UNIVERSIDAD DISTRITAL FRANCISCO JOSÉ DE CALDAS

Visión Electrónica
Más que un estado sólido

https://revistas.udistrital.edu.co/index.php/visele

VISIÓN ELECTRÓNICA

A CASE-STUDY VISION

Development of mechanism for entertainment device

Desarrollo de mecanismos para dispositivo de entretenimiento

Maria Katalina Bonilla-Ramírez [1], ***Karol Geraldinne Torres-Pachón*** [2], ***Stefany Puentes-Cantor*** [3], ***Karen Juliette Forero-Rubio*** [4], ***Yolanda Torres-Pérez*** [5], ***Edwin Yesid Gómez-Pachón*** [6]

INFORMACIÓN DEL ARTÍCULO

Historia del artículo:
Enviado: 20/02/2019
Recibido: 11/03/2019
Aceptado: 27/04/2019

Keywords:
Fun device
Horse race
Kinematics
Mechanism
Movement
Static

Palabras clave:
Dispositivo de diversión
Carrera de caballos
Cinemática
Mecanismo
Movimiento
Estática

ABSTRACT

The objective of this project is based on the design and manufacture of a mechanism for a didactic product, awakening the interest of those who have affinity to horses and their skills. It is intended for people between 20 and 50 years old. Ergonomic, functional, use, aesthetic, structural and mechanical aspects were taken into account. In addition, the mechanisms were verified through the Working Model and SolidWorks software, with their corresponding static and kinematic calculations of the mechanism. The purpose of the project was to design a toy in the shape of a racecourse where there were two horses in competition, these displacements being generated by a crank movement exercised by the user, which was determined by kinematic calculations with the use of polar coordinates, finally we developed a prototype in scale 1-1 where we observed the speed of movement, the trajectory and the time it takes to carry out the activity. We conclude that for the development of competitiveness it is necessary to use a train of gears, which allowed the reduction of speed and the linear movement of the horse.

RESUMEN

El objetivo de este proyecto fue el diseño y fabricación de un mecanismo para un producto didáctico, despertando el interés de quienes tengan afinidad a los caballos y a las competencias de estos. Está destinado a personas entre los 20 y los 50 años. Se tuvieron en cuenta aspectos ergonómicos, funcionales, de uso, estéticos, estructurales y mecánicos. Además, se verificó los mecanismos por medio del software Working Model y SolidWorks, con sus correspondientes cálculos estáticos y cinemáticos del mecanismo. La finalidad del proyecto fue diseñar un juguete en forma de hipódromo donde estuvieran dos caballos en competencia, siendo estos desplazamientos generados por un movimiento de manivela que ejerce el usuario, el cual fue determinado mediante cálculos cinemáticos con el uso de coordenadas polares, finalmente desarrollamos un prototipo en escala 1-1 en dónde se observó la velocidad de movimiento, la trayectoria y el tiempo que tarda en realizar la actividad. Concluimos que para el desarrollo de la competitividad es necesario el uso de un tren de engranajes, que permitió la disminución de velocidad y el movimiento lineal del caballo.

[1] BSc. In Industrial Design, Escuela de Diseño Industrial, Colombia. Current position: Research Group DITMAV, Universidad Pedagógica y Tecnológica de Colombia, Colombia. E-mail: makabora01@gmail.com

[2] BSc. In Industrial Design, Escuela de Diseño Industrial, Colombia. Current position: Research Group DITMAV, Universidad Pedagógica y Tecnológica de Colombia, Colombia. E-mail: karotorres39@gmail.com

[3] BSc. In Industrial Design, Escuela de Diseño Industrial, Colombia. Current position: Research Group DITMAV, Universidad Pedagógica y Tecnológica de Colombia, Colombia. E-mail: stefany.puentes@uptc.edu.co

[4] BSc. In Industrial Design, Escuela de Diseño Industrial, Colombia. Current position: Research Group DITMAV, Universidad Pedagógica y Tecnológica de Colombia, Colombia. E-mail: karen_jf12@hotmail.com

[5] BSc. In Mechanical Engineering, MSc. In Engineering, Ph.D. In Engineering, Escuela de Diseño Industrial, Colombia. Current position: Research Group GENTE, Universidad Pedagógica y Tecnológica de Colombia. E-mail: yolanda.torres01@uptc.edu.co

[6] BSc. In Mechanical Engineering, BSc. In Physical, MSc. In Materials and Manufacturing Processes, Ph.D. In Materials Science and Engineering, Escuela de Diseño Industrial, Colombia. Current position: Research Group DITMAV, Universidad Pedagógica y Tecnológica de Colombia, Colombia. E-mail: edwin.gomez02@uptc.edu.co.

