon	7	Lentils	0	0.978	Kg
A102	Lentils with lemon	7	Lemon mix	0	0.022	Kg
A105	Chipotle Lentils	8	Lentils	0	0.963	Kg
A103	Chipotle Lentils	8	Chipotle mix	0	0.047	Kg
A106	Chicharitos with lemon	11	Chicharitos	0	0.978	Kg

Figure 8 First level product level. 20/2018

In the second level as seen in Figure 9, the components of the first level mixtures are shown. For example, it is highlighted that 0.012 kilograms of salt, 0.001 kilograms of citric acid and 0.007 kilograms of dried dehydrated lemon juice are needed to make 0.02 kilograms of lemon mixture.

Mother Code	Son Code	Son Component	Nieto Code	Nieto component	Quantity	Unity
1	A102	Lemon mix	A160	Salt	0.012	Kg
1	A102	Lemon mix	B102	Citric acid	0.001	Kg
1	A102	Lemon mix	B103	Dehydrated Lemon Juice	0.007	Kg
2	A103	Chipotle mix	B104	Chipotle pepper	0.007	Kg
2	A103	Chipotle mix	A104	Chile Wide	0.004	Kg
2	A103	Chipotle mix	B106	Tree chili	0.002	Kg
2	A102	Lemon mix	A160	Salt	0.006	Kg
2	A102	Lemon mix	B103	Dehydrated Lemon Juice	0.003	Kg
2	A102	Lemon mix	B102	Citric acid	0.001	Kg

Figure 9 Product level to second level Oct 2018

The levels are directly related to the master list and it is precisely how the necessary proportions of each component are obtained to meet the demand for the final product.

Materials requirement for snack production

The division of the finished product in levels one and two sends information on the quantity of ra[w] material to obtain a specific final product to material requirement sheet.

The material requirement basically multiplies the amount of raw material necessary to produce a product by the total demand of th[e] finished product. Considering that the product range is wide, the system searches and adds th[e] raw material in common that some products have.

In Figure 10, part requirement calculation ob[...] addition the raw material week de[...] product is highlighted. T[...] was made both for the fi[...] the respective levels of [...]

Mother Code	Son Cod	Descript	Quant	Unit	Specifi	Week	Week
1	A10	Peanut H	0.98	Kg	98%	0.00	0.00
1	A10	Lemon mi	0.02	Kg	2%	0.00	0.00
2	A10	Peanut H	0.96	Kg	96%	0.00	0.00
2	A10	Chipotle	0.01	Kg	2%	0.00	0.00
2	A10	Lemon mi	0.00	Kg	1%	0.00	0.00
2	A10	Chile Wi	0.01	Kg	2%	0.00	0.00
7	A10	Lentils	0.97	Kg	98%	0.00	0.00
7	A10	Lemon mi	0.02	Kg	2%	0.00	0.00

Figure 10 Requirement master section file 2018

Leveling of snack produc[...]

As a complement to the [...] system, a production lev[...] that is, that the leaf d[...] the snack proportionally [...] weeks.

Level		WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8
	Plan	138	138	138	138	138	138	138	138
	Balan	-63	-125	-188	-250	-313	-375	-438	-400
	Cob	-0.3	-0.6	-0.9	-1.2	-1.5	-1.8	-4.3	-4.0

Figure 11 Production leveling

Figure 11 shows the leveling of [...] production of a product [...] the plan indicates the q[...] each week to level the pr[...] made to reduce days and [...] production to be distrib[...]

Creation of executable file in Excel and Visual Basic

After completing the [...] version) of the MRP, it [...] ability to perform autom[...] the editable mode or Ex[...] used, with which the ne[...] application were develop[...]

This executable file [...] same way to protect the i[...] the source code and as [...] avoid modifications.

The objective of programming in Visual Basic is to add an interface that allows to protect the information that the system has, for this, a UserForm1 was added in Visual Basic, where two TextBox and two CommandButton were added.

The UserForm is a customizable user interface in Visual Basic, in the UserForm the forms or objects that allow access to information for the program to provide a response or output are attached. As shown in Figure 12, VisualBasic shows the UserForm and the attached tab of the items that can be added.

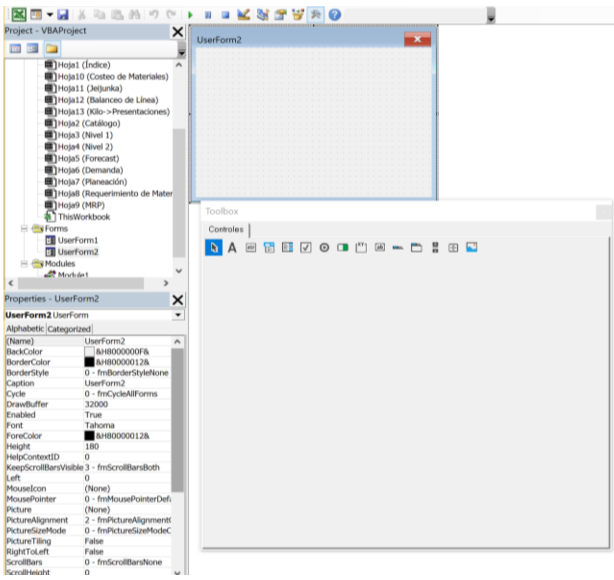


Figure 12 UserForm in Visual Basic. Oct. 2018

TextBox allows the user to enter the access information, such as username and password. The CommandButtons allow to enter the information typed in the TextBox, or to exit the generated interface of the program. Figure 13 shows the basic form of the interface with the elements already mentioned.

