Article

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Application of CAD, CAM, CAE, in prototype design and manufacturing of electric car lift

Aplicación de CAD, CAM, CAE, en diseño y manufactura de prototipo, de elevador eléctrico para autos

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Abstract

Industry 4.0 is currently supported by additive technologies that are increasingly accessible, which allow us to use them in different applications within the industry, such as designing devices, mechanisms or machinery in less time and cost, within the technologies. Additive, there is 3D printing, simulation software (CAD, CAM, CAE) that allows us to visualize and simulate the operation before manufacturing it, avoiding errors and costs. The use of additive technologies in the design of an electrical device for a car scissor lift, commonly known as a "scissor jack", will be demonstrated.BFirst step, the components that already exist such as the standard scissor lift are drawn, to be able to manipulate it in design software, later we will design the elements, such as motor fastening and other components. Second, perform a finite analysis of the components, to analyze that the parts and materials with which they were designed will withstand the stress to which they will be subjected, so that if necessary, corrects the model before making the prototype. Third, assemble and simulate its operation in software, verifying any anomaly in the simulation to correct before manufacturing. Fourth, carry out field tests, for their validation

Design, Innovation, Cost

Resumen

Actualmente la industria 4.0, se apoya con tecnologías aditivas que son cada vez más accesibles, lo que nos permiten su uso en las diferentes aplicaciones dentro de la industria, como es diseñar dispositivos, mecanismos o maquinaria en menor tiempo y costo, dentro de las tecnologías aditivas, está la impresión 3D, software de simulación (CAD, CAM, CAE) que nos permiten visualizar y simular el funcionamiento antes de fabricarlo, evitando errores y costos. Se demostrará el uso de las tecnologías aditivas en el diseño de un dispositivo eléctrico para elevador tipo tijera de auto, conocidos comúnmente como “gato de tijera”. Primero paso se dibuja los componentes que ya existen como el elevador de tijera estándar, para poderlo manipular en software de diseño, posteriormente diseñaremos los elementos, como son sujeción del motor y demás componentes. Segundo, realizar un análisis finito de los componentes, para analizar que las piezas y materiales con las que fueron diseñadas soportarán el esfuerzo a la que serán sometidos, para que en caso necesario corregir el modelo antes de realizar el prototipo. Tercero, ensamblar y simular su funcionamiento en software, verificando alguna anomalía en la simulación para corregir antes de manufacturar. Cuarto, realizar las pruebas de campo, para su validación.

Diseño, Innovación, Costo

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Introduction

The industry is becoming more competitive and demanding, they have to apply technological tools to be more efficient and more competitive, one area of application is that of design. When designing we must avoid manufacturing it and that they do not work because it has too many errors and this causes us costs, with the tools we anticipate and minimize errors, cost and time. Giving a competitive advantage to the company for its faster response in the design of a product or in proposing solutions, therefore it is necessary to know and handle technologies to be more efficient, some tools that can support, for the design of new products and equipment. I present an example of the application of tools in the design of "electrical device for scissor lift for automobiles" that most of us know to come in standard equipment of most vehicles. Using 3D printer and materials like PLA.

Objetive

Demonstrate the application of technology in the design and manufacture of a prototype of an electric device for a car scissor lift (scissor jack), using additive technologies, CAD software, CAE, and 3D printer.

Methodology

It began with the drawing of a standard equipment scissor jack, scaled 1:1.

Using design software, each component was designed for subsequent assembly.

Subsequently, a finite analysis of the components was carried out to analyze that the parts and materials with which they were designed, if they are adequate, simulate the effort to which the components will be subjected, and if necessary, correct the model before making the prototype. Once the analysis has been validated, they will be assembled, simulates their operation in software, verifying any anomaly in the simulation, such as interferences or an erroneous assembly, to correct before manufacturing, already validating the simulation we will continue to carry out field tests, for their validation, and go ahead or, if applicable, return to the design and correct depending on the field test results.

Component drawing

We start with the drawing of a scissor lift that generally comes as standard equipment in compact cars and the motor with a 12volt reducer that we will use, in the scissor lift, shown below.

