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Ergonomics study applied to automotive systems and motor vehicles

Estudio en ergonomía aplicado a sistemas automotrices y vehículos automotores

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Abstract

Objectives

Implement an ergonomics engineering proposal where an appropriate design is generated for the suitable well-being of an automobile driver, carrying out a detailed study of human anatomy.

Methodology

Apply knowledge of software design (CAD/CAM) by simulating ergonomics tests and computer impact tests. Catalog the benefits of improvement and study the existing models of the various technologies of three competitive companies as differentiating the car models under study.

A good car is constructed in every detail so that it is possible to concentrate fully on traffic while driving. The driver's pose is comfortable and relaxed. His attention is not irritated or distracted by cumbersome searches of the controls or by environmental disturbances such as excessive heat or cold, noise, or exhaust fumes. In addition to this conditioning, the best possible visibility during the day and at night protects the sight and the nerves, allowing foresighted driving, thus assuring the temporary life of the people.

Contribution

To protect the car driver's life and prevent physical degenerative and anatomical diseases by applying engineering studies in ergonomics.

Ergonomics, Degenerative, Conditioning

Resumen

Objetivos

Implementar una propuesta de ingeniería de ergonomía donde se genere un diseño apropiado al adecuado bienestar de un conductor de un automóvil, realizando un estudio detallado de anatomía humana.

Metodología

Aplicar conocimientos de diseño en software (CAD/CAM), simulando pruebas de ergonomía y pruebas de impacto por computadora, catalogar los beneficios de mejora y estudiar los modelos existentes de las diversas tecnologías de tres compañías competitivas, así como diferenciar los modelos de automóviles bajo estudio.

Un buen coche está construido en todos sus detalles de modo que sea posible concentrarse plenamente al tráfico al ir al volante. El conductor va sentado cómodo y relajadamente. Su atención no sufre irritación o descuido por engorrosas búsquedas de los elementos de mando ni por molestias ambientales como serían un excesivo calor o frío, ruido o molestias por gases de escape. A este acondicionamiento se añade la mejor visibilidad posible de día y de noche, que protege la vista y los nervios, permitiendo una conducción previsora por lo que asegura la vida provisoria de las personas

Contribución

A salvaguardar la vida de un conductor de automóvil y prevención de enfermedades físico degenerativas y anatómicas aplicando estudios de ingeniería en ergonomía.

Ergonomía, degenerativa, acondicionamiento

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Introduction

We will begin our study by providing the definitions of ergonomics as:

Ergonomics is the discipline that deals with the design of workplaces, tools, and tasks so that they match the physiological, anatomical, psychological characteristics and human capabilities.

However, over time it has been modified especially when it comes to applying it to the study of improvement in various areas of human activity specifically applied to the automotive industry (automotive) and people whose job is to drive a vehicle on a daily basis.

This research has to do with the contribution of the generalized study to the automotive field and is of vital importance because it helps greatly in the prevention of physical risk factors that make it possible to generate prevention of anatomical diseases and degenerative diseases or sequelae that may be exposed to a certain time (more than 5 hours a day), a person who in the day to day performs and drives a vehicle and is exposed to any type of events.

In addition to this the poor safety conditions regarding the handling and use of an unsafe vehicle, it is important to know if you are protected against any possible decompensation, technical or human failure and/or suffer an accident with serious consequences, even perish or live injured or disabled for the rest of their existence.

This is how a good study of re-engineering, ergonomics, human anatomy, physical or anthropomorphic, and study of the good handling of a vehicle, will be trained and prepared for a contingency focus on the needs of daily use of driving a vehicle. On the other hand, knowing the advantages that an analysis of automotive ergonomics could influence a healthy lifestyle and improve our level of healthy living, being aware of it since according to WHO that every day about 3500 people die on the roads in the world. Tens of millions of people are injured or disabled every year (WHO 2016).

On the other hand, applying the concepts of ergonomics, according to Aguirre Montenegro (August 2016) based on several types of research, when specifying ergonomics systemically, we talk about "the study of the human being-built environment system". The author defines "built environment" as the physical, concrete, material components, the product of the human being, which are part of the ergonomic system; for example, a car, a chair, a car seat, etc. It is a challenge for the good use and handles to enjoy and perform.