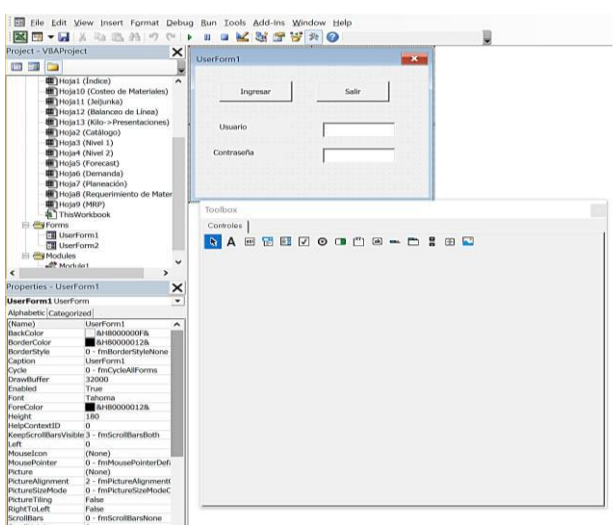


Figure 13 UserForm (basic interface elements) Oct. 2018

After adding the elements to the UserForm, each of the elements was programmed, in the Visual Basic Code tab, as shown in Figure 14, the code only seeks to give instructions to the elements that were attached to the UserForm.

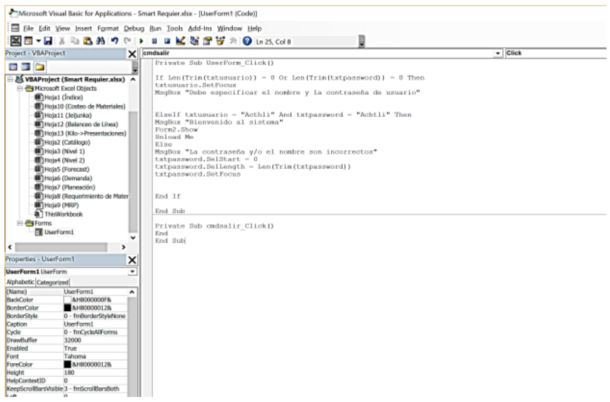


Figure 14 UserForm with basic interface code. 2018

Training of Production Area personnel to use the MRP application

In order to introduce the personnel in the use of the program, training was carried out in the Production Area of the company, where each of the components of the MRP system was explained, but not before introducing the analysis tools used to assess the situation of the company. Their recommendations were taken, thus raising countermeasures to avoid recurrence in the Production Area of the shortcomings found. Subsequently, he trained on the use and handling of the application.

Results

The system that was developed consists of multiple spreadsheets, which, aim to gather information from the different departments, so that production control is kept.

As can be seen in Figure 10, the proposed system has the inter-catalog sections (total products and components), product levels (components), forecast and demand, material requirements, MRP, line balancing, production leveling and cost of materials. In addition, the application can run without an internet connection.

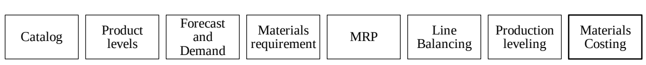
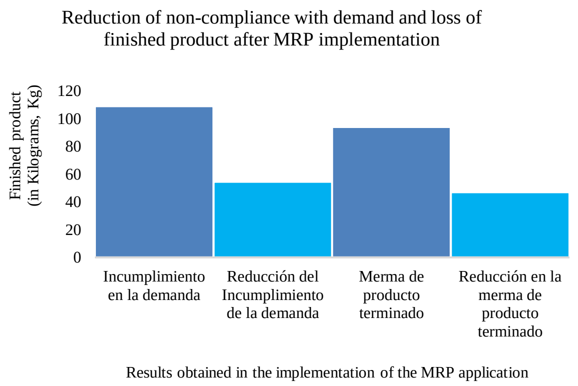


Figure 15 Content of MRP production. Nov. 2018

Graphic 5 shows the results of the test, in which a 50% compliance with demand and the reduction of product was obtained. Considering the above, it is expected the implementation of the system in full these results.



Graphic 5 Expected reduction of non-compliance with demand and decrease in November 2018

Smart Requirer application in Visual Basic

The executable application created as a result of the process carried out in the microenterprise has the name of Smart Requirer. This application allows users to obtain the data provided by the spreadsheet based on Excel, but prevents them from seeing the formulas used or modifying them, thus protecting the functionality of the system.

