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Journal of Technological Prototypes

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Presentation of Content

In the first article we present *3D methodology for designing Grid-Tie Photovoltaic Systems* by BARRETO-BARRAGAN, Manuel, GONZALEZ-LOPEZ, Juan, VILLALVAZO-LAUREANO, Efrain and PEREZ-GONZALEZ, Marco with adscription in the Universidad de Colima, in the netx article we present *Bean cleaner prototype using programable logic* by SOSA-SALES, Jorge, NAVARRO-BERNAL, Odalis, MARTINEZ-VAZQUEZ, Abraham and RODRIGUEZ-MACHUCA, Juan Ruben with adscription in the Universidad Tecnológica de Nayarit, in the netx article we present *Design of a Mechanical System for vehicle liftingt* by CONTRERAS-CALDERÓN, Enrique, ALCALÁ-BAROJAS, Iván, VALDEZ-MARTÍNEZ, Jorge Salvador and BELTRÁN-ESCOBAR, Alberto Miguel, with adscription in the Universidad Tecnológica Emiliano Zapata del Estado de Morelos. *Implementation of an Electric Energy Monitoring System on Main Boards* by QUINTANAR-ENRIQUEZ, Marisol, MAYORQUIN-ROBLES, Jesús Antonio, MEDINA-MUÑOZ, Luis Arturo and LOPEZ-VALENCIA, Gabriel Antonio, with adscription in the Universidad Tecnológica de Nogales.

Content

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3D methodology for designing Grid-Tie Photovoltaic Systems

Metodología de diseño tridimensional para Sistemas Fotovoltaicos Interconectados

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Abstract

This article presents a methodology for the design of Grid-tie photovoltaic systems using computational tools for 3D modeling, in order to have a clearer vision of installation and with the purpose of acquiring the detailed material of what is required to have a more successful initial investment for a project. As a methodological test, a solar power plant is designed on the buildings of the Faculty of Electromechanical Engineering in Manzanillo Colima. For this purpose, the Sketchup and Helioscope softwares are used to obtain the installed capacity of the buildings, selecting the solar modules, inverters and the quantity in meters of accessories such as cable, pipe, etc. SolidWorks is used to design the assembly system and obtain the amount of material with screws included and thus make a much more accurate calculation of the initial investment required.

Interconnected Photovoltaic systems, Sketchup-photovoltaic, Solar systems

Resumen

En este artículo se presenta una metodología de diseño de sistemas fotovoltaicos interconectados la red con herramientas computacionales para su modelado en tercera dimensión con la finalidad de tener una visión más clara de una instalación y con el propósito de adquirir el material detallado de lo que se requiere para tener de forma más acertada la inversión inicial de un proyecto. Como prueba metodológica se diseña una planta solar en los edificios de la Facultad de Ingeniería electromecánica en Manzanillo Colima, para esto se utilizan los softwares Sketchup y Helioscope para obtener la capacidad instalada de los edificios, seleccionar los módulos solares, inversores y la cantidad en metros de accesorios como cable, tubería, etc. SolidWorks es utilizado para diseñar el sistema de montaje y obtener la cantidad de material de forma óptima con tornillería incluida y así realizar un cálculo mucho más acertado de la inversión inicial requerida.

Sistemas Fotovoltaicos interconectados, Sketchup-fotovoltaico, Sistemas solares

Citation: BARRETO-BARRAGAN, Manuel, GONZALEZ-LOPEZ, Juan, VILLALVAZO-LAUREANO, Efrain and PEREZ-GONZALEZ, Marco. 3D Methodology for Designing Grid-Tie Photovoltaic Systems. Journal of Technological Prototypes. 2019. 5-15: 1-6

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Introduction

Solar energy is one of the most attractive types of energy, especially with the constant fluctuation in the supply of the electricity grid. Modern solar cell technologies are increasing their viability due to cost reduction and greater energy production efficiency. This trend in the price of solar cells will increase the applications of solar panels in buildings, houses, commerce and industry.

Solar panels could be integrated into the facades and/or roofs of buildings. There are several geometric considerations for the installation of photovoltaic systems, regarding the installation and the azimuth angle taking into account the influence of shading caused by the environment. (Yoon, Song, & Lee, 2011).

Avoiding shading is useful not only for power generation, but also to reduce the working temperature in cells. A good design and planning can provide savings in the integration of photovoltaic energy in buildings, even in the mounting structures of photovoltaic modules. On the other hand, mounting systems are easier to install and operate the maintenance service once installed.

In the literature we can find a series of articles that use tools to analyze already installed systems or perform some planning-design of photovoltaic systems. (Mondol, Yohanis, & Smyth, 2005) present an electrical and thermal modeling for a system mounted on a sloping roof in Ballymena, Northern Ireland using TRNSYS, similar to that of (Fara, Moraru, Sterian, & Bobei, 2013). (Mohammad I., 2017) proposes to design a photovoltaic solar power plant connected to the 56.7 kW network to meet the demand for electricity at the Faculty of Engineering of the University of Mu'tah. On the other hand, (Peng, Wu, & Huang, 2012) analyze the problems related to photovoltaic energy integrated in the architectural design in China.

Simulation models to analyze the performance of photovoltaic devices are also available in some existing programs, such as PVsyst, (PVsyst, 2019), PVWATTS (Marion, Anderberg, & George, 2001), among others.

There are also a series of articles focused on obtaining the typical PV and VI curves of the photovoltaic modules as presented by (Brano, 2012). These tools provide a good prediction regarding power generation with a small margin of error; however, they do not calculate the installed capacity of a building or system.

For this reason, three-dimensional (3D) planning has also been considered recently, (Malak Yaghi, 2017) discusses the potential of solar panel implementation at the International University of Lebanon using the HelioScope simulation tool, since this tool was validated by (Guittet & Freeman, 2018). Similarly, Google SketchUp is a popular 3D drawing tool that is capable of designing complex 3D models which allows third-party add-ons to add functionality. For example, National Renewable Energy Labs is a SketchUp add-on (Stephen, Kambadkone, & Quanhui, 2009) which is primarily designed to be a geometry editor with geolocation and to work with the EnergyPlus tool to incorporate the 3D design of 3D photovoltaic systems using SketchUp, while using EnergyPlus as a building simulation engine, incorporating photovoltaic modules as in the case of (Hongxin, Guo, Gang, & Wang, 2018) and (Li, Si, & Liu, 2018).

This type of dimensioning gives a clear idea of how a photovoltaic system will be installed, since we can select the capacity of a module and size the installed capacity in the selected place, giving orientation and inclination; however clarity is lacking in the mounting systems. For this reason, this paper aims to present a design methodology that involves several tools in order to obtain in detail all the technical aspects. In this way, we can acquire a detailed list of all the material required to perform an installation and obtain the initial cost with precision to avoid losses and perform an optimized installation.

Section two illustrates the methodological proposal for the design of three-dimensional solar plants; section four shows the obtainment of the required initial investment and finally the conclusions.

Methodological design proposal

The proposed methodology is illustrated in the following flowchart showing the sequential work (Fig. 1).

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First, the surface areas of buildings, trees, and any possible shade are modeled. For this the modeling technique the Sketchup and Helioscope tools are used. These allow us to properly select each of the elements that make up the system since they have incorporated a database of solar panels and inverters that exist in the market. The modeling technique enables shadow analysis to reach an estimate of photovoltaic production considering geolocation; thus, using a quantitative methodology to analyze the energy savings that can be obtained.

The mounting system is also carried out with the simulation technique using the Solidworks tool to obtain the amount of material required such as aluminum rails, screws, wiring etc. With this information, we can obtain the required initial investment and have an estimated return of investment.

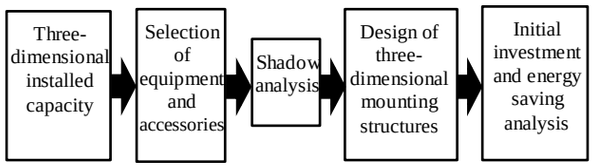

Figure 1 Flow chart of the proposed methodology

1. Dimensioning by building

In order to make the most of the area of the buildings located in the Faculty of Electromechanical Engineering, the largest possible number of panels will be placed on the surface of each building, so that they take advantage of the greatest amount of solar radiation and thus obtain a considerable energy production to create a greater impact in reducing the consumption energy to the grid.

For the dimensioning of the photovoltaic system, the Helioscope and Sketchup tools were used, both in conjunction with the use of Google Maps as shown in Figure 2, which illustrates the dimensioning in each of the faculty buildings. For this study, the use of the manufactured panel of 320 was established with technical specifications described in Table I.