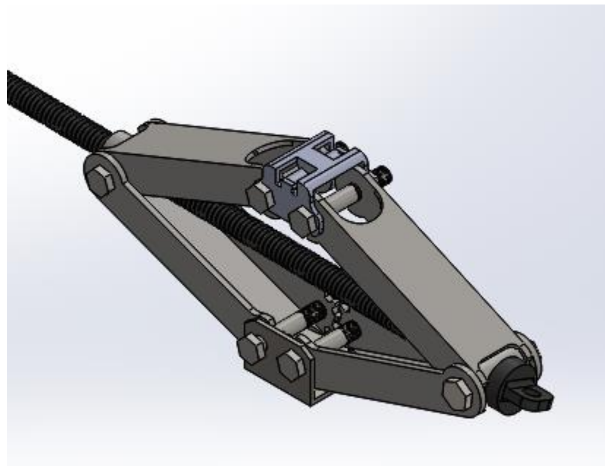

Figure 1 Drawing of a conventional scissor lift, design software

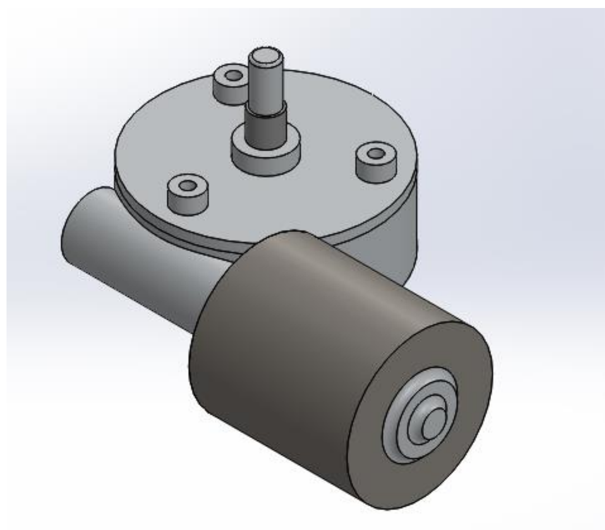

Figure 2 12 Volt motor, design software

The next step was to design the fastening elements to join the motor to the scissor lift, such as: a motor support base, to fasten the 12-volt motor to one side. And in turn will join the scissor lift, PLA material was assigned, for subsequent 3D printing.

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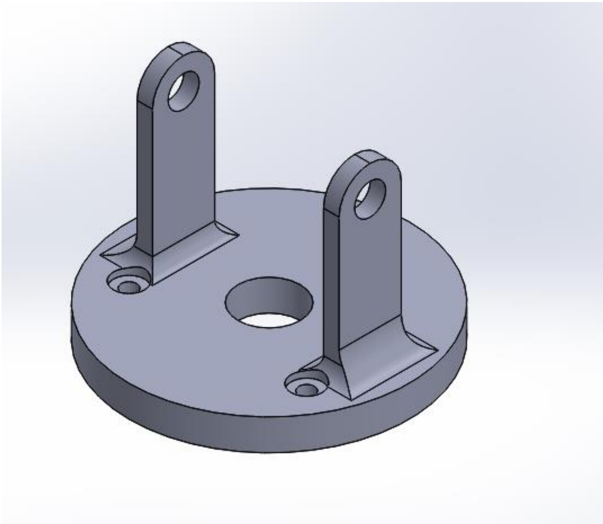

