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Research Article

Performance Improvement of Two Wheeler Locking System Using Value Engineering Technique

Shunmathi M*

Department of Mechanical Engineering, Thiagarajar College of Engineering, Madurai, India

ABSTRACT

This research work mainly developed to reduce the number of vehicles stolen per year. There were 49,791 bikes stolen in 2010-that's over $325 million in losses. There are various methods of prevention to reduce the likelihood of a vehicle getting stolen. Some of these include, Devices used to lock a part of the vehicle necessary in its operation, such as the wheel lock (manual), handle bar. Currently used alarm systems are easily be immobilized. In alarm type locking system, it will only inform the owner by high sound when someone tends to move or start the vehicle and stop the engine. But it will not preventing the movement of the vehicle. In this paper is provided on how to use value engineering technique to improve the performance of wheel locking system using ignition key and to develop a new design in pro e software. In wheel locking system, when ignition key is in off state then both front and rear brakes are applied. This will prevent the vehicle movement when it is not in use. This could be done for disc brake system. The brake fluid is passing from the caliper to the reservoir. So the brake piston releases the brake pads against the disc. By applying the wheel locking system in two wheelers, we could reduce the number of vehicles stolen per year.

Keywords: Value engineering; DC motor with gear train arrangement

INTRODUCTION

Motorized two-wheel vehicles like scooters, motorcycles and mopeds are very popular mode of transport due to their fuel efficiency and ease of use in congested roads or streets. The number of two-wheelers sold is several times that of cars. There were 154.3 million powered two-wheelers in India in 2015 compared with just 28.6 million cars. Yamaha, Hero Moto Corp, Honda, TVS Motors, Bajaj Auto and Mahindra 2 Wheelers are the largest two-wheeler companies in terms of market-share [1-3].

Motor vehicle theft is a big problem in our country. When we parking a two wheeler, we check three to four times whether the locks are working perfect and all locks including ignition key lock, side lock, and wheel lock are checked. This is the current scenario in not only in India, all the peoples are felt by this problem. Now-a-days peoples are using highly expensive bikes like Honda CBR 250R, KTM Super Duke, Ducati monster which costs around lakhs, so the vehicles need protective systems. In present the anti-theft systems used are the ignition key lock, wheel lock, alarm systems are widely used.

It will only inform the owner by high sound when someone tends to move or start the vehicle and stop the engine. But it will not preventing the movement the vehicle. Wheel lock is the manual one. Every time we need to put it back and locks. We need an efficient protective system as it automatically locks the vehicle when it under in locked state and it releases the lock when the vehicle is under ON state. We identified this problem and design a wheel locking system using ignition key. It automatically locks the vehicle when it is under in locked state, and it releases the lock when the vehicle is under ON state [4,5].

Value engineering overview

Value analysis (VA) or Value engineering (VE) is a function-oriented, structured, multi-disciplinary team approach to solving problems or identifying improvements. The value of a product will be interpreted in different ways by different customers. Its common characteristics are a high level of performance, capability, emotional appeal, style, etc. relative to its cost. This can also be expressed as maximizing the function of a product relative to its cost. Value is the least cost that can accomplish reliably a function

Correspondence to: Shunmathi M, Department of Mechanical Engineering, Thiagarajar College of Engineering, Madurai, India, Tel: 09597176702; E-mail: shunmathimech@gmail.com

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or a service. This implies in achieving reduced cost, the quality and performance of the item are maintained. Therefore the value analysis is a technique which builds 'value' into a product. Lawrence Miles developed VA/VE technique is in 1945 based on the application of function analysis to the components of a product. The single objective of modern value analysis is to deliver to the user/customer the required functions at minimum cost and improve the function of existing system. The functional analysis technique is so powerful that is questions everything we do in order to meet the expectations of the customers at the lowest cost. The reason for the preference of this tool by the management is that this technique tries to identify and eliminate the unnecessary costs. But while reducing or eliminating the cost, it takes into account that there is no deterioration of quality parameters. It is not a cheapening technique. Based on the functional requirements, it tries to fulfil the need, want and desire of the customers. And in a bid to avoid erroneous decisions of an individual, it advocates multidisciplinary team approach, and is based on scientific methods of data collection from reliable resources [6-10].

