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Design and Development of a Multi-Purpose Trolley

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Abstract

Trolley is the device used for carrying load or to transport the material from one point to another. For different types of application various types of trollies are available in the market. Depending upon the specific use the one will select the trolley, but it is limited to do a specific work. To overcome this problem, a new trolley was designed which could be used for multi-purpose. There are many types of trolley available in the market for various fields like airport, shopping malls, industries, hospitals etc. to carry the heavy or light loads. This paper contains the development of trolley, which includes design on the basis of creativity skills and fabrication, which can be used for more than one type of task. The trolley designed is the integration of airport trolley and shopping mall trolley. One more advantageous feature added to the design was a motorized wheel which reduces the human effort for carrying of load and also it can be operated manually if required.

Keywords: Automation, Creativity Techniques, Design, Innovation, Multi-Purpose Trolley, Product Development

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1. Introduction

The objective of this research is to design and fabricate a trolley based on the creativity techniques for the multi-purpose. It also provides a better control which are operated by mechanically or electronically for wheel movements in forward and reverse direction. An innovative concept of two in one facility has been conceived and being implemented. The research includes the integration of trolley used at airport and at shopping mall based on the creativity techniques. It is more effective and convenient for the use at airport and as well as at shop mall[2].

The design of trolley is completely based on the creative problem solving process which includes following eight stages:

- Analyzing the environment
- Recognizing a problem
- Identifying the problem
- Making assumptions
- Generating alternatives
- Choosing among alternatives
- Implementing the chosen solution
- Control

2. Methodology

The basic methodology to integrate creativity skills with product development process are:

a. Selection of Product: Classify the range of product and select the one for development.

The product selected is trolley. Trolley used at various fields for a specific work. The intention for selecting the trolley is to integrate two designs or two field of applications into a single product design.

b. Market Survey: Carry out market survey to find the scope of development for selected product.

Depending on the market survey, two field of applications, which includes Airport and Shopping mall are selected. On the basis of requirements, the trolley is redesigned into the single standard design which can be used in both areas.

c. Problem definition: Define the problem regarding the current product.

The trolley used at airport have the unique design operated with the help of brakes. The structure is heavier to move and critical to direct. At the same time the trolley used at shopping mall have the same problem of rigidness and also the customer finds it difficult to direct sometimes.

d. Area of improvement: Depending on the type of product, one need to identify various aspects for development to improve the design.

The following four aspects are identified and selected to improve

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- Aesthetics
- Ergonomics
- Functionality and
- Cost

e. Set of creativity skills/techniques: Creativity skills/techniques are selected to get a best solution for the problem identified.

The design is done on the basis of following creativity techniques.[6]

- Assumption Busting
- Brainstorming
- Browsing
- Creative Problem Solving
- Dimensional Analysis
- Flow charts
- Gap analysis
- Listing
- Using Experts
- Value Engineering

f. Integration and intersection of creativity technique and product development process.

During this phase the concept and idea is generated using the above listed creativity techniques.

g. Development of product

i. Introduction:

The literature survey done for the selected product and feedback taken from the customers to improve on design. So product is finalized on the basis of market need.

ii. Flow Chart:

The flow chart is than prepared which indicates the entire process and checklist. It includes the check point after every stage to verify the process of development simultaneously.

iii. Sketching:

The basic three dimensional sketch of the product is than prepared based on the imagination and need. This sketch represents the basic concept and look of the product.

iv. Design:

With the use of few creativity techniques and theoretical aspects, the design process started which indicates the type of material, safe dimensions, design safety, factor of safety etc.

v. Concept Screening:

The entire design is verified once again to allow for the alteration or re-modification.

vi. Finalized Design:

After brain storming process the design, material selection, dimensions, safety and process was finalized.

vii. Product Design Specification:

The components are than listed along with the material and dimensional specifications.

viii. Fabrication Processes:

The processes like welding, joining, cutting, painting etc. are planned as per the sub assembly and assembly.

ix. Bill of Material:

The component name, component material, number of units used in product manufacturing etc. are tabulated in the sequence of assembly.

h. Result, Discussion and Conclusion

After completion of design, fabrication and finishing the product, it is tested for loading conditions. The results are further discussed and concluded.