Another feature of Smart Requirerer is that the application has a user control to restrict the access of unauthorized personnel to the application, as shown in Figure 13:

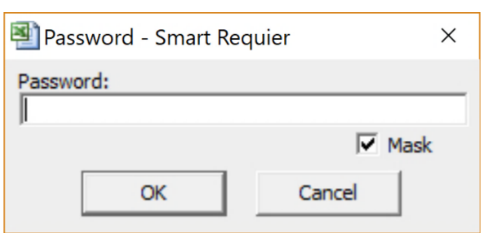


Figure 16 Password requested from Smart Requirer. Nov. 2018

Conclusions

The production planning system with the MRP methodology carried out is expected to reduce 50% of the production default. Although the implementation is in process, it is estimated that in a period of three months it will be achieved one hundred percent, currently the staff is trained and the approval was issued by the company verifying the advantages and achievements of the system.

It is worth mentioning that a possible obstacle to implementation would depend on the times of the company in relation to the fulfillment of its demand.

The conversion into an executable file of the system successfully connected different areas of the company, creating a database that will support its functionality. As well as, support in the planning and fulfillment of the demand of the product.

With the present work, it is intended to make available to small businesses tools in the area of industrial engineering and information technologies, as well as make a scientific contribution from them.

Suggestions

It is suggested to complete the implementation of the system one hundred percent, as well as to replicate in other areas.

For future work, it is suggested to expand research on the use and implementation of industrial engineering methodologies and tools that foster the development and competitiveness of small businesses, innovating processes and technologies.

Acknowledgement

To the Polytechnic University of the State of Morelos and to the snack manufacturing company, for the facilities granted during the realization of this project.

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Manufacture of an automated prototype for corn tortilla cooking

Manufactura de un prototipo automatizado para la cocción de tortilla de maiz

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Resumen

En el presente trabajo de la manufactura de un prototipo automatizado para la cocción para la tortilla de maíz, que es una base de alimentación principalmente de la cocina mexicana, en donde el proceso elaboración se realiza manualmente de manera artesanal por personas que prensan la masa para formar la tortilla la ponen en el comal y durante el proceso de cocción son volteadas de forma manual y utilizando un promedio de 3 tiempo. Por lo tanto, el objetivo fue realizar un prototipo de tres comales giratorios para la cocción de tortilla artesanal para automatizar el proceso de volteado y cocción de la tortilla para la transformación de la materia prima (masa). con el cual se puede programar la temperatura en un rango de 240°C-260°C con gas LP, sin que las personas tengan que voltear la tortilla y de esta forma utilizar menor tiempo y obtener más producción y solo una persona opera los quemadores, pero también se tiene un gran ahorro en el consumo de gas. Para realizar la manufactura y automatización se utilizaron tres disciplinas importantes de la carrera de mecatrónica las cuales son: mecánica, electrónica e informática. Coadyuvando en el proceso del mismo.

Automatización, Manufactura, Sistema

Abstract

In the present work of the manufacture of an automated prototype for cooking for corn tortillas, which is a food base mainly for Mexican cuisine, where the elaboration process is done manually by hand by people who press the dough to form the tortilla put on the griddle and during the cooking process they are turned manually and using an average of 3 times. Therefore, the objective was to make a prototype of three rotating comals for the cooking of handmade tortillas to automate the process of turning and cooking the tortilla for the transformation of the raw material (dough). with which the temperature can be programmed in a range of 240 ° C-260 ° C with LP gas, without people having to turn the tortilla and thus use less time and obtain more production and only one person operates the burners, but you also have great savings in gas consumption. To carry out manufacturing and automation, three important disciplines of the mechatronics career were used, which are: mechanical, electronic and computer science. Helping in its process.

Automátion, Manufacture, System

Citation: GONZÁLEZ-MONZON, Ana Lilia, PIÑA-ALCANTARA, Henry Christopher and RUEDA-MEDINA, Israel. Manufacture of an automated prototype for corn tortilla cooking. Rinoe Journal-Industrial Organization. 2019. 3-5: 18-23

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Introduction

Since historic times the corn tortilla in Mexican cuisine is a very important food base, in the State of Mexico in the municipality of Soyaniquilpan it still has the so-called tortillerías de comal (Calderón, A. E. 2019). As a raw material, the base is the mass of nixtamal where it is transformed by means of a press or totally by hand, its cooking is by means of a comal either with firewood or with LP gas. This process is called artisanal. With the manufacture of an automated prototype for cooking corn tortillas, the process helps to be more effective in its productivity.