PROBLEM IDENTIFICATION

Problem environment

Today most of them using disk brake bikes like 125 cc, 150 cc, 200 cc and soon. So the idea of this project to improve the function of locking system only in disc break bike. The main theme of this project to control the movement of vehicle when ignition key in LOCK state and release the movement of vehicle when ignition key in ON state.

Objectives

- Stepping up the security of to two wheelers.
- Improve the function of ignition key.

Scope

- It only prevent the front and back movement in the vehicle not to protect the whole system of the bike.
- It could be easily assemble and maintainable.

METHODOLOGY

Value engineering methodology

The value engineering methodology provides the process and structure that is used to apply the value job plan in the study.

VE job plan

The job plan is a systematic and organized plan of action for conducting a VE analysis and assuming the implementation of the recommendations. This project comprises a six-phase job plan as below:

- Information
- Function
- Creation
- Evaluation
- Development
- Recommendation
- Result

Information phase

In this phase, the project is being studied and all the facts related to the project are obtained. Some of the existing security system are explained this phase.

Ignition lock

A bike key is the one which is used to start an automobile. Modern key designs are usually symmetrical, and some use grooves on both sides, rather than a cut edge, to actuate the lock. It has multiple uses for the automobile with which it was sold. A key start the ignition, open the inlet valve petrol tank. Recently, features such as coded immobilizers have been implemented in newer vehicles. More sophisticated systems make ignition dependent on electronic devices, rather than the mechanical key switch.

Ignition lock has the operation of starting and stopping the engine and locks the handle bar towards the one side (right or left). This action prevents the straight movement of the vehicle. But, now people are very smart. They learned to start the engine even without having the key; one man can easily lift the front side of the vehicle and begin to move to his place, so here the ignition key lock fails.

Wheel lock

This a low security mechanism mounted on the frame that immobilizes the front wheel by moving a steel bolt through the spokes to prevent motion. It uses a straight or circular bolt which extends from the housing. U-locks are more secure than most other kinds of locking mechanism because they are more resistant to cutting with high-leverage hand tools such as bolt cutters.

The wheel lock is fully manual so every time of starting we must pull out the U rod and bring in it to the provided holder and when we want to lock, we need to pull out the U rod from stand and bring it between the alloy. In alarm type locking system, it will only inform the owner by high sound when someone tends to move or start the vehicle and stop the engine. But it will not preventing the movement the vehicle. For a certain distance of movement, it will turn of the ignition but it won't prevent the vehicle movement.

DESIGN PHASE

In this phase ideas are generated for improving performance and setup the security of the wheel locking system using different technique like change the design (Figure 1).

Working of Locking System is under 2 stages:

- When the ignition key is going to OFF state.
- When the ignition key is going to ON state.

When the ignition key is going to OFF state:

- When key is going to lock state, the DC motor runs, so that

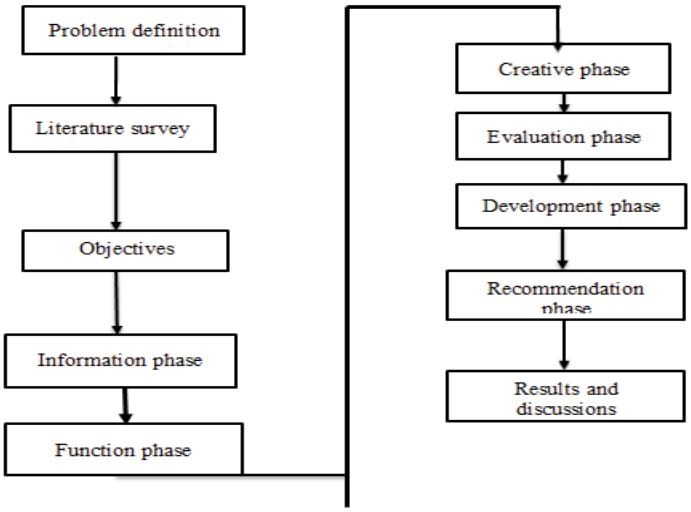

Figure 1: Methodology.

the pinion will rotate and this causes the bar will press the brake piston. This helps the piston to compress.