Figure 3 Design of motor support in LA, design software

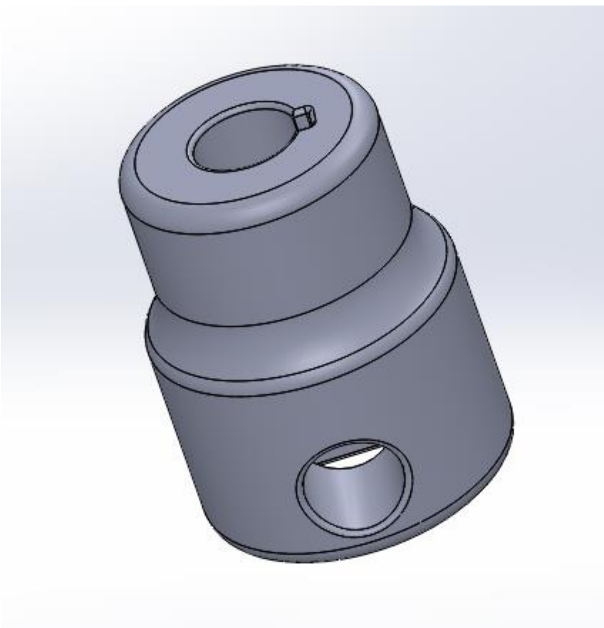

Figure 4 Coupling design, design software

Coupling design to give movement of the scissor lift motor, at one end it has a hole and at the other end it has a slot with a through hole, also in PLA material.

Control design, the button was acquired, but the housing had to be designed, leaving the assembly as shown in figure 5, with an outlet and inlet for the power cables at the bottom a cover-to-cover contaminants and dust.

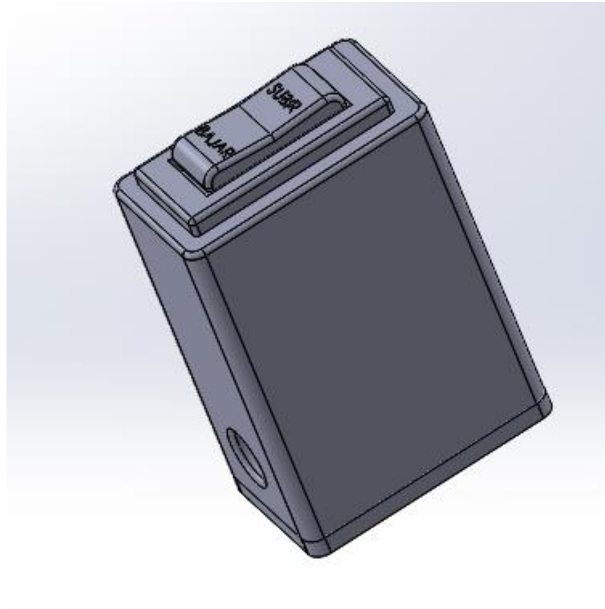

Figure 5 Control design, design software

Having the designed components, the finite analysis is carried out, a force of 150 nm was applied. For torsion, we started with the base of the motor support and the results were as follows.

Finite element analysis

Having the components designed, we proceed to the finite analysis applying a force of 150 nm. For torsion, we started with the base of the motor support and the results were as follows.

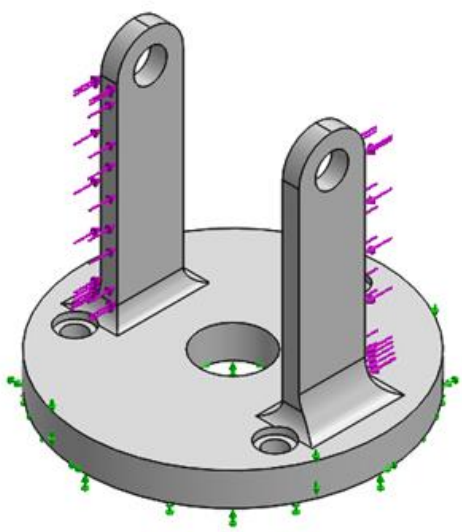

Figure 6 Finite analysis support model, finite analysis software

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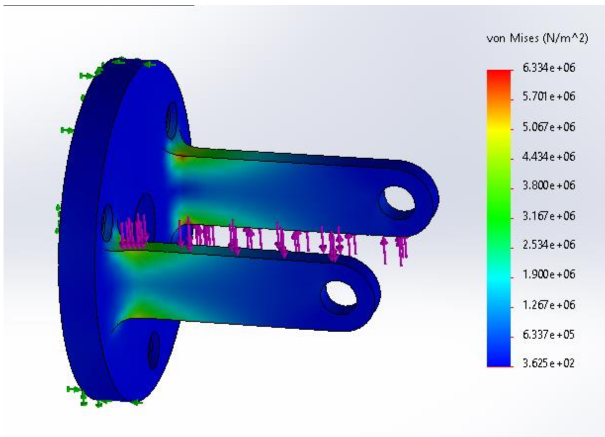

