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Development of Multi-Purpose Trolley

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ABSTRACT

Trolley is the mechanical device used for carrying load or to transport the material at various points. For different kind of applications, we have to select specific type of trolley. To overcome the problem of specific task trolley, one new trolley is designed which can be used for more than one field application. This paper contains the design and development of trolley on the basis of creativity skills to perform multi functions. The trolley designed is the integration of airport trolley and shopping mall trolley. The major areas of focus while designing are aesthetic, ergonomics, function and cost.

Keywords- Multi-Purpose Trolley, Creativity Techniques, Product Development

I. INTRODUCTION

The objective of this research is to design and fabricate a trolley using creativity techniques, which can be used at multiple fields. An innovative concept of two in one facility has been conceived and being implemented. New product development is an extremely challenging and complex process. Innovation is naturally uncertain, and firms may invest considerable time and money in new product ideas with no guarantee that they will ever become commercially feasible [1]. Product development involves either improving an existing product or its presentation with some modifications, or developing a new product as per the requirements of a particular market segments. To keep up with changes and trends in the marketplace it is necessary for the companies to develop the product consistently to ensure their success and future profitability.

II. METHODOLOGY

The basic methodology to integrate creativity skills with product development process are*[2, 3]*:

a. *Selection of Product*
b. *Market Survey*
c. *Problem definition*
d. *Area of improvement*
   - Aesthetics

- Ergonomics
- Functionality and
- Cost

e. *Set of creativity skills/techniques(Refer Annexure I)*

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

g. Development of product

a) Introduction
b) Flow Chart
c) Sketching
d) Design
e) Concept Screening
f) Finalized Design
g) Product Design Specification
h) Fabrication Processes
i) Bill of Material

h. Result, Discussion and Conclusion

III. MATERIALS AND METHODS

The structure of designed trolley is shown in figure no.1, which is re-modified design, based on customer feedback. A full four side structure is being developed to carry and withstand the load including the self-weight of the trolley. The trolley has strong frame and supporting structure made up of stainless steel of grade SS 202. Two Polyurethane (PU) wheels are proposed as front wheels which are freely rotating. The rear wheels are PU wheels which contains the breaking switch. The entire trolley structure is made up of circular metallic pipe to improve the aesthetic look of trolley. The height, width and length of the trolley is in proportion and ergonomically sound. The base is additionally designed with a C - frame section to support the luggage. The design resembles an airport trolley with different section. The joints are welded to provide the additional strength. The base frame contains one more parallel section which is inclined, so that the luggage can be slide on the surface smoothly and effortlessly.

Fig. 1 Multi-purpose Trolley Actual Sub-Assembly

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 handle can be removed by opening the nut-bolts provided at the side so that in future it can be re-modify with electronic controls. 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 side vertical frame.

IV. DESIGN CALCULATIONS& ASSUMPTIONS

Let, *[4, 5]*

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)

τ : 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

M : 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

b_k : 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

The shaft, key and circular section for frame is designed and according to safe dimensions the components are taken for fabrication of trolley*[4, 5]*.

a. Torque:

A pipe of 1" (25.4 mm) diameter and 1.2 mm thickness is selected as a frame section for manufacturing of trolley.

Inner diameter, di = do – 2t = 25.4 – (2 * 1.2) = 23 mm

On the basis of strength,

$T = \Pi/16\ \tau_{max}\ do^3\ (1 - k^4)$

b. Effort applied at the handle (P):

Effort required at the handle of the trolley when trolley is completely empty. Assuming the effect of direct stress (σ_o) as well as bending stress (σ_b). *[4, 5]*

$\sigma_R = (\sigma_o) + (\sigma_b)$

$(\sigma_o) = P/A$

$(\sigma_b) = M/Z = (32.P.e) / (\Pi * ((do^4 - di^4) / d_0)$

$\sigma_R = (\sigma_o) + (\sigma_b)$

$(\sigma_R) = [P / ((\Pi/4) (do^2\text{-}di^2)] + [32 * P * 990.6 / (\Pi * ((do^4 - di^4) / d_0)]$

By calculation, effort of minimum 50 N is required at the handle.

c. Wire frame basket

Two wire frame baskets of different sizes are provided out of which, one 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 basket is made from wire of 1.5mm gauge and 3mm gauge. Another one is fixed at the top which is 4.25" x 22" x 3" in dimensions to keep small items. The dimensions are selected depending on the proportionality, so that it will aesthetically look better. The dimension of the trolley which is detachable are as follows:

Width of basket = 23"

Length of basket = 12"

Height of basket = 8"

The ends are curved for aesthetic of trolley with the fillet radius of 8"

d. Wheels

Polyurethane wheels of 3" diameter and 1" thick are used at the base for transportation of trolley structure from one point to another. Four wheels are used which makes the motion of trolley free and easy. The additional advantage of these wheels are noise reduction, more load carrying capacity, less force required to slide, can work on any surface and high resistance to corrosion.