- The brake fluid is passing from the reservoir to the caliper.
- So the brake piston presses the brake pads against the disc.
- Due to this friction will be generated and brake is applied.
- As shown in Figure 2, the brake is applied till the key is move on to off state (Figure 2).
- When the ignition key is going to ON state:
- When key is going to ON state, the DC motor runs in opposite direction, so that the pinion will rotate and this causes the bar will release the brake piston. This helps the piston to retract.
- The brake fluid is passing from the caliper to the reservoir.
- So the brake piston releases the brake pads against the disc.
- Due to this brake is released.
- As shown in design, the brake is released when the ignition key is going to ON state (Figure 3).

The Function Analysis System Technique aids in thinking about the problem objectively and in identifying the scope of the project by showing the logical relationships between functions. The organization of the functions into a function-logic, FAST diagram enables participants to identify of all the required functions (Figure 4).

Fast diagram for wheel locking system

Benefits of the Function Analysis System Technique

- Develop a shared understanding of the project
- Identify missing functions.
- Define, simplify and clarify the problem.
- Organize and understand the relationships between functions.
- Identify the basic function of the project, process or product.
- Improve communication and consensus.

Evaluation phase

The Evaluation Phase is the fourth phase in the Value Analysis process. This is where the ideas generated from the Creative Phase are systematically evaluated, screened prioritized and short-listed for their potential to save cost and/or value.

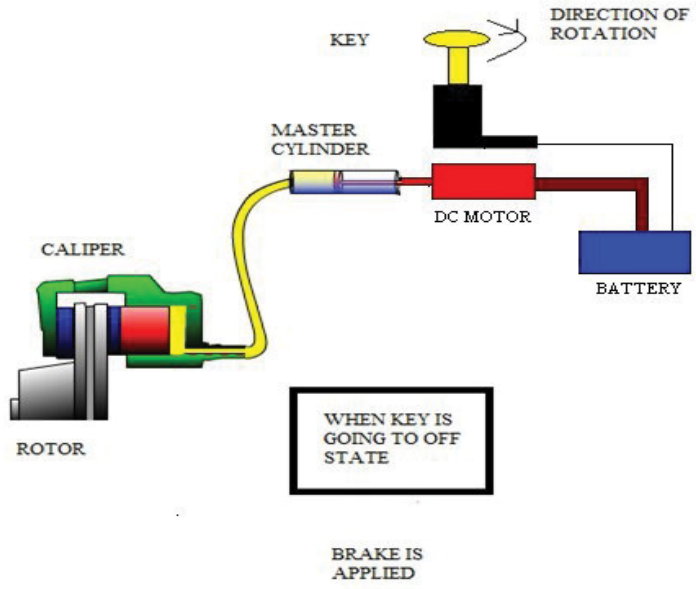

Figure 2: Applying brake when ignition key is going to lock state.