Figure 7 Results VonMises Tensions, finite analysis software

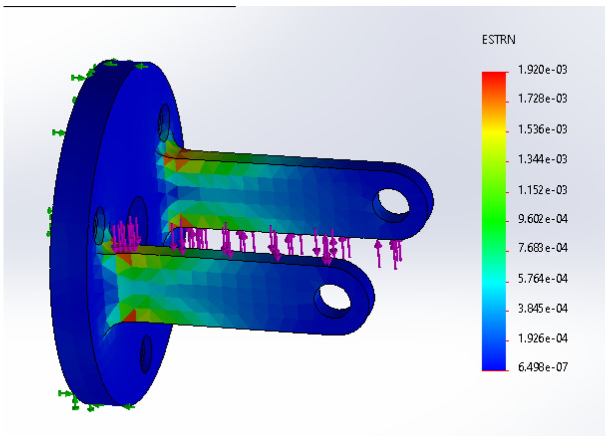

Figure 8 Results Unit deformations, finite analysis software

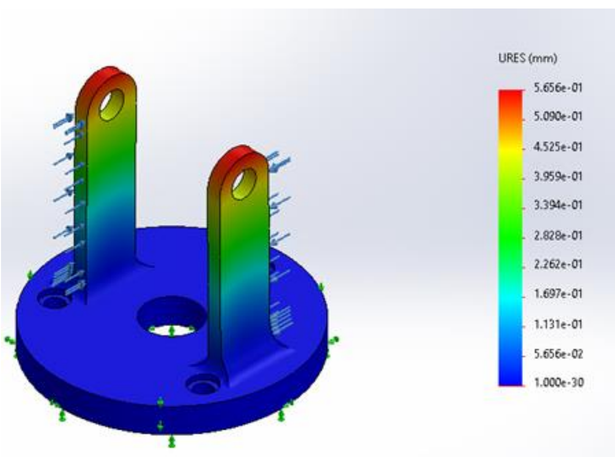

Figure 9 Results of displacement analysis, finite analysis software

As can be seen in the images, the results are satisfactory, red is when it is close to the limits, which is minimal, this gives us certainty in the design.

Subsequently, we subjected the coupling to analysis, also in PLA material, to a torque of 150 nm. and the results were as follows.