3. Materials and Methods

The structure of proposed trolley is shown in figure no.1. A full four side structure is being developed to carry and withstand the load up to 150kg including the self-weight of the trolley.

The trolley has strong frame and supporting structure. Two caster wheels are proposed as front wheels which are freely rotating. The rear wheels which are connect to battery of 180Watts, 12Volts D. C. motor with a speed of 1500RPM. The gear box of speed ratio of 1:80 is attached on the rear shaft which reduces the actual moving speed of trolley.

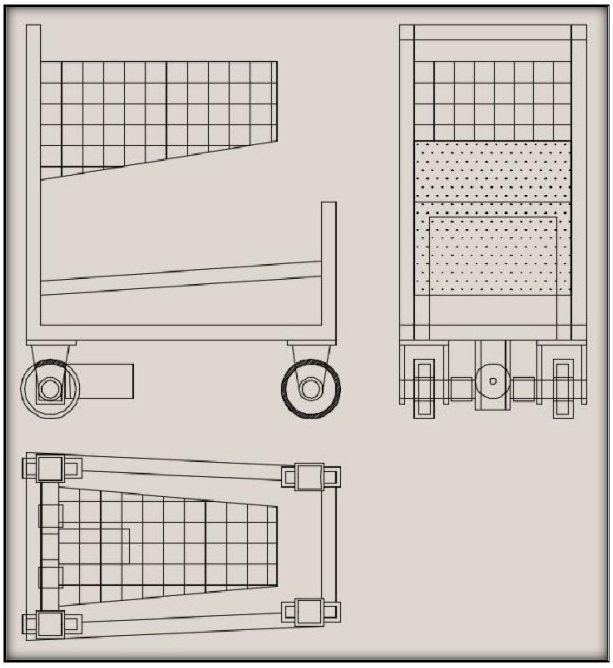

Figure 1. Sketch of Multi-purpose Trolley Actual Sub-Assembly

A switch is provided at the back of the trolley, which is nearer to operator, to move trolley either in forward direction or in

reverse direction. The frame base is metallic and covered with the sun mica coated wooden sheet to improve the aesthetic look of trolley and to cover all the electrical accessories. The height, width and length of the trolley is in proportion and ergonomically sound. The base front part is covered with another vertical hollow channel like structure to support the luggage.

The design resembles an airport trolley with different section. Here the square sections are used instead of circular sections and the joints are welded to provide the additional strength

As the trolley designed for multiple uses especially for two field applications viz. airport and shopping mall as described above, additional cart of wire frame structure is provided with the attachment as an additional accessory. The cart is over hanged at one end, hence the design looks aesthetically good at the same time the cart is attached with the help of hooks on the back vertical frame. Various slots are provided to adjust the height of cart as per the user requirement which makes it user friendly.

4. Standard Components and Assumptions

The following components are standard and taken directly from the market and depending on these standard components other design calculations are carried out:

- Motor: 180Watts, 12Volts, 1500RPM D.C. motor
- Gear box with speed ratio of 1:80
- Bolt and bush as per requirements

Let,

d : Diameter of shaft in mm

P_w : Power transmitted in watts

T : Torque developed in N-m

N : Speed of shaft in RPM (Revolutions per minute)

: Shear stress of shaft and key material in MPa

σ_{cr} : Crushing stress of key material in MPa

σ_R : Resultant stress in MPa

σ_o : Direct stress developed due to axial loading in MPa

σ_b : Bending stress developed due to eccentricity in MPa

: Bending moment produced due to effort on frame in N-mm

Z : Section Modulus in mm^3

P : Effort in N

A : Area of frame section in mm^2

bk : Width of key in mm

t_k : Thickness of key in mm

L_k : Length of key in mm

R : Radius of shaft in mm

b : Width of frame section in mm

t : Thickness of frame section in mm

5. Design Calculations

The shaft, key and square section for frame is designed and according to safe dimensions the components are taken for fabrication of trolley.

a. Shaft:

As shaft is the main component which is used to carry the load as well as torque. Hence, designing a shaft on the basis of strength:[4]

The power of motor is 180Watts and speed is 1500RPM. The gear box reduces this speed to (1500/80 ≅ 19RPM)