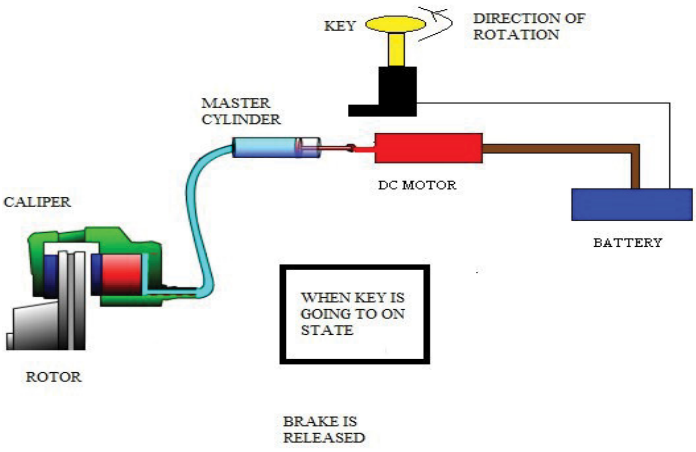

Figure 3: Applying brake when ignition key is going to on state.

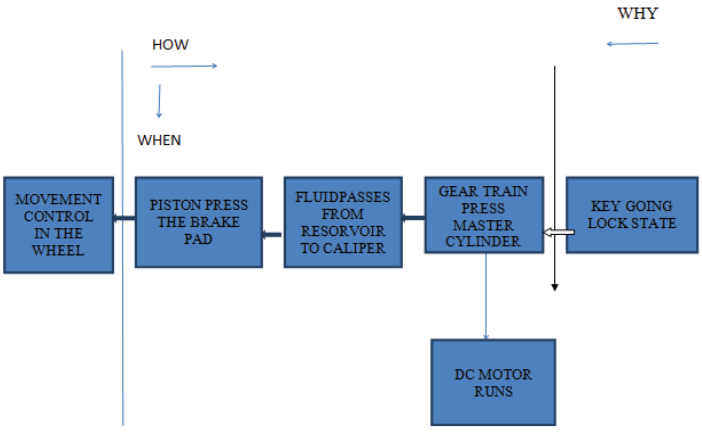

Figure 4: Fast diagram for wheel locking system.

Pro-E overview

Creo Elements/Pro (formerly Pro/ENGINEER), PTC's parametric, integrated 3D CAD/CAM/CAE solution, is used by discrete manufacturers for mechanical Engg design and manufacturing.

Pro/ENGINEER was the industry's first rule-based constraint (sometimes called "parametric" or "variational") 3D cad modeling system. The parametric modeling approach uses parameters, dimensions, features, and relationships to capture intended product behavior and create a recipe which enables design automation and the optimization of design and product development processes.

This design approach is used by companies whose product strategy is family-based or platform-driven, where a prescriptive design strategy is fundamental to the success of the design process by embedding engineering constraints and relationships to quickly optimize the design, or where the resulting geometry may be complex or based upon equations. Creo Elements/Pro provides a complete set of design, analysis and manufacturing capabilities on one, integral, scalable platform. These required capabilities include Solid Modeling, Surfacing, Rendering, Data Interoperability, Routed Systems Design, Simulation, Tolerance Analysis, and NC and Tooling Design.

Creo Elements/Pro can be used to create a complete 3D digital model of manufactured goods. The models consist of 2D and 3D solid model data which can also be used downstream in finite element analysis, rapid prototyping, tooling design, and CNC manufacturing.

All data are associative and interchangeable between the CAD, CAE and CAM modules without conversion. A product and its entire bill of materials (BOM) can be modeled accurately with fully associative Engineering drawings, and revision control information. The associativity functionality in Creo Elements/Pro enables users to make changes in the design at any time during the product development process and automatically update downstream deliverables. This capability enables concurrent Engineering–design, analysis and manufacturing engineers working in parallel – and streamlines product development processes.

ANALYSIS

Creo elements/pro has numerous analysis tools available and covers thermal, static, dynamic and fatigue finite element analysis along with other tools all designed to help with the development of the product.

These tools include human factors, manufacturing tolerance, mould flow and design optimization. The design optimization can be used at a geometry level to obtain the optimum design dimensions and in conjunction with the finite element analysis.

Surface modeling

Creo has a good surface modeling capabilities also. Using commands like Boundary blend and Sweep we can create surface models. Advance options like Style (Interactive Surface Design Extension - ISDX) and Freestyle provide more capabilities to designer to create complicated models with ease.