The research is based on another conceptualization that outlines the ergonomic system as the object of study of ergonomics, composed of three known and predetermined elements: the human being, the object/machine, and the physical space. Which are related to each other or to their parts, and interact to carry out work or activities that can be motor, sensory or rational (Meroño Gallut., 2006).

Development

To begin to make an analysis of the ergonomic study, one must first think under what type of conditions this study will be developed, in this case, the answer is the need to create an ergonomic design that fits the morphological and anatomical dimensions of an average citizen living in the region of Tecamachalco Puebla, Mexico; because the cars that generally exist in most Latin countries are of foreign origin and this type of vehicles are molded to the morphological and ergonomic conditions of their country of origin.

For this reason, it is common to see people who find that the car is too big and wide for them".

To start with the analysis we created a table in which all the parts of the body that were going to be measured were indicated: height, weight, back length, back width, arm length, arm, forearm, hand length, waist width, leg length, etc. As shown in Table 1.1 (Gómez Darío 2016). We proceeded to take a small population sample in the site where the study will be conducted, in this case, in the region of Tecamachalco Puebla, and collect the necessary data to start this study.

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Thus, the average of each of the parts of a body were statistically determined and an average standard of the person living in the city was found. Based on these results, proposals and analyses on the type of design that would be used were made without neglecting the safety and comfort factors.

The following results show a sample analysis which are the measurements of the average man, obtained from a data collection table 1.

Average measurements		
Height	174	cm
Arm length	25.6	cm
Forearm length	32	cm
Chest depth	24.1	cm
Hip depth	22.3	cm
Back width	39.7	cm
Hip width	34.5	cm
Leg length	41.6	cm
Calf length	36.1	cm
Weight	76-3	cm

Table 1 Average measurement

In these measurements, the visualized average man in a seated position from the comfort angles is what the driver will have when occupying the physical space (volume units). The comfort angles range from the smallest to the largest. Therefore, the lower limit and the upper limit of the mentioned angles are analyzed in the following figure. (A1, A22 Figure 1) Details of the analysis and measurements of the space are shown when occupied by the driver with the lower limit comfort angles.

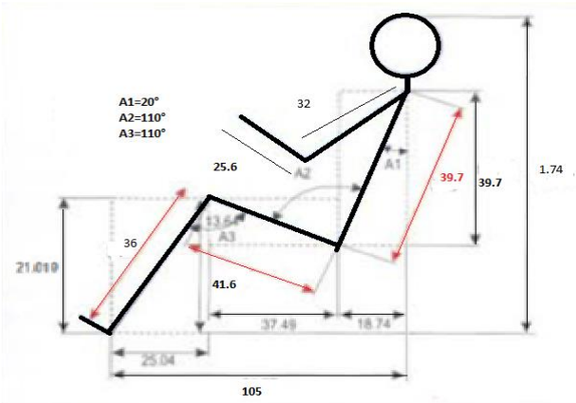

Figure 1 Average measurements in seated position.

These measurements vary according to the position of the passenger. It is also observed that there are two measurements that are the widest. 130 cm in height and 105 cm in width: based on this measurement, the area to be occupied by the individual in the front cabin is determined (Dario Gomez).

Figure 2 Average figure to be simulated

Subsequently, by observing the market of standard-size vehicles for five passengers the proposal design size is for two occupants. The following space is proposed for our front cabin (cab).

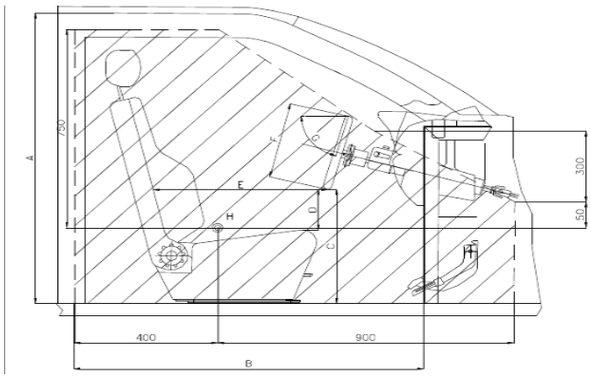

Figure 3 Pre-study design

With these measurements of the occupancy spaces in the cabin, we can undertake the designs of the elements that make up the front cabin. After that, the average man in a seated position is drawn in a 3D CAD program to have a better view of the space that the person will occupy. According to the measurements collected. This is done to evaluate the space occupied by the driver inside the vehicle. Now, with this information, the sketches of the parts of the driver's cab and its components to be operated are drawn.