This dimensioning allows taking advantage of as much space as possible for the placement of the photovoltaic modules, considering the losses due to shadows.

Figure 3 illustrates one of the buildings dimensioned with 320W photovoltaic modules oriented from north to south with an azimuth angle of 180º. In this case, aisles are left for maintenance when required. For this building, 160 panels with two 27.6kW inverters are considered, the inverter data is illustrated in Table II.

Figure 2 Dimensioning in Sketchup

Figure 3 Laboratory in Sketchup

The analysis of shadows illustrated in Figure 4 shows that there is only a loss of between 2% and 3% mainly by trees, in the months with less radiation and only a few hours after sunrise and sunset.

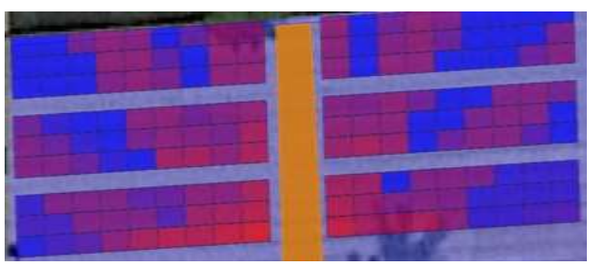

Figure 4 Laboratory shadow analysis

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Model: JC320M-24/Abs	
Rated power [W]: 320	**Ground connection:** N/D
Tensión a circuito abierto: Voc[V]:45.60	**Short circuit current Isc [A]:** 9.0
Max Voltage Vmp Power: 37.40	**Max Power Current Imp [A]:** 8.56
Coef Voc temperature [V/oC] -0.137 **[%/oC]** -0.300	**Coef Isc temperature [mA/oC]** -3.6 **[%/oC]** 0.04
Max Tens Syst (IEC) [V]: 1000	**Coef Pmax temperature [%/oK]:** -0.4

Table 1 Technical specifications of the selected panel

The electrical connections are illustrated in Figure 5. It shows two parallel chains of 20 panels connected in series that will be connected to a 30A fuse which go to the input of a Maximum Power Point Tracking (MPPT) of the inverter. Connected to this are 80 panels. With this connection the inverter works correctly, since the input voltage is 920V open circuit and 18A short circuit, input values that can be seen in Table II.

2. Mounting system design using 3D SolidWorks

The purpose in this section is to acquire the necessary material for the installation considering the type of aluminum mounting rails, in addition to the necessary hardware and accessories.

It is worth mentioning that mounting systems can be designed in any other CAD tool such as Solidworks or AutoCAD; the objective is to minimize the costs in the installation of the mounting systems, as well as the accessories.

Figure 6 illustrates the assembly of all parts for the analysis of material required for the structures. Due to the size of the selected modules and looking for an optimization in the use of aluminum angle, the figure shows a structure for 9 solar panels.

Each structure is made up of 14 sections of 6m of 1.5-inch aluminum angle, these components will be fastened by 16 3/8" stainless steel screws due to the humidity and salinity of the environment.

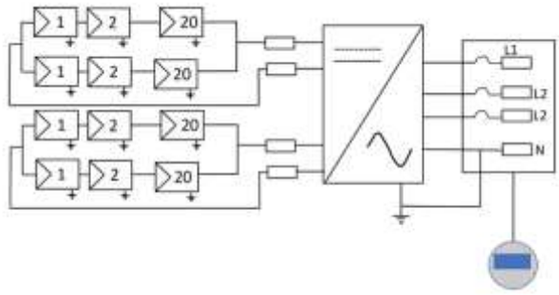

Figure 5 Single line connection diagram

3. Estimation of photovoltaic production

Once the analysis has been carried out for each of the buildings, in terms of their dimensioning, shadow analysis and disengagement of assembly structures, an analysis of energy production versus current campus consumption is performed.

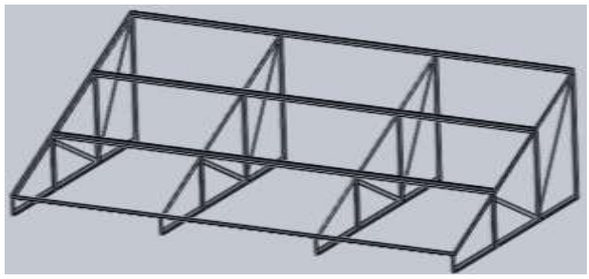

Figure 6 SolidWorks assembly system design

The monthly average of solar radiation in the inclined photovoltaic assembly indicates that the minimum generation during December is (20.9MWh/month) and maximum in March (35.07MWh/month), this is because of the variation in temperature of the location. The photovoltaic power generated for each month is illustrated in Figure 7.

These generations represent an average saving of 31.9% of total consumption. Figure 8 illustrates the generation of energy per day throughout the year; these data are obtained with the PVsys and Helioscope software and show an average daily production of around 1000kWh/day.

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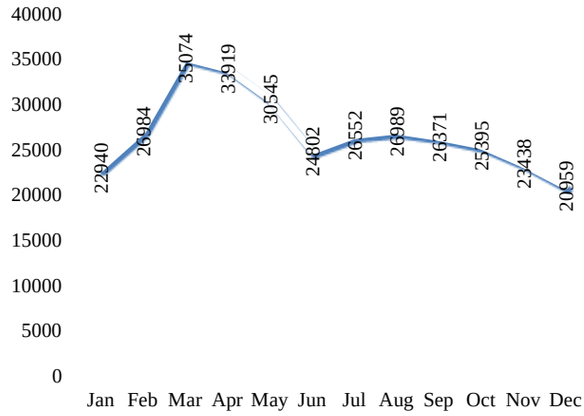

Figure 7 Monthly energy generation

Figure 9 shows the analysis of current energy consumption on campus along with the generation per month.

Investor Data	
INPUT	**OUTPUT**
Rated input power (Pdc,r) **[W]: 28600**	**Nominal Active Power** (Pac) **[W]:** 27600
Maximum input power (Pdc,max) **[W]:** 31100	**Max Active Power** (Pac fp=1) **[W]:** 30000
MPPT maximum power (Pmppt,max) **[W]:** 16000	**Max Apparent Power.** (Smax) **[VA]:** 30000
Maximum input voltage (Vin,max_abs) **[V]:** 1000	**Nominal voltage** (Vac) **[V]:** 400
Min. op tension of MPPT (Vin,min_mppt) **[V]:** 70%Vstart	**Nominal frecuency** (fr) **[Hz]:** 60
Max. op tension of MPPT (Vin,max_mppt) **[V]:** 950	**Number of phases: 3**
Maximum input voltage (Vin,max_abs) **[V]:** 1000	**Rated power factor Fp = 1**
Tens. Default activation (Vstar_ref) **[V]:** 430	
Tens. Range activation (Vstar_rag) **[V]:** 250-500	
MPPT number: 2	
Max. MPPT current (Imppt_max) **[A]:** 32	
MPPT short circuit current (Iscmax) **[A]:**40	

Table 2 Technical specifications of the selected inverter

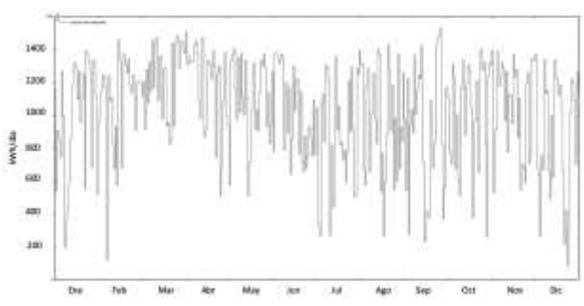

Figure 8 Energy production per day

Initial investment analysis

Table III illustrates in detail each of the materials required to perform the installation in the building illustrated. The initial cost for this building is 30,000US; it is worth mentioning that the costs were obtained with local suppliers and in some cases with manufacturers, so the initial cost depends on these and therefore may vary.

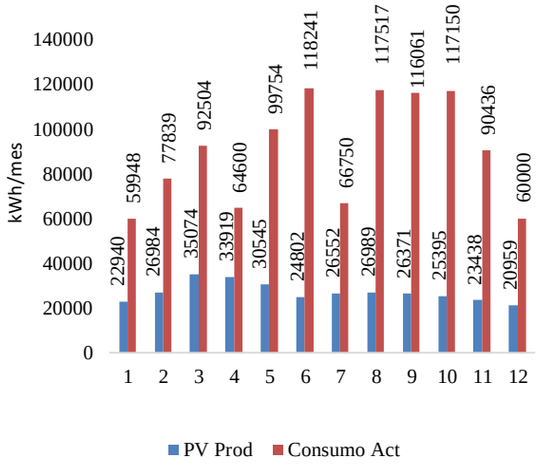

Figure 9 Energy production per day vs consumption

After performing this procedure for each of the buildings, the initial investment required ranges between 450,600US with a return of investment of 4.3 years, with the conditions under which the analysis was performed, that is, with the rates, costs and consumptions.