Citar este artículo como: M. K. Bonilla-Ramírez, K. G. Torres-Pachón, S. Puentes-Cantor, K. J. Forero-Rubio, Y. Torres-Pérez and E. Y. Gómez-Pachón, "Development of mechanism for entertainment device" , Visión electrónica, algo más que un estado sólido, vol. 13, no. 2, p.p. 300-304 july-december 2019, https://doi.org/10.14483/22484728.15161

1. Introduction

The development of a mechanism for a fan element, starts from a challenge to implement mechanicals mechanisms in a toy where people over 20 years old could interact, this is how the idea of taking horse races in racetracks was born as a reference for the toy.

Horse races in racetracks are used as a base for a game, that had been reflected in games that were made through a console, based on them the idea of implementing the same base in a toy, where two people could compete at the same time without the necessity for a screen or any plug, only through a crank that would allow your horse to move along a lane.

This is how the challenge of choosing the right mechanism for the correct operation of the proposed toy was born. In this way, the users and each one of the elements of the problem that would perfect the choice of the materials and the dimensions to be used were analyzed.

2. Development of the Topic

The development of mechanisms for a fun element was born with the purpose of creating a prototype where people between 20 and 50 years old will participate in an activity where there competition is evident, horseracing and table football are taken into account for the development of the project. Three different stages were taken into account for the develop the mechanism developed [1].

2.1. First Stage

2.1.1. Determination of requirements

However, it is necessary to determine the requirements as a first step for the development of the project, since it determines the design variables for the prototype.

Functional: the potential users of the toy are in an ages range between 20 to 50 years, which allows us to observe percentiles of an average adult (percentile 5, 50 and 90).

The gears are in a variety of very extensive materials to obtain the right properties for the use that they will be given. The resistance and durability, that is to say the resistance to wear of the material, had to be taken into account. For this reason, wood was taken into account as a material for development of the prototype, it has characteristics such as: elasticity, flexibility, hardness, resistance to shock.

Structural: the toy must be light or at least comply with the minimum parameters; an oversizing would generate an additional load for the user that transports the product.

It is taken into account that when exerting a rotational movement on each of the sides of the product, loads and vibrations are generated, so it was necessary to fix the axes of the gears to lateral rails, thereby ensuring the shape and stability of the elements in movement.

Each of the elements of the product must be configured in such a way that they do not lose their positioning in the development of the activity.

Technicians: The dimensions of each of the elements of the product were determined through static and kinematic analysis of the elements.

It is necessary to test the previous mechanisms, being that these can fail due to manufacturing defects, calculations, among others.

Use: The product could have indicative functions [2]. Due to the product is entirely made of wood, it facilitates the maintenance process since it does not present corrosion.

Esthetic: The material to be worked will be wood. This material is sanded, sealed, and its tonality is neutral in order to monopolize the age ranges.

The product will not have sharp tips, each of the corners are rounded in order to avoid injuries. Ergonomic: it is necessary to take into account the positions in which the user will be at the time of exercising the activity, see Figure **1**.

It is also necessary to measure the handle to know the size of our handle, which will be the main percentile of users, see Table **1**.

Figure 1: Anthropometric position, claw grip [3].

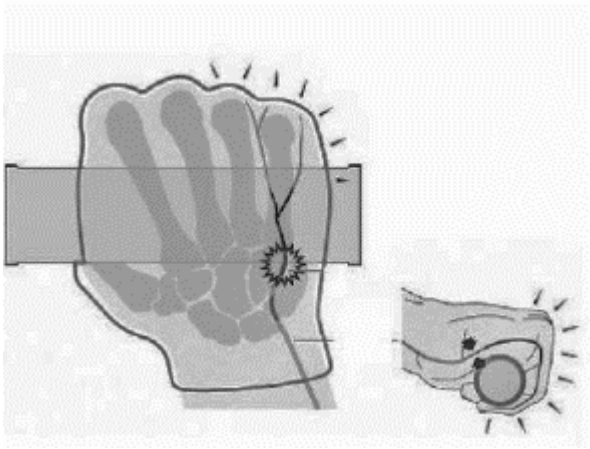


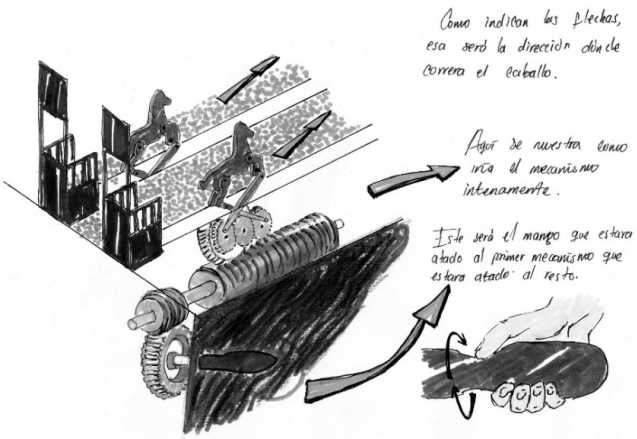
Table 1: Reference of hand grip percentiles [4].