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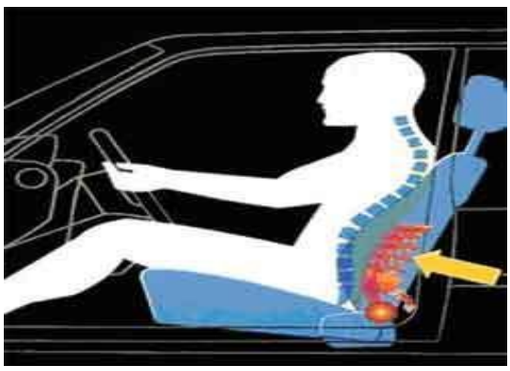
Figure 4 3D cabin simulation

There is another anatomical study with greater complexity. This study will not consider the lumbar are (Peláez, P.,)a Therefore, a good car is built in all its details so that it is possible to concentrate totally on traffic while driving (3).
The driver is comfortable and relaxed. His attention is not irritated or distracted by cumbersome searches of the controls or by environmental disturbances such as excessive heat or cold, noise, or exhaust fumes. To this conditioning, we added better visibility during the day and at night, which protects the eyes and nerves, allowing for foresighted and safe driving (Figure 1).

A)



B)

Figure 5 A) Lumbar study, B) Real simulated model taken from the original American source

The anatomically correct and relaxed riding position is decisive for reliable vehicle control. In addition to anatomy, ergonomics is also essential: quick and convenient access to the controls, adjustable steering wheel, adjustable headrest, etc. Pleasant cabin climate control is also a vital factor in physiological safety. If you have to sweat at the wheel, you can hardly concentrate on the traffic.

For safe and controlled driving, seat comfort is necessary. To achieve an optimum degree of seating comfort, manufacturers provide solutions such as:

- Electric displacement control.
- Electronic longitudinal, height, and lumbar adjustment (memory).
- Heating.
- Degree of the solidity of the cushion.
- Level of the lateral and lumbar support of the backrest, which should prevent fatigue.

The designers invested a great deal of money to build the controls arranged such that the controls are within easy reach of an average-sized passenger. The drives are grouped according to the functions they activate, prioritizing the safety elements, later the control elements, then the comfort elements, and finally the accessories.

The aim is to have the car's controls within easy reach of the driver. So, he can effortlessly operate the vehicle, avoiding distractions and thus preventing dangerous situations Figure 4.

Figure 6 Ergonomically designed operating controls

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The ergonomic design of the front panel and the pedal group is essential since the control, signaling, and information elements must be within the driver's reach. The controls must be smooth to operate, easy to read, and simply accessible. Incorporating a control on the steering wheel that regulates the radio's functions keeps the driver from having to move his eyes and hand to the radio (auto stereo) Figure 7.

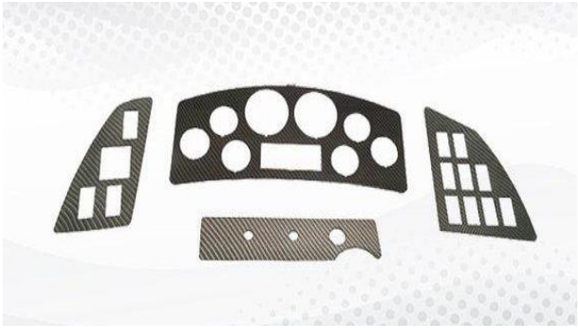

Figure 7 Ergonomic study of the digital front and side panel

In the content, all graphs, tables, and figures must be editable in formats that allow modifying size, type, and the number of letters for editing purposes. These must be of high quality, not pixelated, and observable even if the image is reduced to scale.

Each article should be presented separately in 3 folders: a) Figures, b) Graphics, and c) Tables in JPG format, indicating the number in Bold and the sequential Title.