Conclusions

We carried out the analysis of the energy behavior of a photovoltaic system integrated in the buildings of the Faculty of Electromechanical Engineering of the University of Colima. The use of several tools such as Helioscope, PVsyst, Sketchup, Solidworks allowed us to know in detail the energy performance of the power produced and the technical needs of the project.

The roof segments chosen for the installation are suitable, since they do not offer significant losses due to shading and have enough free space. The results obtained regarding the solar resource and the technology performance are perfectly adjusted to previous studies.

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Material	Quantity
320W solar panel	162
INVESTOR 27.6-TL	2
MC4 (pair)	24
MC4 3 way (pair)	2
Connection cabinet	2
30A fuse	2
50A 3Ø thermomagnetic protection	2
Anodized 6m aluminum angle	252
THW cable 10 AWG at 1000V (m)	176
Isolator switch	4
Peak Suppressor	4
T and LB Condulet	6
1 * 1/4 stainless steel screws with double washer and lock nut	500
4 * 1/4 stainless steel screws with double washer and locknut	700
1/8 * 3/4 stainless steel screw	200
Harpoon wall plug 3/8 "	144
High temperature silicon	2
3/4 "thin wall galvanized steel pipe	20
Fuse holder	4
Grounded windmill	2
Bare cable cal 8 (m)	100
THW cable cal 8 AWG (m)	12
Data Logger monitoring system.	1

Table 3 Initial investment of building

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Bean cleaner prototype using programable logic

Prototipo limpiador de frijol aplicando dispositivos lógicos programables

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Abstract

The project focuses on the cleaning of beans through the separation of impurities by screening machines, with the aim of helping small farmers who grow and sell their beans. Beans are among the most comsumed foods; however, the cleaning process is tedious, so we want to develop a system that performs such process in different stages of selection. Grains vary in price and quality in different places due to the conditions in which they are sold. This is because when they are sold in a supermarket, the product must be considered first level, which means, they must be of a homogeneous size and clean of any type of garbage. The purpose of this prototype is to clean the beans in such a way that it separates the impurities they might have and obtain a clean product. We begin by defining the cleaning procedure, then performing the structure and placement of sensors and actuators, and finally the programming and adjustments necessary for its operation. With this prototype, people who cultivate and extract the seeds can perform the cleaning and generate greater profits.

Screening, Process, Oblong

Resumen

El proyecto se enfocada a la limpieza del frijol mediante la separación de impurezas por medio de cribadoras, esto con el objetivo de ayudar al pequeño agricultor que cultivan y venden su frijol. El frijol es uno de los alimentos que se encuentra dentro del top de los más consumidos, sin embargo el proceso de limpieza resulta tedioso, es por ello se quiere desarrollar un sistema que realice dicha limpieza en diferentes etapas de cribado. El frijol varía de precios y de calidad en distintos lugares debido a las condiciones en las que se vende, esto se debe a que cuando se comercializa en un minisúper o supermercado, el producto debe ser considerado de primer nivel. Esto quiere decir, limpio de cualquier tipo de basura y tamaño homogéneo. Este prototipo tiene como finalidad limpiar el frijol de tal manera que separe las impurezas que pudiera tener y se obtenga un frijol limpio. Iniciando por definir el procedimiento de limpieza, posteriormente realizar la estructura y la colocación de sensores y actuadores y por último la programación y ajustes necesarios para su funcionamiento. Para quien cultive y extraiga la semilla, pueda realizar su limpieza y genere mayores ganancias con este prototipo.

Cribado, Proceso, Orificios oblongos

Citation: SOSA-SALES, Jorge, NAVARRO-BERNAL, Odalis, MARTINEZ-VAZQUEZ, Abraham and RODRIGUEZ-MACHUCA, Juan Ruben. Bean cleaner prototype using programable logic. Journal of Technological Prototypes. 2019. 5-15: 7-13

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Introduction

Bean is a crop that has historically been associated with the development of pre-Hispanic cultures, and currently plays a primary role as a traditional crop in several regions of the world. In Mexico, the Phaseolus vulgaris L. variety is the second most important product in the agri-food sector, not only because it is a source of income for thousands of producers, but also because it occupies an important place in the population's diet, mainly that of the lower income social strata (Siacon-sagarpa, 2016).

Grains and cereals harvested manually or mechanically always contain impurities. The impurities normally found in agricultural products are usually fragments from the plant itself, such as stubble, leaves, grain pieces, branches, etc. Likewise, there are other impurities that do not come from the plant itself, which are called foreign matter and that are generally made up of wild seeds, part of other plants, lumps, sand, stones, etc. The impurities present in agricultural products are a consequence of carelessness during cultivation, mainly in the control of weeds, and the methods used for harvesting.

For the conservation of grains during storage, it is necessary to consider two important aspects of impurities: One of them is the fact that their presence makes the conservation of grains more difficult; and the other refers to the difficulty they present for the proper operation of the storage units. The excess of impurities negatively influences the conservation of stored products because they are normally hygroscopic and tend to moisten the grains, in addition to being favorable means for the development of insects and microorganisms (F.A.O, 2019).

The biggest problem in this type of harvest is the cleaning process to be implemented, since the product regularly has impurities, such as dirt, stones, branches or some other type of garbage that falls when it is extracted. This is a problem for those who grow it, since the product is not completely clean, many times it has to be sold to someone else who is responsible for cleaning or selling it at a lower price to compensate for the part that the bean is missing.

Therefore, creating a system that can perform this process is a great advantage and helps all those who are dedicated to growing beans or some other seed. The implementation of a cleaning prototype that guarantees and commits to delivering a higher quality product is very satisfactory, because the cleaning process will take less time, preventing the raw material from passing to other people responsible for this process, reducing costs and obtaining more profits for the farmers.

Self-consumption and healthier eating with organic products (Sierra, 2014) is generating an area of opportunity in which prototypes are of great importance. This is because crops are in smaller quantities since they are expected to be only for self-consumption of the family or population (Agricultura ecológica, 2019), (San Martín granja integral, 2019).

Development

In this prototype, it is desired to carry out the cleaning of the bean with moving sieves. As the bean moves and falls from one sieve to another, the impurities that it could have fall to another part of the process to be separated. The clean and selected bean according to size continues with the cleaning process until it reaches a conveyor belt, where it can be packaged later or be subjected to a final visual check to ensure that the product is clean.

Currently there are machines responsible for this type of cleaning; however, it is intended to develop a prototype that is functional for the small and medium farmer, improving the manual method that we all know, which only consists of separating the stones from the beans.

Prototype procedure and operation

Bean cleaning consists in the total or partial elimination of impurities, to facilitate its conservation during storage, which is the objective of this prototype.

The separation of impurities is based on the differences between the physical properties of the beand and the impurities. When these properties are similar or identical, the separation becomes difficult; a clear example is when the stones are the same size as the beans.

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In this case, whenever possible, the separation should be based on the property the difference of which is most marked.

The bean has three dimensions as shown in Figure 1. The 3 dimensions of the bean are: length, width and thickness. In cleaning machines, only the length and thickness dimensions are used to perform the separation.

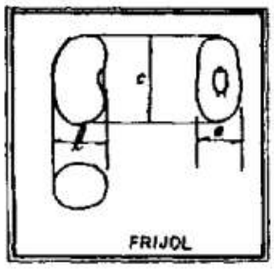

Figure 1 Bean Dimensions
Source: Grain cleaning (FAO 2019)

To carry out bean separation it is necessary to determine which method is more convenient.

Separation depending on the width: To separate the beans of the same width, a round hole shank can be used, considering that the beans have the same length and thickness. Figure 2 shows this type of separation.

Figure 2 Separation based on width
Source: Grain cleaning (FAO 2019)

Separation depending on thickness. Grains that have different thicknesses can be separated with a mesh of elongated or oblong holes, if they are the same length and width. An example of this separation is shown in Figure 3.