Within the contents of this work, systems, automation and manufacturing are the first part of the background as the basis for technological innovation and development of the project's generalities. The second part is where he describes the livelihood of the work that includes software and hardware with the Arduino electronic platform (Reyes 2016). In the third part, the methodology used for the design and manufacture of the prototype for cooking the tortilla, which subsequently describes the steps to follow for the construction process. In the fourth part as final, there is the operation and testing of the automated machine for cooking the handmade corn tortilla, as the fifth and final conclusions of the results obtained from the prototype.

Systems

These are the computer ... it
possible to execute s... n a
computer. For example, operati...
applications, web brow... ams
such as Word, Excel
Solidworks, Arduino. T... ys
work hand in hand. Whil... ides
the operations, the ha... ical
channel through which this fu...
performed

Automatization

Industrial automation, considered as the management of information in companies for decision making in real time, incorporates computer science and automated control for the autonomous execution and optimally of processes designed according to engineering criteria and in line with the business management plans (DNP, Colciencias. Strategic Plan of the National Program for Industrial Technological Development and Quality, 2000-2010).

Human logical procedures are entrusted to automated machines which process information much faster than man, with the help of mathematical models that describe both the technology itself and the human analytical and regulatory activity. It is the presence of automatic management systems in technological processes that ensure its optimization without the direct intervention of man. Production thus acquires the appearance of an automatic cycle that can be quickly and efficiently restructured.

Manufacture

A manufacturing is an inc...
transformation of raw materials into...
finished product that is ...
be sold, that is, it is ...
market, in the distribut...
in charge of the area of...
word is linked to the cause...
precisely in the most rem...
was produced by manual
hands. (Miranda 2018).

Arduino electronic platform

Arduino is an open source electronics creation platform, which is based on free, flexible and easy-to-use hardware and software for creators and developers. This platform allows to create different types of microcomputers of a single plate to which the creator community can give them different types of use. (Reyes 2016).

Figure 1 Arduino

Methodology

As part of the knowledge necessary to manage the activities associated with development, a methodology was applied to achieve the ideal project time.

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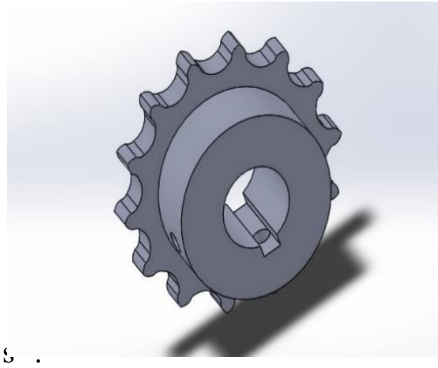
It consists of four phases



- Preliminary, which all ... the necessary information ... design framework.
- Basic design, analysis ... ion
- Prototype manufactur... construction
- Programming controlled ... o with secondary elements.

Figure 3 Mesh

The method is to determine the physics equations that model the kinematic structure behavior. Once the kinematics model is obtained, it is evaluated in simulation in order to ensure its definition. In this way, the kinematic parameters are evaluated and by computer simulation. The next step of this methodology is to design and build the systems. In this part, it is usually possible to perform the control design.

Mechanical design

The design of the final fall of the tortilla will be coupled to the third lower comal where it has the functionality to have the fall, to accommodate them and to be able to remove them without any problem of disassembling it to carry out the looting to weigh it and make the sale and thus avoid more work for the personnel that will be working for the operation of the machine see (figure 2).

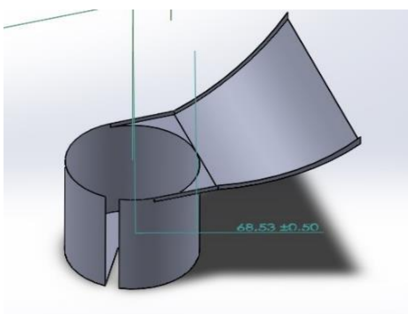


Figure 2 Caída de tortillas

In the transmission of force, the smaller gear wheel was contemplated, which is consistent with the larger gear wheel, where how many teeth the smaller gear wheel related to the revolutions of the reduction motor were calculated. (see figure 3).

To draw the relationships of how long it takes to make a 360 ° turn as shown in the following formula see (table 1).

Piñón 14	28
vueltas_____________1 min	
28 vueltas______________60s	
Engrane 74	۰ ۶ / ۴ ي πȣ φ
۲ ٥ / ۲ ۵ πȸ ψ ωᶻ χπȣ φ	

Table 1 Formula

The design of the four lower bars to support the weight of all the components and have greater stability where 4 are seen in the lower part and 4 in the upper part. Upper and lower bars with averages of length 86 cm, width of 5 cm and 7.6 cm high where 4 were used for the top and 4 at the bottom to have greater stability in the structure and strength. The four bottom bars to support the weight of all the components and have greater stability where 4 are seen at the bottom and 4 at the top. See (figure 4).