Gender	Percentile (mm)		
	5	50	95
Female	40	45	50
Male	39	45	50

2.1.2. Proposal mechanism to be developed.

It is seen some accessories that will be implemented in order to simulate a racetrack this way will be referred to the activity, see Figure 2.

Figure 2: Sketch of proposal for the prototype.



Source: own.

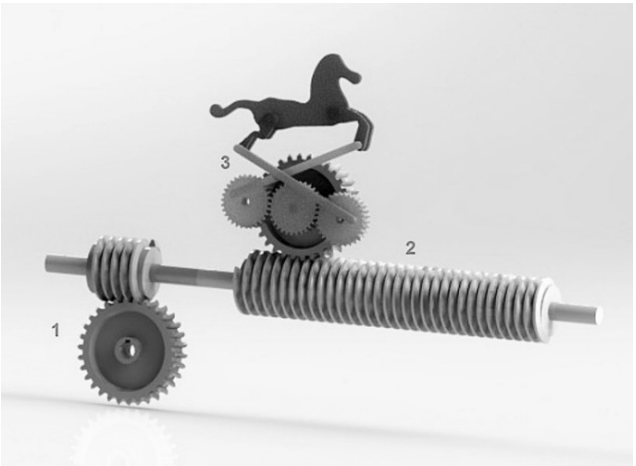
2.2. Second Stage

2.2.1. Determination of design parameters .

The definitive parameters were determined after performing static and kinematic calculations. Also structural elements were determined in order to present a definitive alternative with their respective planes, simulations of the proposed mechanisms were continuously carried out to verify how it worked and if it was suitable for the project. Finally, physical verification of the model's operation was carried out.

During the development of the project several proposals for mechanisms were made, this being one of the main concerns for the proper functioning of the product. Within the mechanisms proposed initially, a screw-worm was thought of as the main mechanism (see Figure 3). However, it did not meet the requirements that were raised from the beginning, so it was necessary to return to contemplate other types of mechanisms and make the relevant calculations to be functional.

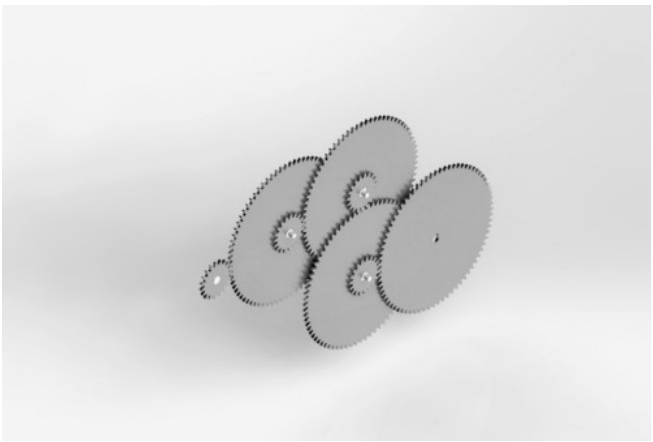
Figure 3: Set of mechanisms of the individual route of one of the horses of the competition.



Source: own.

It was deduced that the mechanism that best matches the proposed parameters is that of transmission by chains, since although it has limitations in terms of the horse's "cavalcade" movement, this mechanism did move along a route. After determining that the chain mechanism would be used, one more mechanism was added to decrease the speed; this consists of a gears train (see Figure 4), where the speed decreases until it reaches the expected.

Figure 4: Mechanism used for speed reduction.



Source: own.

All the above was deducted thanks to the calculations made, since these are the ones that give foundation to the project, the calculations made initially were static, being these based on the loads that the user would generate when starting the game, t was also they took into account the weights on the mechanisms and how much they had to resist when they got moving.