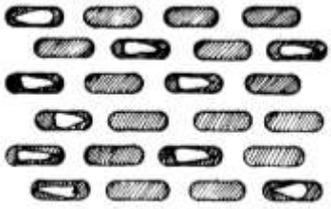

Figure 3 Separation based on thickness
Source: Grain cleaning (FAO 2019)

Once the separation method to be implemented is determined, it is necessary to choose the type of perforation of the meshes used as screeners in the cleaning prototype, which is related to the shape of the product. According to the type of grains and impurities, it is necessary to choose a mesh appropriate to the shape of the product. An example of how the mesh separates the impurities is shown in Figure 4.

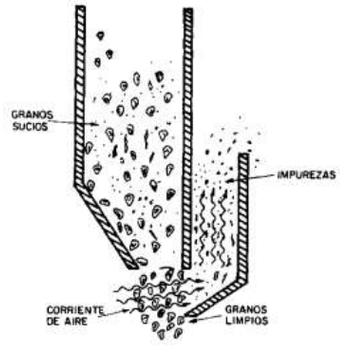

Figure 4 Cleaning mesh
Source: Grain cleaning (FAO 2019)

On this occasion it was decided to use oblong holes which are generally used in the separation of materials in which the elongated shape predominates, so they are mainly used to separate the grains according to their thickness. The oblong holes are specified by taking the width dimension and the hole length dimension. They are usually installed with the longer axis of the hole in the direction of grain movement, since separation is thus facilitated.

Another point to consider was the vibration system used to oscillate the screenings, so that the product comes into contact with the holes, making separation easier, and slides on the screens. The vibration system must have devices capable of modifying the amplitude and frequency of the oscillating movements, so that the mass of grains, with shapes and sizes other than spherical, will remain with the longitudinal axes of the grains perpendicular to the surface. In this way, when oscillating with precise movements, it will allow the grains to pass through the holes. Having these points already, we proceed with the design of the structure.

First, the part of the structure that would support the screens and the hopper was assembled, as well as the circuit part.

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Figure 5 shows the part of the structure in which some planks were drilled to adapt the screen meshes. The back of the structure was left to put a board where the circuit would go.

Figure 5 Wood structure
Source: Prepared by the authors (2019)

Then, the conveyor belt that would be placed at the end of the last screening mesh was constructed. Figure 6 shows the band that has two axes which execute the action of the rollers, the axes are made of endless screws, which are attached to steel plates and bolted with nuts. At one end of the belt a motor was fixed, which transmits the movement towards the axis causing both to keep rotating through the conveyor belt. The conveyor belt is made of canvas. Presence sensors were placed in the band, which will keep it in operation when it detects the bean or make it stop when it no longer detects the presence of beans in the band.

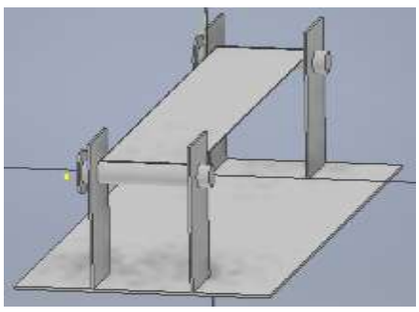

Figure 6 Conveyor belt
Source: Prepared by the authors (2019)

Two presence sensors were placed: one at the beginning of the conveyor belt and the other at the end of the belt. The first sensor will make the band work whenever it detects the beans and the second sensor will deactivate it if there are no longer any beans in the band.

Two servomotors and two vibrating motors were also placed. One of the servomotors was used in the hopper to manipulate a connecting rod system which makes it open the hopper lid. And the other servomotor is in the band to transmit the movement between the axes. The vibrating motors were located in the screening meshes, so that they can move the mesh and thus the bean cleaning process is carried out as the route is implemented on the mesh. Figure 7 shows where these components are located.

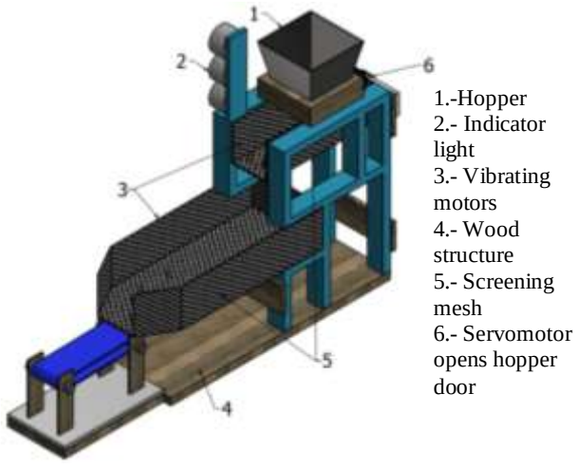

Figure 7 Location of components
Source: Prepared by the authors (2019)

The operation of the prototype consists of depositing the bean in the hopper and by pressing the power button the hopper gate will open and the bean will fall on the first screening mesh, where the movement of the vibrating motors will perform the cleaning.

The function of this section is to separate the impurities which are larger than the beans in the mesh so that the beans fall to the next screening mesh, where the smaller soil and stones of the beans will separate as they move.

The clean beans will continue until they reach the conveyor belt, where sensor 1 is activated to keep the belt moving, until they fall into the container or packaging bag; if sensor 2 does not detect beans in the band, it will indicate to the band Stop working. Figure 8 shows the general structure of the prototype.

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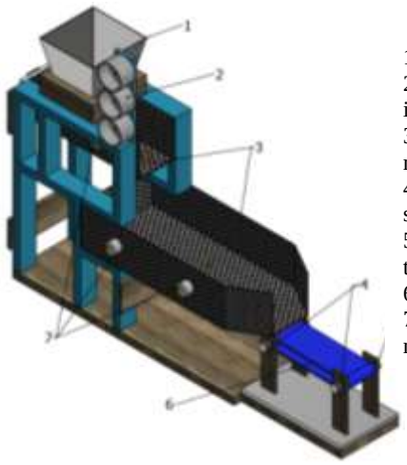

1.-Hopper
2.- Process indicator light
3.- Screening mesh
4.- Presence sensor
5.- Servomotor of the band
6.- Conveyor belt
7.- Vibrating motors

Figure 8 General structure of the prototype
Source: Prepared by the authors (2019)

The purpose of this system is to make the bean pass through screening sections where it is cleaned of impurities, so that it is as clean as possible.

Programming Operation

This project was developed in CUPL language, using its free compiler called AWINCUPL which was supplied by Atmel. The CULP language is a universal compiler for various programmable logic systems, among them is GAL (Generic Array Logic). In this specific case, we use the GAL16v8.

Below is the programming used for our bean cleaner, which includes the header, pin declaration and processing commands or functions, where we can see the 3 main parts of the program such as configuration, declaration of inputs/outputs and logical functions.

```
Name     Limpiado de frijol;
PartNo   00;
Date     07/11/2018 ;
Revision 01;
Designer EQUIPO;
Company  HP;
Assembly None;
Location
Device   g16v8;

/*          ***************          INPUT          PINS
*********************/
PIN         2  =  Botón  puerta                        ;  /*
*/
PIN     3 = Sensor1              ; /*                    */
PIN     4 = Sensor2              ; /*                    */
PIN         5  =  Botón  encendido                     ;  /*
*/
PIN     6 = x                    ; /*                    */

/*          ***************          OUTPUT         PINS
*********************/
PIN      12  =  Motor  puerta                          ;  /*
*/
PIN      13  =  Motor  banda                           ;  /*
*/
PIN       14  =  Vibradores                            ;  /*
*/
PIN      15  =  Luz  encendido                         ;  /*
*/
PIN       16  =  Luz  espera                           ;  /*
*/
PIN      17  =  Luz  apagado                           ;  /*
*/
PIN    18 = y                   ; /*                    */
PIN    19 = z                   ; /*                    */

Luz encendido= Botón encendido;
Luz espera=! Botón puerta & Botón encendido;
Luz apagado=!Botón encendido;
Motor puerta= Botón encendido & Botón puerta;
Vibradores= Botón encendido;
Motor banda= Botón encendido& (Sensor1#Sensor2);
PIN         2  =  Botón  puerta                        ;  /*
*/
PIN     3 = Sensor1              ; /*                    */
PIN     4 = Sensor2              ; /*                    */
PIN         5  =  Botón  encendido                     ;  /*
*/
```

Within the code, the input variables were declared: the gate button that controls the hopper opening; the power button where the motors and indicators are activated so it also influences the operation of the conveyor belt; the sensor 1 and sensor 2 which are presence sensors that will activate the band when they detect beans in the band and will stop working when it does not detect them.