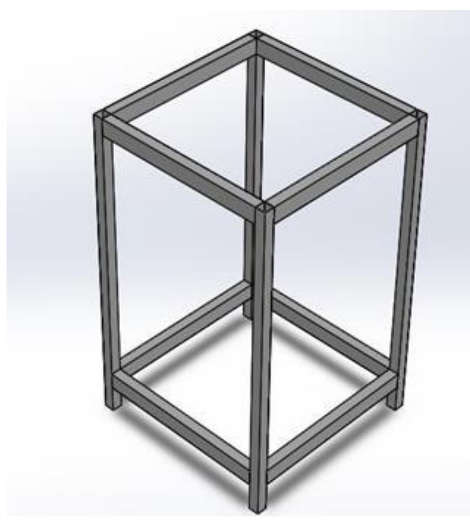


Figure 4 Barras inferiores

In the lower and upper, the support bars for the bearing blocks were assembled to load the entire weight of the hooks and the comals where you will have the freedom to rotate 360 °. See (figure 4).

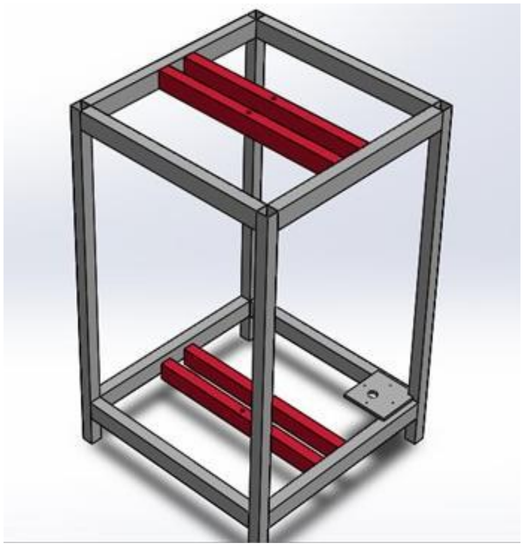


Figure 5 Barras superiores

For the rotation of the arrow, load bearings were assembled to support what the comals are and for the translation wheels were assembled for ease of movement.

The circular burners under each grid for the temperature of the tortillas placing one burner for each grid considering the space between each grid. See (figure 6).

Figure 6 Prototype

Control Design

Chain drive

The main mission of cargo chains is to transmit high levels of effort. For this, the gear system was used due to having a larger section resistant than the normal transmission chains by the gearmotor and avoiding oscillations between the transmission system for them a gearing of 74 teeth was used a diametral passage 40 where it was assembled in the bottom of the arrow and the structure.

Gearmotor

Direct current gearmotor of 150 volts of 1/8 HP with 28 revolutions per minute was used. An electric motor has a certain power in HP and has a certain operating speed at which the output arrow rotates, for example 1800 Revolutions per Minute (RPM). These two characteristics: Speed and Power have a certain "torque" or "torque" that the engine can release. It is precisely the "pair" that will allow us to rotate a certain load or not, the higher the "pair" the larger the load we can rotate. How fast we can do it will depend on the power of the gearmotor. The two characteristics are interrelated and depend on each other.

Figure 7 Motorreductor

Volt relays

A relay is a switch that can be activated by an electrical signal. In its simplest version it is a small electro-magnet that, when excited, moves the position of an electrical contact from connected to disconnected or vice versa. (Administer 2015).

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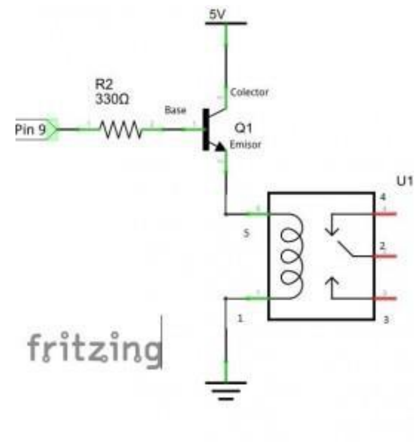

Figure 8 Circuito relevador

Thermometers

The K thermocouple temperature sensors with Max6675 model that are easy to use for programming, which were placed in the first comal to verify the temperature if it is correct for cooking the tortilla which to be displayed on an LCD screen.

First, the objective of this practice is to verify the functionality of the pressure sensor. The force becomes a change of resistance, as a result we vary the intensity of an LED. This intensity is identified in the pressure in the sensor

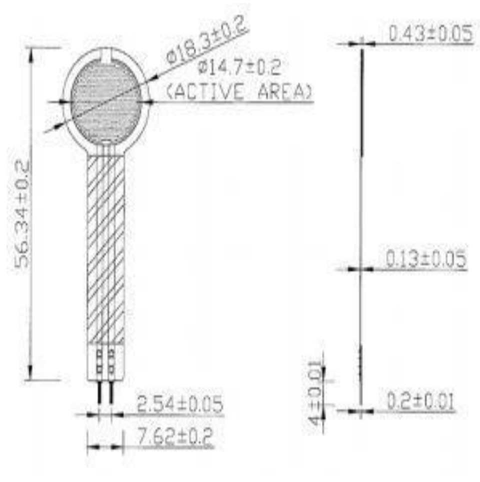

Figure 9 Características sensor MF01

Programming

In the programming stage the arduino MEGA was used for its versatility and ease of programming the machine, it is a free-use platform in terms of software and hardware. The relay code to execute in the arduino program is shown to be able to control the gearmotor and that is done through steps to complete the cooking of the corn tortilla.