As we know,

<eq not clear in MS word>

T = 14.25 N-m

On the basis of strength,

<eq not clear in MS word>

For selected material value of shear strength, τ= 28MPa

14.25 x 103 =16π x 28 x d3 d = 13.43 mm ≅ 14 mm

b. Key

Key is the element which connects bush and gearbox to transfer the same amount of power. Square key, which is equally strong in crushing and shear, is assumed.[3,4] Shear stress for selected MS material τ = 28MPa

And Crushing stress σ_{cr} = 56MPa[1]

$T = b_k * L_k * \tau * R$

$14.25 \times 10^3 = 5*175*\tau*7$ τ = 2.32MPa < 28MPa

Hence, assumed *key of 5x5x175 is safe in shear.*

$T = 0.5 t_k * L_k * \sigma_{cr} * R$

$14.25 \times 10^3 = 5*175*\sigma_{cr}*7$ σ_{cr} = 4.65MPa < 56MPa

Hence, assumed *key of 5x5x175 is safe in crushing.*

c. Bush

For transition fit of bush with shaft, a standard metallic bush selected for M25 bolt having following specifications:

Length of bush = 50mm Internal diameter of bush = 14mm External diameter = 25mm

d. Bearing

Bearing is the device used to reduce the friction between the shaft and wheel. The shaft is of 14mm diameter hence with the clearance a standard bearing which have internal diameter of 15mm is selected from design data book.

Bearing selected is 6002.[1]

e. Frame square section design

Frame is the rigid structure and act as a base to sustain the entire load. Therefore it is required to design the frame in such a way

that it won't break or bend. Hence assuming the effect of direct stress (σ_o) as well as bending stress (σ_b).[4]

$\sigma_{R=} (\sigma_o) + (\sigma_b)$

$(\sigma_o) = \quad = \frac{500}{*}$

<eq not clear in MS word>

Assuming square section,

Therefore b=t

$\sigma_{R=} (\sigma_o) + (\sigma_b)$

<eq not clear in MS word>

t = 35.25 mm ≅ 38 mm b = 38 mm

f.Wire frame basket

A wire frame basket is an additional attachment provided at the top of the trolley to carry the shopping goods and is very much resembled to the shopping mall trolley.

The section of the basket is trapezium when observed from the top. The basket is made from wire of 6mm gauge and 3mm gauge.

The side nearer to operator = 24" in width The side nearer to operator = 12" in height The opposite side = 15" in width

The opposite side = 8" in height

The length of entire basket in horizontal plane is 24"

g.Wheels

Wheels of 6" diameter and 2" thick are used at the base for transportation of trolley structure from one point to another. Two wheels are on the rear shaft which are motorized and two front wheels are freely rotating which makes the motion of trolley free and easy.

6. Project Photos

Figure 2. Gearbox.

Figure 3. Bush.

Figure 4. Front wheels and Battery.

Figure 5. Rear Wheel with shaft, bush and keyway.

Figure 6. Base.

Figure 7. Trolley Sub Assembly.

7. Conclusion

The trolley has been successfully designed and fabricated. Functioning of the same has been confirmed by loading conditions and found working as per requirements. Automation of wheel has been developed successfully and tested to reduce the human effort at the handle of the trolley for giving appropriate direction. The same working model of trolley is being developed with more creative modifications in future as per the required market conditions.

8. References

1. Design Data Book. Data Book of Engineers, compiled by PSG college of Technology, Coimbatore. Reprinted edition. 2004 Jul.
2. Bin Haron AN. Design And Fabricate Multipurpose Trolley. Faculty of Mechanical Engineering, Universiti Malaysia Pahang. 2010 Dec.
3. Bhandari VB. Design of machine elements. Tata McGraw Hill Education Private Limited, Edition. 2010.
4. Khurmi RS, Gupta JK. Machine Design. Eurasia Publishing House. 2005.
5. Sainath S, Surender K, Vikram Arvind V. Automated Shopping Trolley for Super Market Billing System. International Journal of Computer Applications (0975 – 8887) International Conference on Communication, Computing and Information Technology (ICCCMIT-2014).
6. Higgins JM. 101 creative problem solving techniques. The Handbook of New Ideas for Business. 1994; 3–181.

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