From the programming the connection circuit was made. Figure 9 shows the connection circuit.

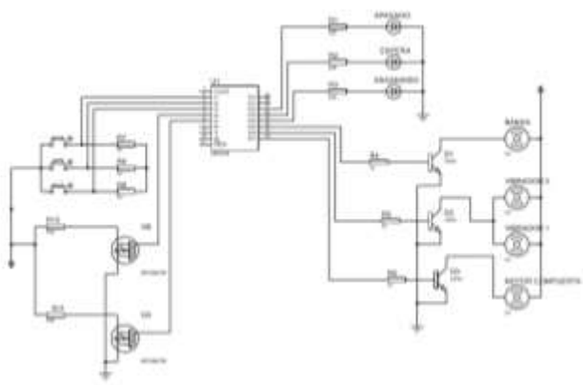

Figure 9 Connection diagram
Source: Prepared by the authors (2019)

Methodology to develop

This project developed from the need of small bean farmers in the northern area of Nayarit, the home region of one member of the team. The Peruvian bean was used as a reference for the validity of the prototype.

Results

Finally, the prototype carried out the main objective which is to clean the beans. This action was possible, since after the screening process there was a final product approximately 95% clean of the impurities that it presented. However, certain details emerged such as not all beans can be cleaned because there are only two screening processes, and due to the selection of the holes in the cleaning mesh.

For portions of 1 kg of beans, the prototype performs the cleaning in an approximate time of 3 minutes, having a cleaning quality of up to 95%. As mentioned earlier it was a process with two screening stages and a specific type of hole, just making a bean separation considered first.

The proposed prototype is exclusive for the cleaning of Peruvian beans, this is determined by the type and hole size of the mesh that performs the cleaning. If we want to change beans, it is necessary to determine the size and shape of the mesh hole.

With the aforementioned, it can be said that this prototype will provide added value to bean crops of small farmers in the northern part of the state of Nayarit.

Discussion

The cleaning of agricultural products is a practice adopted thousands of years ago and little has changed since then, because nowadays the same mechanical principles are used. In rural areas, cleaning systems are quite rudimentary, usually employing manual sifters.

Therefore, a system to reduce this effort, making more efficient the process and giving added value to the final product is of great help to small bean producers. Taking the above, it can be said that the prototype meets the main objective.

It is important to consider that commercial brands already exist, for example zaccaria who offer better benefits than the prototype presented in this work (Zaccaria, 2019); but for the small farmer to consider the expense of a machinery with industrial characteristics is very complicated, and the prototype described in this document is viable to be acquired and implemented in the small farmer cleaning process. In addition to the aforementioned company, we can mention hegamex, Labtronic, Hydropure, Grupogaurel, among others, that make this type of machinery for the industrial sector with very similar characteristics as the zaccaria company.

The National Polytechnic Institute carried out the design and construction of a machine to screen bean seeds, (Almanza, 2010) which consists of a single screening trap having a process on which it bases its cleaning of the product for the time it takes to circulate the bean. In the case of the prototype described in this document, it consists of two stages and therefore the time is reduced by consuming less electrical energy and therefore being more efficient. In a similar protocol as a classification of corn (Washinton & Rolando, 2013) and a prototype of a bike-blender (Varas, 2018), both are intended to solve a need in a particular social environment, an intention that this paper also shares.

In the process of other grains such as rice, it is implemented through bulldozers with holes in the mesh according to the standard that is required to be cleaned (Agroindustrial Study and Design, 2016); in the case of the bean cleaning prototype, the same principle applies and we remark that its advantage with respect to these products is the cost of the machinery (Rios & B., 2009).

Conclusions

In the Bean Clean prototype, the bean cleaning is carried out but in a different way from what already exists; in particular this prototype is only for the Peruvian bean since the measures for the meshes were taken of a sample of this type of grain. We have the limitation of the type of bean that is used, since the sizes that each one has are different.

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A projection is to make the Bean Clean have the ability to clean more types of beans, adapting it so that each type can have an exit preventing them from mixing with each other.

The benefit to society could be that the cost of beans would be lower since it was not necessary to pay a company for doing the cleaning procedure. Also, if the consumers gain a lower price, they would stop looking for the beans that are sold without cleaning and would save time in doing the process manually.

Even with the corrected details, such as the size of the spaces through which the bean passes in the first and second screening mesh, the prototype is functional and allows us to carry out our task without any problem.

However, a disadvantage in comparison to other cleaning systems, it cannot clean any type of bean and does not have more screening meshes. Other systems also work to select beans that can be considered top-tier, a situation that cannot occur in its entirety in this prototype.

Disregarding the possible disadvantages, this prototype could be implemented on a larger scale and its investment cost could be less than what other equipments cost. Finally, we made a prototype capable of cleaning the beans which was our objective, along with clearly explaining the results obtained and the possibilities for improvement.

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Design of a Mechanical System for vehicle liftingt

Diseño de un Sistema Mecánico para elevación de vehículos

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Abstract

The automotive industry has always been concerned with improving day by day all of its vehicle models, developing more comfortable systems for its users, such as rear cameras, automatic parking systems, collision detection, air bags, etc. However, it has neglected certain aspects like the replacement of tires when having a puncture, using devices that have not changed in a long time. We present the design of a protoype coupled to a bottle-type hydraulic jack to elevate automotive vehicles, replacing the mechanical energy provided by the human with electrical energy of direct current provided by the car's battery. The prototype consists of a 12 V gear motor that moves a gear train mechanism to activate a crank that will be coupled to the jack to produce the lifting.

Hydraulic jack, Gearmotor, Crank mechanism, Gear trains

Resumen

La industria automotriz se ha preocupado siempre por mejorar día a día todos sus modelos de vehículos, desarrollando sistemas más confortables para sus ocupantes como cámaras traseras, sistemas de estacionamiento automático, detección de colisiones, bolsas de aire etc. Sin embargo ha descuidado ciertos aspectos como son el reemplazo de un neumático al sufrir una pinchadura, empleando dispositivos que no han cambiado en mucho tiempo. Se presenta el diseño de un prototipo acoplado a un gato hidráulico tipo botella para elevar vehículos automotores, reemplazando la energía mecánica ejercida por el ser humano por energía eléctrica de corriente continua proporcionada por la batería del automóvil. El prototipo consta de un motoreductor de 12 V. que mueve un mecanismo de trenes de engranes para activar una manivela que será acoplada al gato para producir su elevación.

Gato hidráulico, Motorreductor, Mecanismo biela manivela, Trenes de engranes

Citation: CONTRERAS-CALDERÓN, Enrique, ALCALÁ-BAROJAS, Iván, VALDEZ-MARTÍNEZ, Jorge Salvador and BELTRÁN-ESCOBAR, Alberto Miguel. Design of a Mechanical System for vehicle liftingt. Journal of Technological Prototypes. 2019. 5-15: 14-19

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Introduction

Velasco (2019) defines innovation as the transformation of an idea into a marketable product or service, new or improved, or a new method that provides a social service.

Maldonado (2005) innovated a mechanical jack through some changes and ergonomic applications, so that the user has ease and comfort while lifting a car, having the certainty that by simply activating a control, it can perform the task without using physical force.

A research and design of a rotating hydraulic cylinder jack using a rod-crank mechanism, coupling a 12V electric motor was developed by Afkir (2018).

The design was carried out with the SolidWorks 2017 program, used for 3D design and for simulating finite elements, in order to verify that the different components can withstand the previously calculated forces.

Camarena and Santamaría (2012) developed a hydroelectromechanical system capable of supporting the weight of a tourist car of segments E and F, at its different loading points, in order to be an adjunct in the task of replacing a damaged tire or provide maintenance to certain auto parts.

García (2017) carried out the work which consisted in the design of a virtual prototype of a hydraulic bottle jack. This model has been chosen, because it is very easy to use, reliable and portable. This work has been done using Autodesk Software, Inventor Professional 2018. A virtual simulation is performed to check the static integrity of the machine, using finite elements. Since the jack does not work at a certain speed, but it is the user who provides it with variable acceleration and movement through manual operation, the dynamic simulation falls to an illustrative background.

Design process

Design is a fundamental phase of the product life cycle. Numerous research projects were able to highlight the influence of design on industrialization, costs and production deadlines, marketing efforts and maintenance or recycling activities of the product.

Studies show that 75% of the life cycle costs of a product are determined at the end of the design phase and are directly attributable to the decisions made; in addition, during this phase 40% savings can be made. Improving the result of this engineering process has an important impact for the company.

There are different types of design processes in the bibliography and each industrial company adopts the one that best suits its needs.