It is noteworthy that the kinematic calculations, of speed ratio between the worm and the crown, allowed to define that the crown would not move along the endless, it was also taken into account that one of the purposes of the game was that the player did a lot of laps and the horse did not move at the same speed, but during the game there was more and more emotion, in this way an initial angular velocity of 15,707 $\frac{rad}{seg}$ a linear speed of end of 0,008589 $\frac{m}{seg}$. These were the ones that each time oriented to choose the suitable mechanism, since not only the alternative of the endless screw was taken into account, thanks to these calculations it was also possible to find the reduction of speeds, where a geometry of the gears was obtained as the diameters where a speed ratio obtained was of 4, since the diameter of the pinion is 0,03 m and the gear diameter is 0,12 m, in this way it was also possible to find the number of teeth that each one will have, thanks to the known pressure angle 20° and an amount of 18 teeth was taken for the pinion (minimum required according to Robert L. Norton [5]), then it was raised:

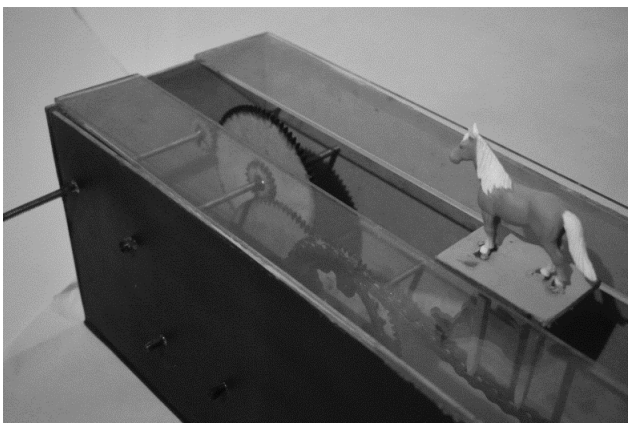
$$VR = \frac{N_p}{N_G} \tag{1}$$

Where:
VR: Speed ratio
N_P: Number of teeth of the pinion
N_G: Number of gear teeth

So, $4 = \frac{18}{N_G}$ resulting in an amount of 72 teeth in the gear. Then the diametral step was found, resulting in 15.24 (this was determined thanks to the division of the number of teeth over the diameter, either pinion or gear), but as this step was not normalized, it was searched in design books of machines the closest to this step, in this case the diametral step was 16, in this way recalculated the number of teeth of the pinion and the gear. Also, thanks to this, the geometry of the gear and the pinion was obtained, thus finding the clearance, the total height, the circular passage, the addendum, the dedendum, the external diameters, the distance between centers and others. In addition, the distance between centers that had to be had between catarinas was taken into account, since the chain mechanism was chosen for the displacement of the horse in the course of the track.

On the part of the design software, the movements, characteristics of the pieces and sizes necessary for the operation were simulated, in parallel was compared with the results, obtaining that the geometry calculated for pinions and gears comply with the speed ratio that had been raised, and in turn generated the reduction of expected speeds (Figure 5).

Figure 5: Final prototype of the game.



Source: own.

3. Discussion and Conclusions

• According to the results of the static and kinematic analysis, the relationship between speed and number of turns (angular and linear speed) was checked together with the model, knowing that it is proposed that the angular speed of input is of 15,707 $\frac{rad}{sg}$ and the linear speed of output is 0,008589 $\frac{m}{sg}$.

• The decrease in speed of the mechanism to ensure its proper functioning could be achieved thanks to the kinematic analysis with which the number of teeth and the diametral gear pitch were calculated allowing a smooth and optimal circular movement.

• Although, the screw was taken into account for the construction of the toy, considering that there would be a displacement, thanks to tests of operation, it was proved that the crown of the worm screw, would only rotate on its axis and that it would not comply with the purpose of this mechanism.

• It was of great importance to observe the simulation by means of a software, since these can foresee the possible failures in the system before the mechanisms take construction and incur expenses of production.

References

[1] K. T. Ulrich and S. D. Eppinger, "Diseño y desarrollo de productos", Quinta edición, México: Mc Graw Hill Education, 2013.

[2] E. Heller, "Psicología del color", Primera Edición, España: Droemer Verlag, 2008.

[3] S. R. Acherman, "Toys as teaching tools in engineering: the case of Slinky ®", *Ingeniería y Competitividad*, vol. 17, no. 2, 2015.

[4] J. Estrada, J. A. Camacho, M. T. Restrepo and C. M. Parra, "Parámetros antropométricos de la población laboral colombiana 1995", *Revista Facultad Nacional de Salud Pública*, vol. 15, no. 2, 1998, pp. 112-139.

[5] R. L. Norton, "Diseño de Maquinaria", Cuarta Edición, Mc Graw Hill Education, 2009.