Code

int relay=0;
void setup () {
// put your setup code here, to run once:
pinMode(relay,OUTPUT);
}
void loop() {
// put your main code here, to run repeatedly:
digitalWrite(relay,1);
delay(3000);
digitalWrite(relay,0);
delay(1000);

Table 2 Arduino code gearmotor control

Results

The foregoing meets the objective of facilitating the process of making corn tortillas by hand, with the manufacture of the prototype with the function of the mechanical and electrical where it turns mechanically for cooking and thus repeats turn two times to finish the process of cooking the tortilla, by means of an arduino it was programmed together with a thermocouple that has the function of detecting the temperature of the comals to establish in a range of 240 ° C- 260 ° C, shown in a display also with an infrared sensor to count along with the electric force floor sensor that will send the reading when in the basket weighing a kilo and how many pieces are, in the same way how many are made per hour. automation according to the above results in time savings, increased production, savings as gas L.P. and also avoid burn accidents in tortillas. (see image 2).

Figure 10 Prototype

Conclusions

The importance of this prototype contribute to the integration of the different areas by integrating the interdisciplinarity of the mechatronic career, (Mechanics, Electronics, and Computer Science), since they are an important part for the development of the functional prototype to offer competitiveness in the tortilla industry , handmade since it is not a market very often in the field of automation, so it is important to venture into the development of this product.

Considering that it is a high-consumption food in Mexico, this is why with the manufacture of the arduino control rotary grid that uses different sensors and devices that programmed throw the temperature control and by means of a thermocouple the kilos produced and activation automation of turning, without leaving aside the energetic used as it is the LP gas that today has a high cost so that its consumption was reduced in great quantity, without leaving aside the workforce the risks and the load of work

Therefore, an automated comal for any type of business dedicated to artisanal tortillas has the benefit of energy savings, greater productivity and lower accident rates.

Acknowledgments

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Technological level of the Aerospace Industry of Ensenada, B.C. in its manufacturing processes

Nivel tecnológico de la Industria Aeroespacial de Ensenada, B.C. en sus procesos de manufactura

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Resumen

El presente proyecto se realizó con la finalidad caracterizar el nivel tecnológico de la industria aeroespacial de Ensenada, B.C. México., en sus procesos de manufactura para establecer áreas de oportunidad y determinar su impacto en la competitividad. Se llevó a cabo una investigación cuantitativa, de tipo descriptivo para establecer el nivel de automatización, los cuales se aplicaron en encuestas directas en visitas industriales (Ovalle, et al., 2013). Se entrevistaron siete empresas en donde se determinó sus diferentes estrategias para la compra de nuevas tecnologías, incluida la automatización. Se identificó que las empresas adquieren la nueva tecnología a través de proveedores previamente seleccionados y en algunos casos cotizando a nuevos proveedores. La vigilancia tecnológica se realiza preferentemente en catálogos o con la visita de proveedores; también por recomendaciones de los clientes, o visitando ferias o misiones tecnológicas. Se registró que algunas empresas cuentan con la asesoría de centros de investigación y que seleccionan la nueva tecnología mediante los criterios de estandarización y adaptabilidad al proceso, seguido de precio y marca. Los mayores niveles de automatización se registraron en la comunicación, seguido de la etapa de proceso de producción, y la del abastecimiento de materiales.

Aeroespacial, Automatización, Competitividad

Abstract

The present project was carried out with the purpose of characterizing the technological level of the aerospace industry of Ensenada, B.C. Mexico., In its manufacturing processes to establish areas of opportunity and determine its impact on competitiveness. A quantitative, descriptive research was carried out to establish the level of automation, which was applied in direct surveys in industrial visits (Ovalle, et al., 2013). Seven companies were interviewed where it was determined that they have different strategies for the purchase of new technologies, including automation. It was identified that companies acquire the new technology through previously selected suppliers and in some cases quoting new suppliers. Technological surveillance is preferably carried out in catalogs or with the visit of suppliers; also by customer recommendations, or visiting fairs or technology missions. It was recorded that some companies have the advice of research centers and that they select the new technology through the criteria of standardization and adaptability to the process, followed by price and brand. The highest levels of automation were recorded in the communication, production process and the stages of supply of materials.