Product development corresponds to several realities and the resulting processes are multiple. Generally, this development is characterized by the type of product studied, in relation to the type of design process applied, and by the type of objectives that the customer defines for the future use of the product.

At a theoretical and practical level in the automotive industry, a design process is defined with the following stages: (figure 1)

- Needs.- Definition of customer requirements.
- Specifications.- Functional analysis is a methodology in the mechanical sector used to define the technical specifications of the product (requirements are also discussed).
- Solution search.- solution formulation and logical verification.
- Preliminary design.- Product structuring in physical components and first geometric definitions
- Detailed design.- 3D modeling and dimensioning.
- Validation.- Verification with simulation or prototypes.

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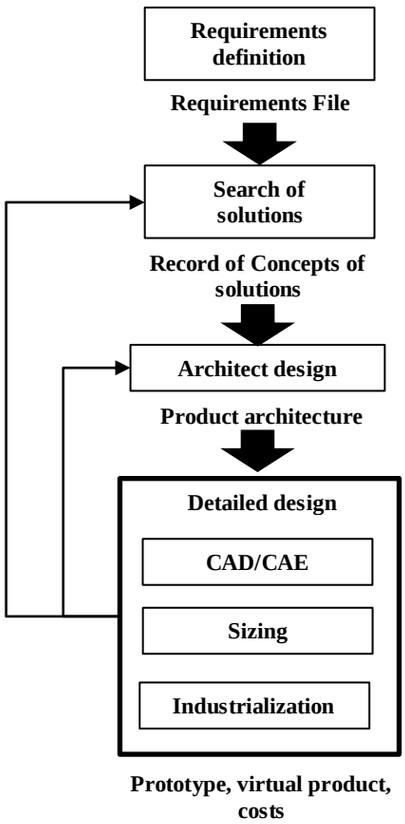

Figure 1 Development process of a new product

Requirement Definition

Designing a prototype that can be adapted to a bottle-type hydraulic jack to perform the car lifting, which is economical and easy to use.

It was decided to innovate a hydraulic jack, through some changes and electrical applications, so that the user has ease and comfort while lifting a car, having the certainty that by simply activating a control, it can perform the task without using physical force.

The main parts of a hydraulic bottle jack are as follows: (figure 2)

Figure 2 Parts of a bottle-type hydraulic jack

Search for solutions

In this stage, we pondered the different ways of solving the problem. As a first option, it was considered to place a motor reducer coupled directly on a cam. It was calculated that the engine did not have enough torque to lift the vehicle. It was decided to place a gear train in order to increase torque, sacrificing speed.

Due to economic issues, the required materials were searched in an industrial waste center, which were the following:

1. A 12V motor with speed reducer at 50 rpm, power of 1/125 hp and torque of 10 lb/in

2. A bottle-type hydraulic jack with a capacity of 2 tons. (figure 3)

3. Straight gears of 20, 46, 26, 36, 26 and 32 teeth with equal diametral pitch.

Figure 3 Acquired Materials

Due to the conditions of the hydraulic jack, it was correctively maintained, verifying its operation.

Product architecture

The drawings of the required parts were carried out in the SolidWorks package, as well as their assembly, as shown in Figure 4

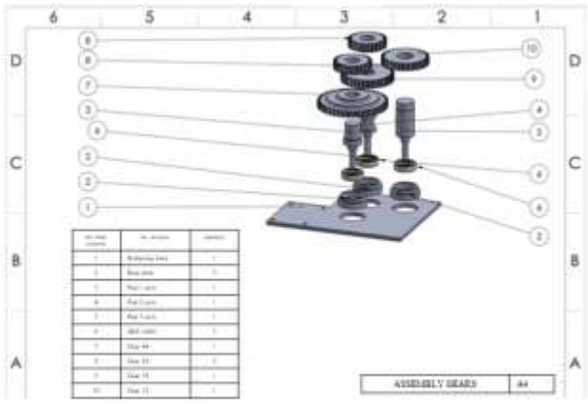

Figure 4 Assembly of parts

The gear train arrangement was as follows: z1 = 20 dte, z2 = 46 dte, z3 = z5 = 26 dte, z4 = 36 dte and z6 = 32 dte.

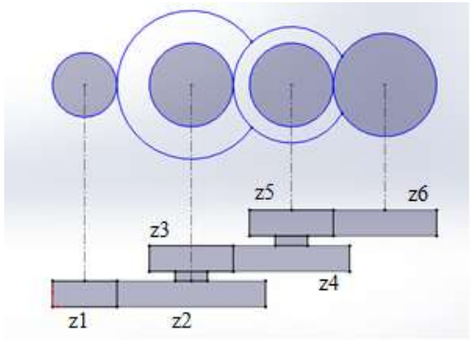

Figure 5 Gear train

With the data obtained above we know that the transmission ratio *i* is equal to

$$i = \frac{z1*z3*z5}{z2*z4*z6} = \frac{20*26*26}{46*36*32} = 0.255 \quad (1)$$

So the output speed will be

$$n6 = i * n1 = 0.255 * 50 = 12.75\, rpm \quad (2)$$

And the torque

$$T = \frac{hp*716}{rpm} = \frac{\frac{1}{125}*716}{12.75} = 0.45\frac{kg}{m} = 39lb/in \quad (3)$$

Next, we purchased the following materials for the manufacture of the prototype:

- 1018 steel plate
- 1018 steel rounds
- 1018 steel tubes
- 6001 bearings

These materials were machined and turned for the construction of the prototype according to the design specifications drawn in SolidWorks.

We purchased 14 gauge AWG cable and a plug for car cigarette lighter for the motor voltage supply. In order to start the engine, a pushbutton was used instead of a switch, so that the hydraulic jack only works when it is pressed; in this way, it is ensured that the motor, and therefore, the hydraulic jack, starts up voluntarily and avoids any type of accidents or involuntary operations.

Prototype

Figure 6 shows the assembly of the parts manufactured for the prototype construction.

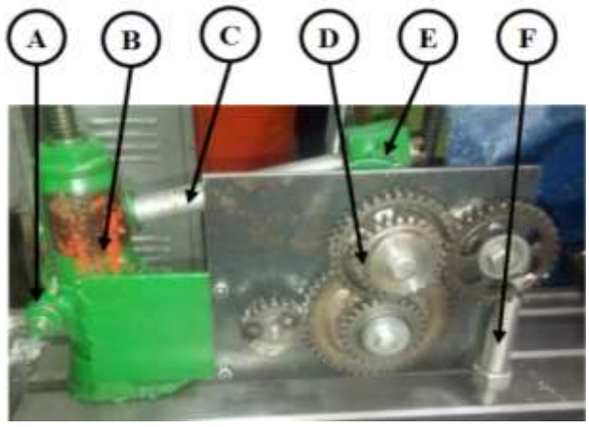

Figure 6 Final assembly

The components are:

a. **Tightening screw**. Allows the prototype to be mounted to any type of hydraulic bottle jack with a capacity of 2 tons.

b. **Bottle-type hydraulic jack**. It is responsible for lifting the vehicle to perform maintenance or changing the damaged tire.

c. **Drive lever**. It lifts the hydraulic jack by means of an alternative linear movement.

d. **Gear train**. They are responsible for reducing speed and increasing torque.

e. **Crank**. Uses a follower to perform the movement of the operating lever.

Leveling screw. Used to level the prototype with the hydraulic jack.

Costs

This part of the report presents the prices of the components used, both acquired as new and reused.

Regarding the reused materials, they were acquired, as previously mentioned, in an industrial waste plant, so we show the difference between these and the costs of the new materials: (Table 1)

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Material	Price for new product	Price Found in recycling
Hydraulic jack	$ 550.00	$ 100.00
12v motor	$ 469.00	$ 50.00
Gears	$ 600.00	$ 150.00
Total	$ 1,619.00	$ 300.00

Table 1 Reused material costs

As it can be seen in the total costs, there was significant savings when acquiring these materials.