Manufacturing

By using the fundamental abilities of the software with regards to the single data source principle, it provides a rich set of tools in the manufacturing environment in the form of tooling design and simulated CNC machining and output. Tooling options cover specialty tools for molding, die-casting and progressive tooling design. To design the wheel locking system uses Pro-E software.

Pro E model

Figure 5 represents Pro E model.

Disc brake standard

- Rotor disc dimension=240 mm. (240×10^{-3} m)
- Rotor disc material=Carbon Ceramic Matrix
- Pad brake material=Asbestos
- Coefficient of friction (Wet)=0.07-0.13
- Coefficient of friction (Dry)=0.3-0.5
- Maximum temperature=250°C
- Maximum pressure=1MPa (10^6 Pa)

Gear calculation

- Number of Teeths In The Pinion Z_1=14
- Diameter of The Pinion D=50 mm
- Speed of The Pinion N_1=800 rpm
- Thickness of The Pinion T=10 mm
- Module=3
- Gear Ratio=3.5
- Number of Teeths In The Annular Gear

$$I \times z_1 = 3.5 \times 12$$

$$= 49$$

- Face Width=10 × m

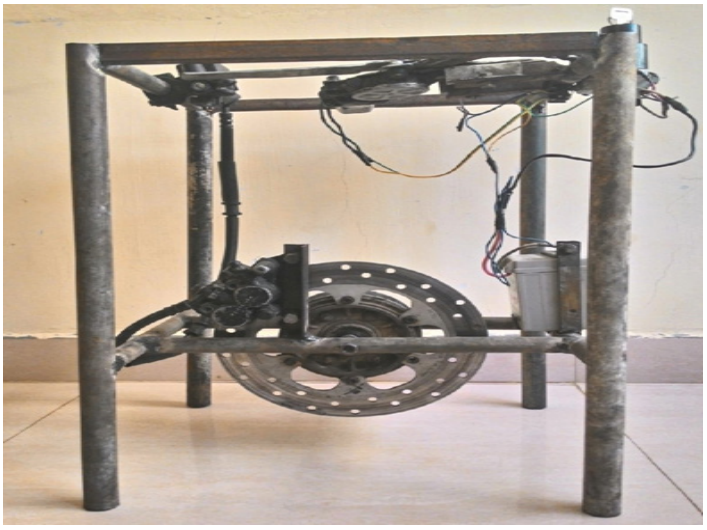

Figure 5: Pro E model of wheel locking system.

=10 × 3

=30 mm

- Pitch circle dia of the pinion
- $d_1=m \times z_1=3 \times 12=42$ mm
- Speed of the pinion

$=(3.14 \times d_1 \times N_1)/60$

=107.72 mm/s

Braking calculations

- Mass of Vehicle=150 kg
- Mass of vehicle with rider=150+120= 270 kg
- Diameter of caliper piston= 25 mm =0.025 m
- Area of Caliber Piston=4.90×10^{-4} m^2
- Wheel radius of Vehicle=0.35 m
- Effective radius of brake pad (r)=0.112 m
- Co-efficient of friction=0.4

Development phase

In development stage further can be improved the simulation of the product. To analysis the various flow and movement in the process like, when DC motor rotates, gear train also rotates and that gear rod to touch the master cylinder spring so that force will be analysis. After that master cylinder to transmit the fluid from caliper through brake cable so that flow moment also analysis. Then the hydraulic fluid press the brake piston of caliper and its pushes the disk so thermal stress also analysis.

Advantages

- No manual work needed.
- Stepping up the security of the vehicle.
- It can be implemented in two wheelers and four wheelers.

Disadvantage

- It only arrests the movement of the wheel and not the vehicle.

CONCLUSION

The wheel locking system should be designed by implementing value engineering concept this will help to improve security of the system. In this phase the preliminary activities for designing the wheel locking system using ignition key are done. In the next phase the analysis and implementation process will be carries out.

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