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The Importance of Linking the Academic Bodies with the Productive Sector in Problem Solving

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Abstract

In the city of Chihuahua, there exists an important maquiladora sector that is dedicated to plastic injection; they mainly produce connectors for the automotive industry.

The Technological Education Management academic group of the UTCH along with student interns participated in coordination with the multidisciplinary team in the areas of design and automation of the ACC plant in the project of designing and fabricating semi-automatic equipment that guarantees the assembly of several components, it has to meet certain requirements such as: safe to operate, operated pneumatically, operated by a collaborator, comply with a cycle time, ensure specifications of assembly according to the standards of the automotive industry.

Through the use of this equipment, it is sought to reduce the participation of the workforce in the assembly of the components for the connector, to prevent and avoid incidents of poor quality due to human error variations such as fatigue, distraction, boredom, mood swings, etc.

Academic group, internship, tie-up, problem-solving

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Introduction

The Academic Body Management of Technological Education of the Universidad tecnológica de Chihuahua and the University Superior Technicians Ramón Parra Díaz, Eladio Chavira Hernández and Sergio Alejandro Alicano Valdiviezo in connection with the productive sector develop in the company AUTO CONECTORES DE CHIHUAHUA ELCOM, S. de R.L. of C.V. (ACC) a project for the solution of an existing problem in the area of design and automation. This company belongs to the Yazaki Corporation which was founded in the year of 1929, its headquarters are located in the city of Hibara Japan.

In 1966 the first companies of the Yazaki Corporation were established in the North American continent, locating their headquarters in Michigan.

ACC was established in the state of Chihuahua in 2001. In July 2004, Auto Connectors of Chihuahua opened plant 2, taking its turn in the molding of connectors and wedges by means of plastic injection, within the automotive industry.

In the production area it is necessary to have a semiautomatic equipment that guarantees the assembly of several components, which must meet the following requirements: be safe to operate, be pneumatically activated, operated by a collaborator, comply with a certain cycle time, ensure assembly specifications according to the standards of the automotive industry.

Currently the sub-assembly operation is performed manually; For this reason, it is not guaranteed that the product meets the required quality specifications.

With the implementation of this team, it seeks to reduce the participation of the workforce in the assembly of the components of the connector, to avoid incidents of poor quality due to causes of the variation of the human factor such as fatigue, distraction, boredom, mood, etc.

The academic body, the students in stay in coordination with the multidisciplinary team of the design and automation area of the plant. Conduct previous meetings in order to identify the root cause of the problem in the production area.

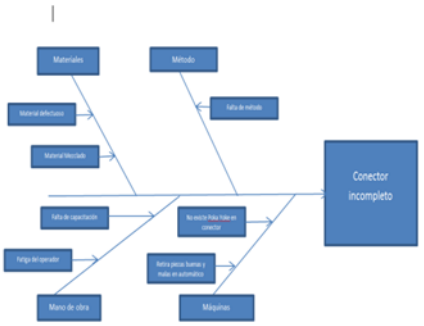

Figure 1. Diagrama de Ishikawa

Figure 1 shows the Ishikawa diagram where the materials used, method, labor and machines are analyzed. The analysis results in the need to design a semiautomatic team of connector assembly which is designed, manufactured and implemented by the young TSU during their stay at the ACC company in the period September-December 2016.

During this advisory stage, potential defects of the connector assembly are identified such as: badly assembled wedge, sunken wedge, missing wedge, use of damaged or defective connector in the molding, wrong model, defects in raw material, badly assembled arrowheads , damaged seal, poorly assembled CPA, sunken CPA, prolonged cycle time.

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The conclusion of these work sessions was that these defects must be detected and eliminated with the design of the equipment in question.

Justification

The present project is considered viable because it has the support of ACC for the design, manufacture, implementation and monitoring of the semiautomatic equipment that guarantees the assembly of several components and comply with the quality standards required by the automotive sector.