Methodology

This study also takes into account the ergonomic-biomechanical risk actors (Muñoz, V. Z., Tomás, M. S. A.,) and, as a main approach, adopts a gender and age prism. The results show the prevalence of risk factors related to the existence of an increasingly aging and feminized population, with a higher rate of exposure to ergonomic-biomechanical factors, due to the development of activities derived from the use of hand tools.

From the cause-effect analysis, we have obtained a review of the most frequent occupational musculoskeletal disorders (MSDs) that could possibly occur (tendinitis, lumbago, muscle pain, among others) due to the development of agricultural activities, specifically in the oil sector, where the redesign of hand tools is proposed (in the case of the sub sector analyzed: the harvester and the use of tractor), the use of new technological tools (such as collaborative robots), as well as the implementation of activities oriented to a healthy aging as preventive organizational measurements of MSDs. This study of the redesign of technological tools complements this report in which it is foreseen that a protected population in an oleic work environment and in our case of transport and use of a vehicle coincide in the aspect of anatomical suffering.

Taking into account another study by (Perrazo, L. M., Díaz, M. R., Vaca, S. C., & Salazar, D. A.,2019) where overexertion by activities in which there is manual handling of loads, causes major injuries in the occurrence of musculoskeletal disorders. This research ergonomically evaluates the activities of handling and transporting loads in workers in freight transport maintenance. It uses an assessment method called MAC (Manual Handling Assessment Charts). The risk assessment is performed with the UNE-EN-1005-2 and (MAC) methods, the physical work capacity is established through the Manero staggered test, and the musculoskeletal symptomatology is analyzed through an adaptive version of the Nordic Kuorinka questionnaire. The results of the assessment indicate that 30.4% of the activities have an unacceptable high-level risk that negatively affects the lumbar area. The MAC method shows that 18.75% of the activities present a high risk of damage of physical integrity in terms of the staggered test 100% of the subjects of the staggered study have a high physical work capacity (PWC) for their age (>45 ml/kg*min). The body regions of the workers with the most negative impacts are the lower back, knees, and, to a lesser extent, the upper extremities.

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Correa A, Mosqueda A, explains that: participatory ergonomics was born as a strategy to prevent work-related musculoskeletal disorders, reduce the physical and mental workload, and involve workers in the identification, planning, and control of risks in their work. The participatory ergonomic intervention has been promoted in Scandinavian countries and in North America. The concept, participatory ergonomics, began to be used in the early 1980s. Participation means giving workers the opportunity to exercise control over the design of their workstation and the tasks they perform. This is justified by the fact that workers know better than anyone else the risks of their workstation and this allows them to develop effective proposals for improvement According to Marie St-Vincent, a Canadian ergonomist, participatory ergonomics is when workers, accompanied by technicians, are actively involved in the diagnosis of problems, with solutions. There is still no positioning in our organizations; however, it is possible that from various areas those interventions are carried out to reduce and impact the risk factor, but these actions are carried out in a very isolated manner.

Results

The results, from analysis in figure 1 and 2, as well as table 1.1, which states that if all the elements of an average human are not appropriate for the size and physical design of the average citizen, you can opt for a more in-depth study of anatomy, and ergonomics specially to achieve adaptation to a more comfortable and comfortable size.

That by its design can be replaced by orthopedic devices, which would be molded to the automobile system. This study based on an analysis of design and ergonomics foresees the use of a vehicle taking in recommendation first the good handling and of course the recommendations of use but knowing how to choose a type according to the physical dimensions of a person whose physical measurements are known. This study indicates that if we prevent based on a study model of our anatomy is likely in full cause to have a better standard of living and health in the daily use of a vehicle, on the other hand establish a model suitable to our anatomy and ensure by manufacturer's indications all safety measures of use and driving.

Acknowledgement

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Conclusions

For reliable vehicle control, it is relevant to know the anatomically correct and relaxed position. In addition to anatomy, ergonomics is a must: quick and convenient access to the controls, adjustable steering wheel, adjustable headrest, etc. Pleasant cabin climate control is also an essential factor in physiological safety: If you suffer discomfort at the wheel, you will hardly concentrate on the traffic. Clearly explain the results obtained and the possibilities for improvement

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Annexes

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