V. PHOTOS

Fig. 2 Polyurethane Wheel

Fig. 3 Polyurethane Wheel breaking switch

Fig. 4 Detachable basket

Fig. 5 Fixed Top Small Basket

Fig. 6 Detachable Handle

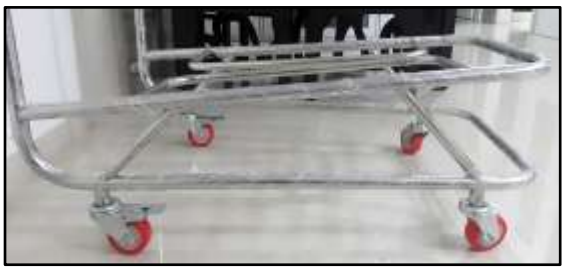

Fig. 7 Trolley Base Frame

Fig. 8 Trolley for Shopping Mall

Fig. 9 Trolley for Airport

VI. FUTURE SCOPE

- The trolley can be designed with PLC controls so that it can move from one place to another without any human guidance.
- The automatic billing system can also be added to this design to reduce the queue issues in a shopping mall.
- The weight of the loaded products can be reflected on the trolley itself so that customer will come to know how much luggage he/she is carrying. It will become easier for the customers, especially when used at the airport.
- The same design and concept can be modify with fully folded feature to reduce the space consumption.
- Sensors can be provided at the handle which sense the human touch and operates the trolley automatically

VII. 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. The re-modification was done on the basis of feedback received from end users. Singledesign can be used for both applications i.e. shopping mall and airport. Effort required to move the trolley is very less as the self-weight of trolley reduced. The structure is robust and rigid. Smooth in operation and can carry enough amount of load. PU wheels reduces the noise, its corrosion resistance is also high. It can be move over almost any kind of surface very easily. Maintenance is easy. The

same working model of trolley is being developed with more creative modifications in future as per the required market conditions.

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Annexure I

• 7 Step Model	• Circle Time	• False Faces
• Adaptive Reasoning	• Clarification	• Fishbone Diagram
• AIDA	• Classic Brainstorming	• Five Ws and H
• Algorithm of Inventive Problem Solving	• Cognitive Acceleration	• Flow charts
• Alternative Scenarios	• Collective Notebook	• Focus Groups
• Analogies	• Comparison tables	• Focusing
• Anonymous Voting	• Component Detailing	• Force-Field Analysis
• ARIZ	• Concept Fan	• Force-Fit Game
• Assumption Busting	• Consensus Mapping	• Free Association
• Assumption Surfacing	• Constrained Brain Writing	• Fresh eye
• Attribute Listing	• Contradiction Analysis	• Gallery method
• Backwards Forwards Planning	• Controlling Imagery	• Gap Analysis
• Body-storming	• Crawford Slip Writing	• Goal Orientation
• Boundary Examination	• Creative Problem Solving	• Greetings Cards
• Boundary Relaxation	• Criteria for idea-finding potential	• Help-Hinder
• Brain Sketching	• Critical Path Diagrams	• Heuristic Ideation Technique
• Brainstorming	• Decision seminar	• Hexagon Modelling
• Brain writing	• Delphi	• Highlighting
• Browsing	• Dialectical Approaches	• Idea Advocate
• Brute think	• Dimensional Analysis	• Idea Box
• Bug Listing	• Disney Creativity Strategy	• Ideal Final Result
• Bullet Proofing	• DO IT	• Imagery for Answering Questions
• Bunches of Bananas	• Do Nothing	• Imagery Manipulation
• Card Story Boards	• Drawing	• Imaginary Brainstorming
• Cartoon Story Board	• Escape Thinking	• Implementation Checklists
• CATWOE	• Essay Writing	• Improved Nominal Group Technique
• Causal Mapping	• Estimate-Discuss-Estimate	• Interpretive structural modeling
• Charrette	• Exaggeration	• Ishikawa Diagram
• Cherry Split	• Excursions	• Keeping a Dream Diary
• Chunking	• F-R-E-E-Writing	• Kepner and Tregoe method
• Circle of Opportunity	• Factors in selling ideas	• KJ-Method

• Laddering	• Problem Inventory Analysis - PIA	• Sticking Dots
• Lateral Thinking	• Problem Reversal	• Stimulus Analysis
• Listing	• Productive Thinking Model	• Story Writing
• Listing Pros and Cons	• Progressive Hurdles	• Strategic Assumption Testing
• Metaplan Information Market	• Progressive Revelation	• Strategic Choice Approach
• Mind Mapping	• Provocation	• Strategic Management Process
• Morphological Analysis	• Q-Sort	• Successive Element Integration
• Morphological Forced Connections	• Quality Circles	• Super-Group
• Multiple Redefinition	• Random Stimuli	• Super-Heroes
• NAF	• Rawlinson Brainstorming	• SWOT Analysis
• Negative Brainstorming	• Receptivity to Ideas	• Synectics
• NLP	• Reciprocal Model	• Systematic Inventive Thinking
• Nominal Group Technique	• Reframing Values	• Talking Pictures
• Nominal-Interacting Technique	• Relational Words	• Technology Monitoring
• Notebook	• Relaxation	• Think Tank
• Observer and Merged Viewpoints	• Reversals	• *Thinkx*
• Osborn's Checklist	• Role Storming	• Thril
• Other Peoples Definitions	• SCAMMPERR	• TILMAG
• Other Peoples Viewpoints	• SCAMPER	• Transactional Planning
• Paired Comparison	• Sculptures	• Trigger Method
• Panel Consensus	• SDI	• Trigger Sessions
• Paraphrasing Key Words	• Search Conference	• TRIZ
• PDCA	• Sequential-Attributes Matrix	• Tug of War
• Personal Balance Sheet	• Similarities and Differences	• Unified Structured Inventive Thinking
• Pictures as Idea Triggers	• Simple Rating Methods	• Using Crazy Ideas
• Pin Cards	• Simplex	• Using Experts
• PIPS	• Six Thinking Hats	• Value Brainstorming
• Plusses Potentials and Concerns	• Slice and Dice	• Value Engineering
• PMI	• Snowball Technique	• Visual Brainstorming
• Potential Problem Analysis	• SODA	• Visualising a Goal
• Preliminary Questions	• Soft Systems Method	• Who Are You
• Problem Centred Leadership	• Stakeholder Analysis	• Working with Dreams and Images