Aerospace, Automation, Competitiveness

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Introduction

The development of the Aerospace Industry in Baja California originated mainly with manufacturing activities. What has generated and maintained a base of more than 200 companies that respond to the requirements of high quality standards and regulatory compliance at the international level. Participating in six segments that are: commercial aviation, defense, space, drones, MRO / R & O and logistics charge. The same group of companies, from large firms, as well as small and medium-sized subcontractors that have the capacity to manufacture custom production orders (Sibaja, 2019). The city of Tijuana stands out with 49% of operations, followed by Mexicali with 34% and the rest is distributed in the municipalities of Ensenada, Tecate and Rosarito.

In the municipality of Ensenada, B.C. 7 companies in the aeronautical sector have been identified, and it has been reported that they have been established in the area for 7 to 15 years. 71.42% are classified as small businesses and 28.57% as medium businesses. In its administration system for decision-making for competitiveness, it can be through a board of directors, legal representative, or general manager and in some cases, they depend on the corporate in U.S.A.

The sector in the municipality offers employment to more than 851 workers, where the highest percentage are women (55.4%). The sector has an outstanding industrial and productive capacity in a wide portfolio of product lines such as rubber seals and molded parts, thermoacoustic solutions, design and manufacture of machinery and tools according to the requirements of international clients (Mandujano et al., 2019).

For the industry in general and for the aerospace sector, the use of technology is necessary to streamline the production process, since they are directly related to productivity and competitiveness. Same that depends on the processes of each company and its products. The technological environment includes the production process, the administrative process, the organization, the procedures, the training of the personnel, and the information (Arias, 1999).

The technological level refers to the degree of automation, which the company has, and it is defined how automated the process is according to the use of machines that follow a predetermined order of operations with little or no labor.

Due to the above, an investigation was carried out in the aerospace companies in the municipality of Ensenada, B.C. to determine the technological level and establish the areas of opportunity that allow to create a synergy between the companies and the academy, to carry out joint work that allows to generate greater productivity and competitiveness in the municipality.

Technological environment

For the industry in general and for the aerospace sector, the use of technology is necessary to streamline the production process as part of productivity and competitiveness. In the technological environment, production processes, administrative processes, organization, procedures, personnel training and information are considered (Arias, 1999).

Another important aspect to consider is the technological surveillance that refers to observing how the technological, economic, social, commercial environment is developing, which allows the company to be updated and prepared for the probable changes, and thus, anticipate the changes for the Decision making in time to reduce risks. It also refers to the search for new technologies that give value to the process.

Business-academy link

For innovation and competitiveness, companies need to have information and knowledge that can be generated internally or by linking with universities or research institutes (Tether, 2002). With this link, the benefit of the acquisition and assimilation of new knowledge, technological development, and the increase in the level of skills and abilities of human and social capital is generated. The link with the academy promotes a good innovation system for technological change, increased competitiveness and economic growth (Maqueda, 2006).

Automation levels

Automation is defined as the process in which machines follow a predetermined order of operations with little or no labor, using specialized equipment and devices that execute and control manufacturing processes. This is achieved using various devices, sensors, actuators, techniques and equipment capable of observing and controlling all aspects of the manufacturing process (Kalpakjin and Prentice, 2002). The levels of process automation can be varied and are derived from the company's own characteristics, which are generally of an economic and technological nature.

The levels of automation are related to a degree of less human intervention in the process, which is replaced by automated machines. The greater the use of machinery, the greater the degree of automation and vice versa. In manufacturing, automation is implemented from raw material supply, assembly, packaging, packaging, storage and logistics. Also included are the Control and supervision operation, information recording and communication processes.

Methodology

A quantitative, descriptive research focused on manufacturing companies in the aerospace sector in Ensenada, B.C. The methodological instruments that were used are those described by Ovalle et al (2013), which were applied, through direct surveys in visits to companies. Seven companies were selected directly according to their availability for the study; The information was provided by personnel at the managerial level, designated by the company itself, who had extensive knowledge of the processes and administration of the same.

The surveys were focused to determine the strategies with which the purchase of new technologies is decided and how technological surveillance is carried out. Also to identify if there is any kind of link with academic institutions or research centers and to establish the levels of automation they present in communication, material supply and in the production process.

Results

Acquisition of new technologies

Of the seven companies, it was identified that decisions for the purchase of new technology, including automation, are carried out through the legal representative (28.57%) or the board of directors 28.57%, followed by the corporate (14.29%) . While the operations management and maintenance area are not considered for the acquisition of new technologies. It was established that the purchase process is preferably carried out through previous suppliers (71.43%), followed by bidding (14.29%), and new suppliers (14.29%).

Of the companies interviewed, 71.43% had automation projects under development, while 28% were not carrying them out at that time. Of the companies with automation projects, 57.14% of the projects focused on the production process and 14.29% on the supply stage. The preference of the total of the companies with respect to the different options of access to the information for the technological surveillance was evaluated. It was found that 71.43% resort to the internet, 57.14% participate in fairs and technological missions, 42.86% consider catalogs or the visit of suppliers, 28.57% resort to research centers or technology transfer and 14.29% it takes into account customer information, while none considers patents.