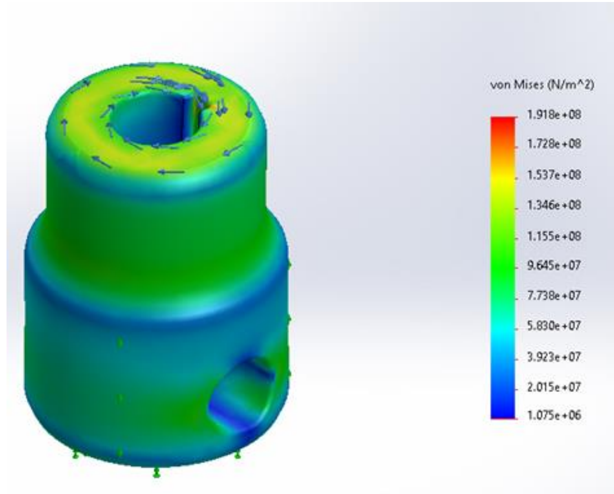

Figure 10 Results VonMises Tensions, finite analysis software

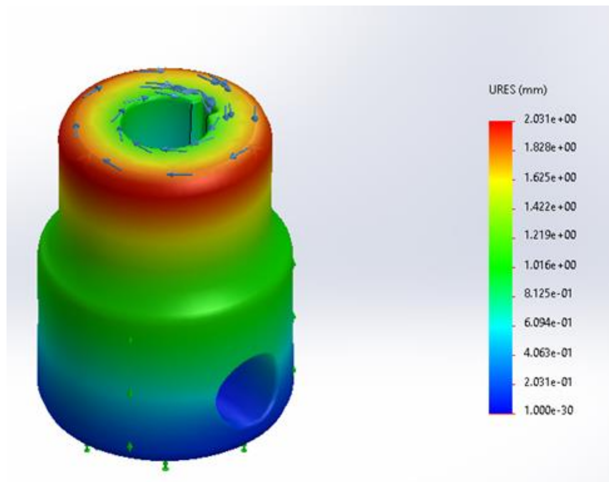

Figure 11 Results Torsion analysis –displacement, finite analysis software

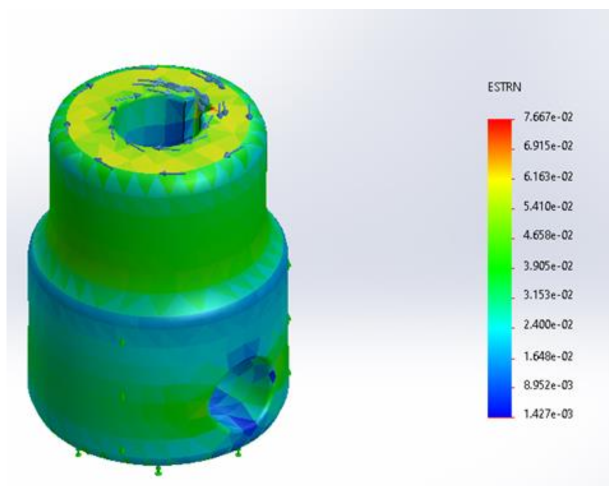

Figure 12 Results Strain analysis, finite analysis software

It can be seen that the analysis results were satisfactory, the switch housing, it was considered unnecessary to submit it to stress analysis. So we proceed to the assembly and simulation of movement.

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Assembly and motion simulation

It was assembled in a simulator with the components, such as, scissor lift, motor, motor support, coupling, switch and hardware, movement was applied.

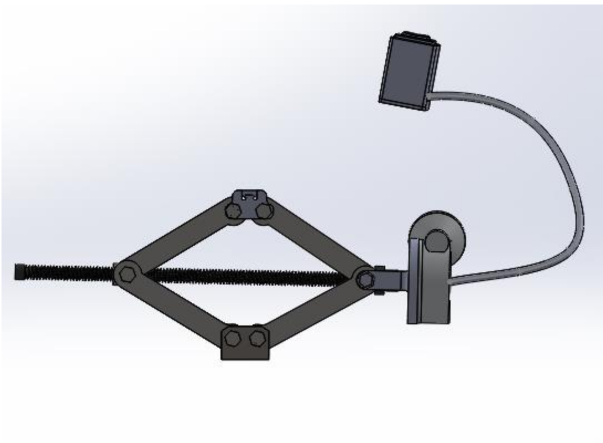

Figure 13 Assembled set, design software

Assembled with all fastening accessories and movement simulation was performed.

The stress analysis simulation being satisfactory, the components were manufactured, in the case of coupling, motor support and switch housing, using a 3D printer, they were printed in PLA material.

3D printing PLA (polylactic acid) material

A 3D printer was used, with a printing area of 250 x 250 x 300 mm. For the manufacture of elements such as motor support, switch housing and coupling, the material was used PLA, first the 3D printing is configured in the CURA software, then it is printed, printing time 7 hours for the 3 pieces.

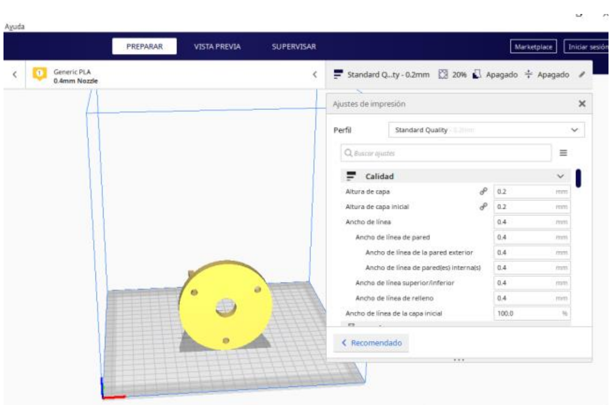

Figure 14 3D Printing software screen, CURA software.

Once configured it is printed, the images are displayed.