This project allows the connection of the university with the productive sector for the solution of problems in their processes with the participation of the academic bodies, being the linking one of the pillars on which the creation of the Technological Universities is based and also the student during his stay in the productive sector, he applies the skills acquired to solve problems during his school career.

With the development of said project in the area of design and automation of the company, it is intended to reduce the possible defects in the sub-assembly as shown in the Ishikawa diagram, with this it is intended to guarantee the quality of the product, as well as to avoid customer complaints.

Problem

In the assembly area of the plant defective connectors are produced, because the operations are carried out manually and there is no poka yoke device (error-proof) that guarantees the correct assembly of all its components.

Hypotesis

With the design, manufacture and implementation of a semiautomatic equipment, the correct assembly of all the components of the connector is guaranteed, the potential defects in the connector assembly will be reduced, such as: badly assembled wedge, sunken wedge, missing wedge, use of the damaged connector or with defect in the molding, wrong model, defects in raw material, badly assembled arrowheads, damaged seal, poorly assembled CPA, sunken CPA and prolonged cycle time.

Objective

Design, manufacture and implement a semiautomatic equipment that guarantees the assembly of several components in the production area of the ACC plant to eliminate the quality defects in the connector assembly.

Theoretical framework

The basic principles of pneumatics, mechanics, automation and industrial safety are investigated for the design, manufacture and implementation of said semiautomatic equipment. Here are some of them:

Tire Circuits

The compressed air distribution network must guarantee the pressure and velocity of the air at all points of use of the pneumatic installations. The regulation and control elements are responsible for regulating the passage of air from the accumulators to the actuating elements; These elements, called valves, can be activated in various ways: electrical, hydraulic, manual, pneumatic or mechanical. The classification of these valves can be done in three large groups:

- Directional valves.
- Anti-return and selector valves.

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- Pressure and flow regulation valves.

The cylinders transform pneumatic energy into mechanical energy, with reciprocating rectilinear motion. There are two types:

- Single effect cylinders

- Double effect cylinders

To produce rotary movement, compressed air motors are used. Here are some types and examples of application:

- Rotary piston motors with paddles: for right and left travel. For example they are used in compressed air screwdrivers.

- Star motors, for example, are used in mining.

- Turbine engines for example are used in dental drills.

The combination of pneumatic devices with electrotechnical devices (magnets and others) leads to electro-pneumatics.

Safety in pneumatic fastening devices

The handling elements of pneumatic clamping devices must be made and arranged in such a way that unintentional actuation is avoided. This can be done by:

- Manually operated switching elements with locking caps or locks.

- A blockage at the control level.

Precautions must be taken to avoid injury to the hand by the clamping device. This can be done by:

- Clamping cylinders outside the feeding area.

- The use of safety clamping cylinders that exerts the full clamping pressure only on the work piece.

- The use of a two-hand shot.

Transducers

Transducer is a device that transforms a type of variable or physical quantity (for example, force, pressure, temperature, speed, etc.) into an electrical signal.

Sensor is a transducer that is used to measure a physical variable of interest. Some of the most frequently used sensors and transducers are voltage calibrators (used to measure force and pressure), thermocouples (temperatures), speedometers (speed). Any sensor or transducer needs to be calibrated to be useful as a measuring device. Calibration is the procedure by which the relationship between the measured variable and the converted output signal is established.

Transducers and sensors can be classified into two basic types, depending on the shape of the converted signal. The two types are:

- Analog transducers

- Digital transducers

Analog transducers provide a continuous analog signal, for example, voltage or electrical current, this signal can be taken as the value of the physical variable that is measured. The digital transducers produce a digital output signal, in the form of a set of parallel state bits or forming a series of pulses that can be counted. In one form or another, the digital signals represent the value of the measured variable.

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Digital transducers usually offer the advantage of being more compatible with digital computers than analog sensors in automation and process control.

Desirable characteristics of the transducers: accuracy, precision, range of operation, speed of response, calibration and reliability.