After this, we established in different places the budget for the purchase of the necessary materials for the manufacture of the base where the motor was mounted and the coupling to make the movement conversion (Table 2). Below are the materials used, as well as their description and price:

Component	Description	Cost
Circular plate	d=4" espesor =1/4"	$ 40.00
Cold square roll	1 ½ x 1 ½ L=2"	$ 50.00
Steel plate	15x15 cm L= 12cm	$ 50.00
Round	D=1/2" x L=2	$ 30.00
Round	D=5/8" x L=1	$ 20.00
License plate	10x10 cm x¼ espesor	$ 60.00
Tube	D=32mm L=33cm	$ 50.00
Screw	D= 5/8 in x 4 in	$ 45.00
Screw	D = ½ in x 3 in	$ 21.00
4 pieces screw	D = 5/16 in x 1 ½ in	$ 16.00
Connector	Plug para encendedor de auto	$ 14.00
Switch	Switch push botón	$ 35.00
Cable (5 m)	Duplex 14 AWG	$ 120.00
3 pcs bearing	Rodamiento 6001	$ 105.00
	Total	$ 656.00

Table 2 Cost of materials used

Performance

For the operation and performance of the hydraulic jack driven by the lifting prototype, the following steps are required;

- The load to be lifted must never exceed the nominal force of the jack.
- The maximum jack travel must never be exceeded.
- The jack must rest on a firm, regular, horizontal surface, free of unnecessary elements and a well lit area. Never rest the jack on a surface that can sink.
- Make sure there are no people in the vehicle. Disconnect the engine and fully brake the vehicle. Wear shims if necessary.
- Do not enter the vehicle or start the engine while it is supported by the jack.
- Place the jack below the lifting point recommended by the vehicle manufacturer and make sure it is not damaged, dirty or with grease. This point should be centered on the jack's head of support.
- Adjust the leveling of the jack with the screw that is welded to the plate. (Figure 7)

Figure 7 Prototype operation

- Connect the plug to the car's electrical outlet.
- Close the discharge key.
- Insert the lever into the jack and the prototype crank.
- Activate the switch to start the engine and watch the crank go up and down.
- To lower, pull the jack lever and crank and slowly turn the discharge key with the lever counterclockwise.
- During the lifting and lowering of the load, it is necessary to take all kinds of measures to avoid displacement of the vehicle load
- The jack must be used without the user being forced to introduce any part of their body under the vehicle.
- In case of vehicle movement, it is necessary to interrupt the lifting.

Conclusions

The methodology used for the development of a new automotive product was followed, which is the one that adapts to the requirements of this prototype.

The prototype was tested in four different types of cars to verify its operation; it was observed that in all cars the survey was carried out successfully.

It was also verified that there was no engine heating due to the work performed.

Being a direct current motor, to achieve a high torque, large reductions were made, which resulted in low output revolutions.

The time it takes for the jack to travel the entire spindle race is 10 minutes, rising approximately 2 centimeters per minute.

No effort is required by the user to lift the car, since the energy required is provided by the car's battery.

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Implementation of an Electric Energy Monitoring System on Main Boards

Implementación de un Sistema de Monitoreo de Energía Eléctrica en Tableros Principales

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Abstract

The cost of electric power has become one of the most representative expenditures in the industrial environment and other organizations, only after human resources. Currently, seeking the reduction of expenses in processes and operations has become a necessity for survival in the market. Therefore, the optimization of any process is the measurement, only what is measured can be managed and therefore improved. The reduction and good use of energy is not possible without having a reliable source of information; that is why the implementation of a useful monitoring system will indicate the expenses and in what way to proceed in order to establish real opportunities for savings, as well as strategies for their maintenance in different networks. Thus, the following paper is the result of the implementation of an electrical monitoring system for an industry in the region.

Energy, Resources, System

Resumen

El costo de la energía eléctrica se ha convertido en uno de los egresos más representativos en el ambiente industrial y demás organizaciones después del recurso humano. Actualmente, buscar la reducción de gastos en los procesos y operaciones se ha convertido en una necesidad para la supervivencia en el mercado. Por tanto la optimización de todo proceso es la medición, solo lo que se mide se puede administrar y por ende mejorar. No es posibles la disminución y el buen uso de la energía sin tener una fuente confiable de información, es por ello que mediante la implementación de un sistema útil de monitoreo nos indicara donde se está gastando y de qué manera podemos atacar para establecer oportunidades reales de ahorro, así como también estrategias para su mantenimiento en las diferentes redes. Por lo que el siguiente trabajo es el resultado de la implementación de un sistema de monitoreo eléctrico para una industria de la región.

Energía, Recurso, Sistema

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† Researcher contributing first author

Introduction

Currently, energy expenditure control is one of the fundamental factors which should be monitored by large companies using electricity intensively as part of their production process. One of the first points to consider is the adaptation of the contracted power to avoid penalties which make supply more expensive. From this, the monitoring and control of electricity consumption on higher consumption equipment is essential to promote energy savings, as well as the visualization of new actions that lead to the optimization of energy use and awareness regarding its usage.

Every day, the optimization of companies' resources becomes more important, which is why maintenance management plays a significant role in achieving this, since good use and proper implementation enable companies achieve improvements and reduce costs (R&H, 2019). Knowing the energy expenditure is the first step to reduce non-useful consumption. This energy excess not only supposes a greater economic cost due to the energy, but also increases the wear of the equipment and the degree of maintenance that we must carry out (IDAE, 2009,).

Economic growth and technological development lead to an increase in the demand for electricity; therefore it is necessary to encourage the efficient use of resources to avoid unjustified energy losses (OLADE, 2013). The implementation of the electric power cogeneration project reduces the production costs of the company ANGLO PERUANA by reducing the consumption of electric power at the Lurín production plant, which allows an increase in operating profit of up to 14%, generating annual savings of 2.9 million US dollars (Gutiérez, 2019).

Methodology

1. Energy Quality in the Industry

The industry is a representative economic sector in many countries, which evolves according to the conditions provided in each local economy. For this reason, it is important to implement policies that seek the optimal use of resources and the renewal of poor processes to reduce energy losses, which represent an economic impact for companies.

Wasted energy could be used to meet the needs of another consumer sector or to expand the productive activities of the same customer.

2. Energy audits

Energy audits are reports regarding energy consumption, which allow identifying the subprocesses that generate losses and quantify the possibilities of improvement and their economic viability.

The energy audit can be preliminary, detailed or special. The preliminary audit is based on a visual inspection. Detailed auditing requires the use of equipment that generates a measurement record. The special energy audit takes records by device and performs a fault analysis for a certain period.

The results obtained, once the improvement measures are applied, will be reflected in the medium and long term, with the reduction of costs for the factory and the increase of the useful life of its facilities.

3. Installed Load Verification

The six existing transformers in this factory until 2017 represent a power of 5700 kVA. Three pad-mounted type transformers were installed to expand the power capacity delivered to the factory, representing 51.7% of the current installed capacity.

Table 1 summarizes the load values installed per transformer in the factory.

Substation	Kva capacity	Main board
1	500	800 Amps
2	750	1200 Amps
3	2000	2000 Amps
4	500	800 Amps
6	2000	2000 Amps

Table 1 Substations – Main Boards

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Design of the Electrical Measurement and Monitoring System

1. Scheme and Distribution of the Measurement System

The constant monitoring of the electric energy consumption will allow registering, controlling and reducing losses, to optimize the management of resources used in the elaboration of medical products, creating databases for a later analysis. Figure 1 illustrates how the electrical monitoring network will be distributed.

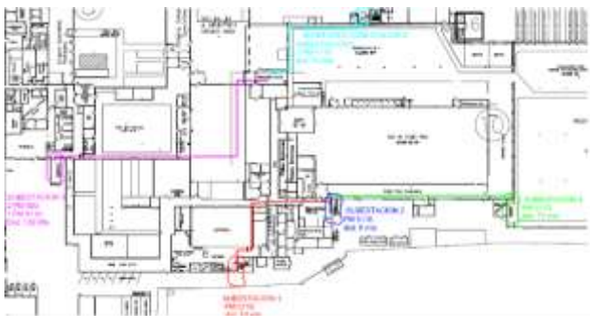

Figure 1 Distribution of Electrical Substations

2. Selection of the Monitoring Equipment

The intelligent measurement system consists of two programmable logic controllers, responsible for centralizing the measurements. An ethernet network with Modbus TCP communication protocol is used for energy measurement equipment. The system includes a Human Machine Iinterface (HMI), implemented through the devices shown in the figures, to allow constant monitoring of measured values, in addition to the storage of historical data.

Figures 2 and 3, as well as tables 2 and 3 illustrate the equipment used, as well as the characteristics of each of them, respectively.