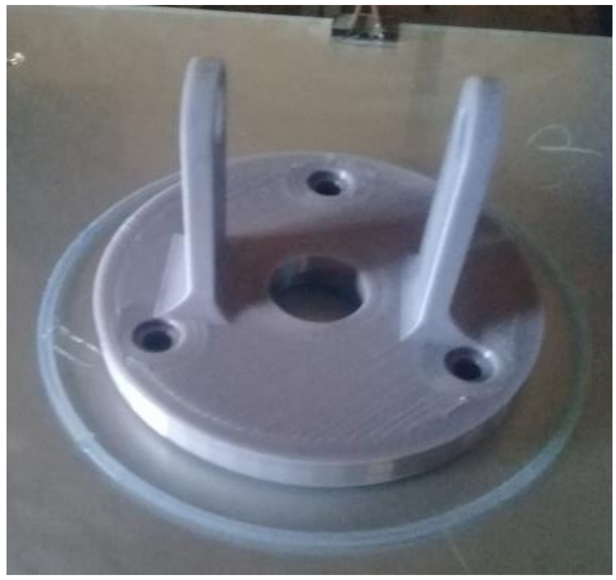

Figure 15 3D Printing in PLA. Motor mount
Source: Own source.

Figure 16 3D Printing in PLA. Cople
Source: Own source

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Figure 17 3D Printing in PLA. Switch housing
Source: own

Prototype assembly and test run

Figure 18 Manufactured and assembled set
Source: Own

Prototype with all the attachments, already assembled and connected, there were no setbacks in terms of component design.

Figure 19 Empty test
Source: Own

Idle test, its operation will be verified and in case of having an error correct it, to be functional, the next step is to perform a field test, with load, of a compact car.

Results

The desired ones were obtained, in terms of design (CAD) and components; Several adjustments were made in dimensions and shape, adjusting the elements of the elevator and the motor, to later validate it with the software, the load and torsional stresses (CAE), the motor and coupling support elements were analyzed, giving certainty From the design, in the assembly simulation, it was verified that there were no interferences or collisions of the different components, before their manufacture and assembly, minimal details were presented, which were corrected for their manufacture with 3D printing in PLA (CAM) which is One of the additive technologies, with this technology, manufacturing costs and times were saved, 118 grams of material was used, the approximate cost of the PLA material was $ 90.00 Mexican pesos with 7 hours - printing machine.

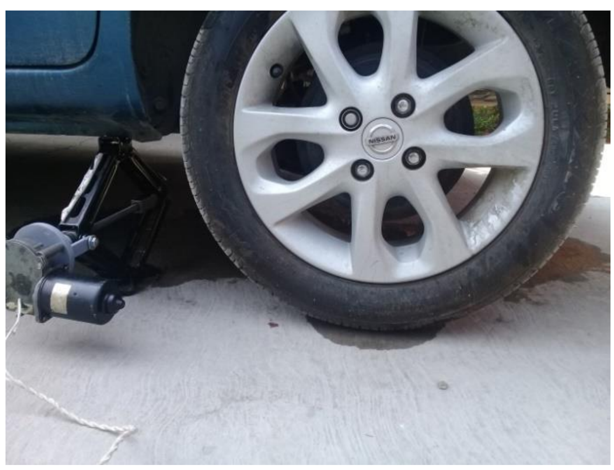

Figure 20 Load test
Source: Own

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Conclusion

CAD, CAM, and CAE technologies have great application in the manufacture of prototypes. As demonstrated in the manufacture of "electric car lift", they are increasingly essential in industries that are constantly innovating their products, to use software specialized from the design, simulation and obtaining a virtual assembly give us a broader and more real vision of the behavior that the new product and components will physically have, increasing the reliability of carrying out the prototypes to a successful conclusion.

At the beginning there were doubts about the resistance of the PLA material, however, when using the technology in the simulations that indicated that the material was resistant, it was carried out with the components and materials applied in the simulations, working as demonstrated, saving costs and Time is essential to increase the competitiveness of companies, especially SMEs, as it makes them more competitive.

With these technological tools, a new design or product can be evaluated, right up to manufacturing, giving greater certainty of the behavior, obtaining as a result competitiveness between companies, with faster response time in an increasingly dynamic market, Industry 4.0 is present.

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