Classification of the sensors according to the type of magnitude:

- Linear or angular position
- Displacement or deformation
- Linear or angular speed
- Acceleration
- Strength and torque
- Pressure
- Flow
- Temperature
- Presence or proximity
- Tactile
- Luminous intensity
- Artificial mink systems

Classification of the sensors according to the operating principle

- Contact
    - Position switches
    - Tactile
- Proximity
    - Inductive
    - Capacitive
    - Ultrasonic
    - Photoelectric

Method

Project development

To start with the design of the equipment, the FMEA format is necessary (format to analyze possible failures and solutions in the connector) which is delivered together with the work order, where the operation of the equipment to be manufactured is explained, movements to be made, adjustment tests or new schedules.

As a second step, the prototype of the 3D machine is designed using Solid Works design software. Figure 2 shows the semiautomatic equipment in 3D modeling where it is observed:

- Nests and pieces.
- Vision sensor.
- Robbery cylinders with which the equipment acts.
- Acrylic and extruded aluminum guard.
- Safety curtains to avoid any type of accident in the operator.

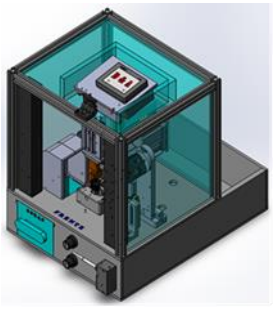

Figure 2 Semi-automatic equipment Designed in 3D

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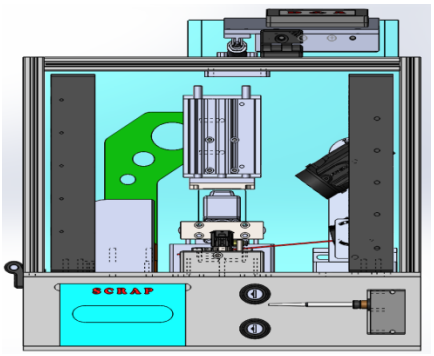

Figure 3 Front View of the Semiautomatic Equipment

In figure 3 it is observed:

- Vision sensor.
- Cylinder that joins the CPA (connector cover)
- Ejection of the piece to the waste container.
- Key switch to open waste drawer.
- Key switch to release the equipment.

This equipment is designed with the relevant safety measures to avoid any accident. It has a sensor to detect the presence of the hands of the operator and interrupt the operation if necessary and two key switches one is to open the waste drawer once it is full and the other is to perform the release of the equipment.

Figure 4 shows in graphic form the correctly assembled components, which are: the connector, CPA and the wedge. These connectors have to be assembled according to the visual aid, this ensures the correct assembly and proper operation of the part in vehicles.

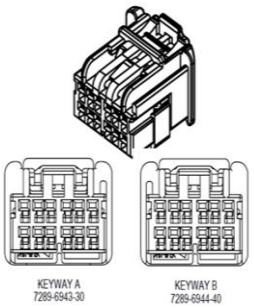

Figure 4 Components assembled correctly

For the assembly of the CPA (connector cover) a robbery cylinder is placed which is programmed by means of a software that allows it to give millimeter distances and thus leave in the best position assembled in the connector.

The vision sensor checks the CPA height, presence of the wedge and checks the equipment's release pieces so that it operates perfectly. It also has a device that automatically sends the defective parts to the waste container, thereby preventing the operator from having contact with parts rejected by the equipment and guaranteeing the quality of the product.

A marking point system is placed. Each time the team makes a good piece, it will be marked and then the operator will make the packaging in the finished product box.

In addition, a touch screen is installed which allows you to keep statistical records such as: observe the cycle time of the equipment, the number of pieces made per hour or shift, as well as observe the quantity of defective pieces in the scrap drawer (waste). This statistic allows the machine operator to release the day's production, repair or release.