From participation in technology fairs, four companies attend at least one of the exhibitions held in Los Angeles, CA., or in Houston, Texas., Or in Las Vegas, Nevada. and only one company mentioned that they participate in a fair that takes place in Paris, France.

On the other hand, of the two companies that do not participate in the mentioned fairs; The staff of one of them attends a conference in the USA organized by its corporate. While the staff of the other company, only attends fairs that are held nationwide in Tijuana, Mexicali and Guadalajara, Mexico. It also indicates that a company does not participate in any fair.

Linking with the Academic sector

Three companies were registered that carry out business-academy linkage for the development of technological projects such as TECNM / I.T.Ensenada, a center in Tijuana or CICESE. On the other hand, a company has its own research center in the corporate USA, and three companies reported that they have no connection with the academy. It was registered that all the companies participate in the programs of professional residences or professional practices for which they receive students from the different academic institutions of the Municipality of Ensenada.

As for the main criteria for the renewal or acquisition of technology, they are indicated in order of importance for the companies, which are: the standardization and adaptability of the process, the guarantee of the machinery, the price, the technical specifications and the scheme of maintenance and / or spare parts, and the brand.

With respect to the aspects that companies take into account for the renewal or acquisition of technology, the production capacity stands out first, followed by the obsolescence of machinery and to a lesser extent flexibility, organizational policy, requests for Customers and quality. With the exception of the organizational policy that is not considered, all aspects were mentioned at least once as important.

The aspects that companies take into account for the automation of their processes, are listed according to the order of importance determined: 1) the increase in production quality, 2) quality, 3) new products, 4) technological modernization, 5) competitive strategy, and 6) process flexibility.

Of the aspects in general that the company knows about its main competitors at national and international level, customers stand out. While the market, processes, products, suppliers and especially technology, factors of importance to companies are not highlighted. Regarding the age range of the machines that are used by the companies, it was determined that 3 companies have 100% - 80% of their machinery in a range of 0 to 5 years.

In another company, 90% of the machinery is in a range between 6 and 10 years, two other companies 60-80% of its machinery is in the range of 11 to 20 years and only one company has 33% of its machinery with more than 20 years.

Automation levels in the production lines

The level of automation was evaluated the production lines called: 1) control and supervision, 2) operational-process, 3) communication, focused on the areas of the process for 1) supply of materials, 2) production process, 3) warehouse and 4) dispatch logistics.

Control and supervisión

For the automation focused on the supply of materials and the productive process, a respective general score was obtained in the seven companies of 50%, which implies that supervision uses equipment and tools for the control type (ON-OFF). For the area of packaging and packaging, Warehousing and Logistics dispatch was determined that they do not have automation.

Process-operation

The automation focused on the supply of materials, indicates that 25% of the operator uses equipment and tools to perform the operations. While for the Production-Process, it is recorded that it is 50%, which implies that the supervisor uses equipment and tools for the control type (ON-OFF). For the area of packaging and packaging, Warehousing and Logistics dispatch it was determined that there is 50% automation for each area, and equipment and tools are used for control type (ON-OFF).

Comunication

The automation in communication, in the area of material supply, obtained 50%, which implies that supervisor uses equipment and tools for the control type (ON-OFF). While for the production process, packing and packaging, storage, and logistics of dispatch was 75%, which indicates that these three areas, operators operate advanced controllers to perform their work. Therefore, it was found that in the area of communication there is the greatest use of automation, followed by the production process and the supply of materials.

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Conclusions

Of the seven companies that were evaluated, it was identified that, for decisions on the purchase of new technology, including automation, they are carried out through the legal representative and the board of directors. Without operations management and maintenance area being considered. The purchase process is preferably carried out through previous suppliers.

71.43% companies interviewed carry out automation projects focused on the production process and the supply stage. For technological surveillance, companies turn to the internet, participate in fairs and technological missions. Consider the catalogs or the visit of the suppliers, and 28.57% resort to research centers or technology transfer. Only 14.29% take into account customer information and none consider patents.

As for the company-academy link for the development of technological projects, companies that participate with academic centers were registered and a company has its own research center on the part of the corporate and three companies have no link with the academy. Automation in companies, stands out in the area of communication, followed by the production process and the supply of materials.

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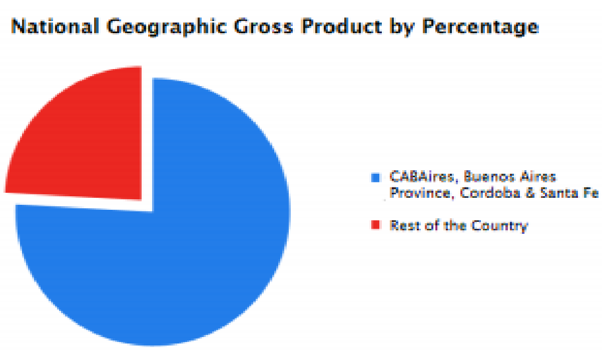

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