Figure 2 Multifunction Energy Meter

General Data	
Family	Power Logic
Product Name	Power Logic PM5000
Short Name	PM5110
Type of product	Power Meter
Device application	Energy monitoring
Type of measurement	Energy Voltage Current Frequency Power factor
Frequency	60 Hz 50 Hz
Supply voltage	100… 415 V AC (45…65Hz) 125… 250 V DC
Type of communication	RS 485 port Modbus

Table 2 PM5000 Meter Features

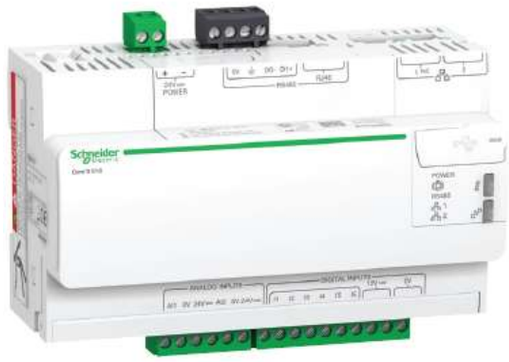

Figure 3 Com'X 510 power server

General Data	
Family	Power Logic
Product Name	ComX
Short Name	ComX 510
Type of product	Energy Server
Supply voltage	Main supply: 24 V - DC
Type of communication network	1 RJ45: RS485, Modbus serial Terminal block: RS485, Modbus serial 1 RJ45: Ethernet, PoE 15W (Power over Ethernet) 1 RJ45: Ethernet, DHCP
Number of inputs	6 Digitals 2 Analogs
Memory capacity	128 MB RAM 256 MB flash 4 GB SDRAM

Table 3 ComX 510 Features

The Com'X 510 power server is a gateway and a compact data logger. It is an essential part of every basic energy management system.

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It collects and stores data on water, air, gas, electricity and steam consumption, environmental parameters such as temperature, humidity and CO2 levels recorded inside a building. The Com'X 510 provides access to reports such as built-in summary pages of devices and circuits, as well as integrated data logging functions. The system allows access to data in real time in a secure way or their transmission to a report format to a database server on the Internet.

Results

After the selection of the components and the distribution of the different electrical meters inside the plant, the software installation and configuration of the equipment used for the electrical monitoring network of the plant is continued.

1. Modbus Configuration RS485 Series PM5110 - PM800

Modbus is a communications protocol located at level 7 of the OSI Model, based on the master/slave (RTU) or client/server (TCP/IP) architecture, designed in 1979 by Modicon for its range of programmable logic controllers (PLCs). Modbus enables the control of a network of devices, for example, a temperature and humidity measurement system, communicating the results to a computer. Modbus is also used to connect a monitoring computer with a remote unit (RTU) in data acquisition monitoring systems (SCADA). There are versions of the Modbus protocol for serial and Ethernet (Modbus/TCP). Therefore, the following figure 5 shows its configuration with the respective steps.

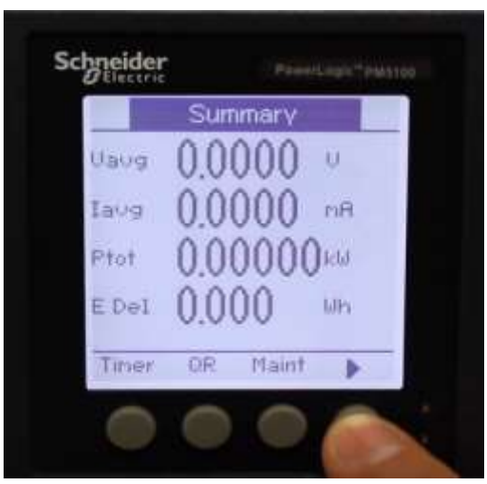

Figure 5 Illustration of steps for the configuration

- Step # 1: Select the Maintenance Menu on the screen.
- Step # 2: After selecting the maintenance menu press SETUP.
- Step # 3: As is common in these devices if the password has not been modified, by default it is (0 0 0 0) and press ok.
- Step # 4: Select the COMM option to modify the terminal parameters.
- Step # 5: Select the direction of the Equipment, the baud rate (9600, 19200, 38400) to work and the type of parity (Even, odd or null). Select OK and save the settings.

2. ModBus COMX510 Configuration

Once we have our electrical monitoring equipment configured, the next step is to configure the COMX510 server, as shown in figure 6 with the respective steps.

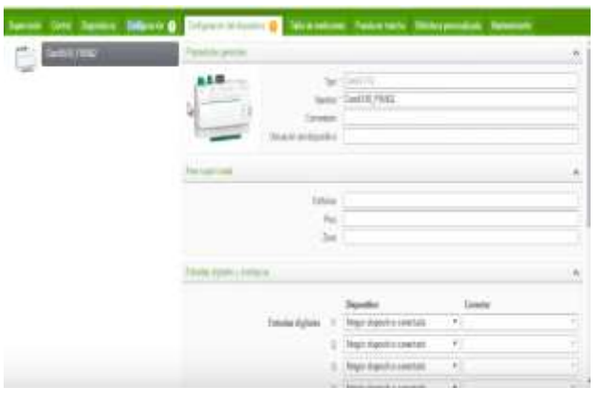

Figure 6 ModBus COMX510 configuration

- Step # 1: First, connect the COMX510 server through the Ethernet cable, one end connected to the Ethernet 2 port and the other end to the computer.

- Step # 2: Once in the computer, open the internet browser and in the address bar place the IP of the server and place the username and password.

- Step # 3: Select the Configuration tab and go to the Communications menu and press Modbus Series.

- Step # 4: Then, the RS485 Modbus configuration will show up in the portal, select the data previously established in the equipment, such as the baud rate (9600, 19200, 38400), the parity (Even, odd or null); in the number of stop bits select 1, in the waiting time select 1 second (1000), in the termination resistance put YES when having impedance, in the serial line polarization put YES, since it is convenient for the master to polarize the line and save the changes.

- Step # 5: The next step is to select the device configuration tab, where it will show all the properties of the COMX510. In this tab we can change the name, place comments, add the location of the device, as well as the building, floor and area where the server is located or supervised.

Finally, Figure 7 shows an image of how the electrical monitoring devices were mounted on their respective boards, in order to obtain the different records previously established.

Figure 7 Board Monitoring

Conclusions

We implemented an intelligent energy measurement system, which enabled the electrical energy measurements of 6 transformers to be stored on a computer.

Among the stored values are the calculations of electric power consumption. All these data are visible in the HMI installed on each electrical panel.

The installation of this HMI interface for monitoring allows for adequate information management regarding the measurement of important parameters, which are used to record consumption in each production period. Before implementing the meters, we worked with estimated values based on the production periods and quantity of manufactured products. The energy data was taken from the meter of the regional electricity company and some existing meters, without being able to make a complete analysis by production line. Based on the project developed, a system is provided to the factory to manage and monitor the consumption of electrical energy and other resources in an appropriate manner. With the data obtained, a permanent record is generated that will allow the implementation of continuous energy efficiency programs, which seek the rational use of resources without affecting the quality of the products, to obtain savings in the plant focused on the development of medical products. With the system implemented, an initial analysis was carried out, characterizing the demand for electrical energy and identifying the load curve according to the processes and machines that represent the highest consumption. The results obtained are intended to develop measures aimed at reducing unnecessary consumption in machines and processes, representing greater savings.

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Abstract (In English, 150-200 words)

Objectives
Methodology
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Introduction

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General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

Clearly focus each of its features

Clearly explain the problem to be solved and the central hypothesis.

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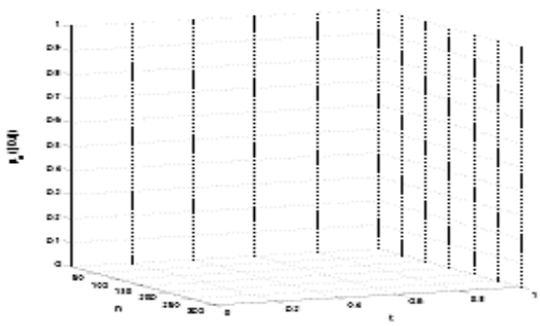

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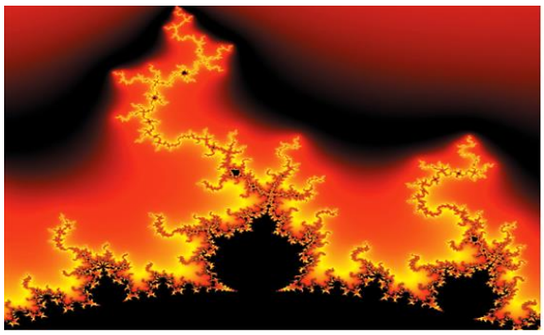

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Develop give the meaning of the variables in linear writing and important is the comparison of the used criteria.

Results

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Annexes

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