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To complement the project, a manual for the use of automotive connector assembly equipment is developed and standardized for the execution of new electrical connectors manufactured in the plant, the manual refers to the steps to be followed to facilitate the development of new equipment:

Equipment design and automatic machine, for which it is necessary

- Request plans of the new product.
- Generate work order to manufacture the new equipment.
- Formats for design and standardization are filled.
- Verify the specifications of the pieces to be built.
- Make the final plans of each machining.
- The design acceptance format is filled.
- The programmer tests for finished work review.
- Validation tests are carried out.

Machining of parts

- Basic revision of the machine.
- Reception of plans.
- Machining in simulator.
- Final machining.

Integration of components

- Identify the components of the equipment.
- Prototype assembly.

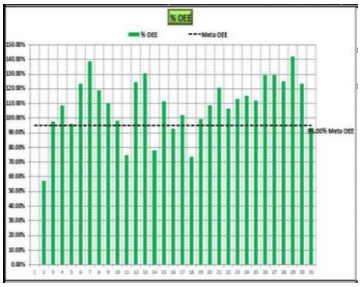
Machine programming

- Verify the necessary PLC for the equipment.
- Schedule the required activities.
- Routines are run to detect defects.

Following each of the steps proposed in the manual facilitates the manufacture of new equipment, allows the training and training of new personnel to the area of design and automation.

Results

As a result, the design, manufacture and implementation of a semi-automatic equipment that guarantees the assembly of the new part number was obtained, this equipment makes the function of a Poka Yoke device fail-safe in the insertion of its components. This ensures that all the elements of the connector are assembled correctly according to the manufacturing plan of this part number and it is possible to develop a general manual of the process of design and automation of new products that allows the manufacture of different equipment, facilitates the training and training for new staff in the area of design and automation, as it is important to have procedures for the development and control of new products and ensure compliance with the requirements demanded by different customers.



Graphic 1 Total equipment efficiency (% OEE)

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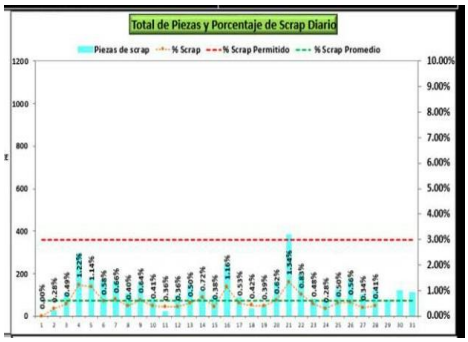
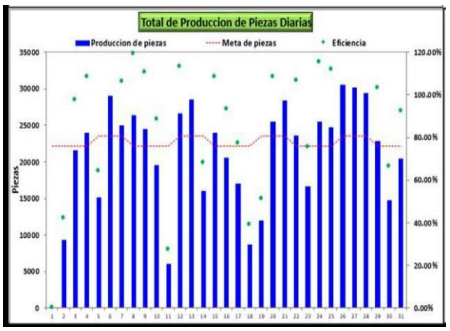
Graphic 1 shows the percentage of the total efficiency of the equipment (% OEE) for the month of December 2017, where a good performance of the designed semiautomatic equipment (108.00%) is observed, remaining above the established goal (95%).



Graphic 2 Total pieces and percentage of scrap daily

Graphic 2 shows us the total of defective parts in the month of December, which is below the allowed percentage.



Graphic 3 Total pieces produced

To complement the good functioning of the machine in Graphic 3 we can see a production of parts above the established goal.

Conclusions

During the collaboration of the academic staff with the productive sector through the stays of the students of the Technological University of Chihuahua, the importance of solving problems that the industry faces every day and in which the students help to improve the productive processes through the implementation of solutions that have an impact on productivity and the cost of manufacturing. In addition it is verified that the student reaches one of the specific competences of the TSU in industrial area maintenance which is to automate operations that were carried out manually by operators and to make more efficient the production in the companies, said competence is necessary to obtain their title of Superior University Technician in Industrial Area Maintenance.

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