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Redesign of Passenger Emergency Alarm Signal Device in Indian Rail Coaches

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Abstract: Redesign improves quality, life time and reduces environmental impacts. A product redesign needs structured techniques to implement innovation with the consideration of cost and quality. The recent technological developments have paved way for design engineers to develop new ideas with the help of various design software's. Most of the redesign products have 75% reference from the existing product. This paper presents a case study on implementing a product redesign using structured design principles. The redesign combines the two components into a single component with the considerations of reducing the number of working parts, increase service life and reduce size.

Keywords: redesign, innovation, passenger emergency alarm signal device, design principles, 3D modelling

I. INTRODUCTION

Redesign and Design are future-oriented practices underpinned by a meliorative purpose. The objective is to improve the conditions or the environments of life, to improve or at least maintain the habitability of the world [1]. Product redesigns happens in various products such as toothbrush, mobiles, shoes, mixer grinders and specifically in automobiles occur at greater frequency. There are various factors involved in-order to opt for the product redesign such as incorporate new functional technology, upgrade the quality, to compete with the competitors in the market and sustain brand value [2]. L. D. Miles in 1950s invented a formal technique for doing redesign and used successfully not only to reduce cost but also to improve functional performance. The essence of his method, as in industrial designing, to focus on functions, Value analysis: (i) define element, (ii) define function, (iii) consider alternatives, (iv) evaluate alternatives, and (v) select best [3].

Creativity is regarded as an essential component of the redesign process and is required throughout the product development process in order to translate innovative ideas into successful products [4]. Inspirations continually emerge and evolve in the mind; they are periodic achievements that divide the thinking process into sections and correlate directly with the final outcomes [5]. Sangwon Lee and Jin Yan have suggested that a CAD tool have multiple mathematical representations and a gesture-based viewpoint-changing interface in order to improve modeling efficiency [6]. Generating new ideas, in turn, depends upon overcoming design conflicts. The approach stimulates innovation by combining two or more distinct reference designs into a single new product. The approach, by design, increases both the number and degree of design conflicts over typical redesign techniques. The induced conflicts stimulate original ideas and innovative design solutions. At the same time, the approach uses structured redesign techniques and design principles to overcome the induced conflicts, which improves solution quality and reduces design time. The redesign approach have two sections such as: (1) gives an overview of prior redesign techniques. (2) describes the new redesign approach [7].

Indian Railways (IR) is the world's eighth-largest employer by number of employees (1.4 million). The coaches used in IR are produced at Integral Coach Factory, Rail Coach Factory, Modern Coach Factory, and Raebareli. Braking is a must for any vehicle that is set in motion with longer payloads and higher cruising speeds being the order of the day. There is a constant search for the better, safer and more efficient braking system. Brakes are mechanical devices used to retard the motion of the vehicle. Air Brake System was introduced by George Westing House to run heavier and longer freight at higher speeds. In Air brake system, compressed air is used for getting the braking force. The compressed air is supplied to the brake pipe from the locomotive. The brake pipe pressure is maintained at 5 kg/cm^2. This pressure can be adjusted by the driver from loco brake system to any value between 0 to 5 kg/cm^2.

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The magnitude of braking force increases in step with the corresponding reduction in brake pipe pressure and vice versa. The system operates on "Poka-Yoke (in Japanese: Mistake proofing)" principle, namely if the pressure in Brake pipe reduce due to train parting, brake will be applied throughout the train automatically.

Passenger coaches are fitted with an alarm chain pull arrangement to enable passengers to stop the train by pulling the alarm chain from within the coach in case of any emergency. Passenger emergency alarm system consists of two components: Passenger Emergency Alarm Signal Device (PEASD) and Passenger Emergency Alarm Valve (PEAV). The passenger emergency alarm signal device does not need any maintenance during normal service except when it is found damaged or is due for periodic overhauling. The passenger emergency alarm signal device should be completely dismantled and overhauled during every periodic overhaul (POH) or if there is any problem in the equipment. These two components in combination give an indication by reducing Brake Pipe (BP) pressure to the Loco pilot and Guard that some passenger is in need to stop the train. The indication is transmitted from the coach in the form of reduction in BP in BP Gauge when the passenger pulls the chain. Passenger Emergency Alarm Signal Device (PEASD) is a manually operated pilot vent valve. It is operated through mechanical force exerted by pulling the alarm chain provided inside the coaches for emergency use. Assistant Driver and Guard finds out in which coach the Alarm Chain Pull (ACP) actually occurred and help to "put right" the concerned coach i.e. the lever needs to be manually reset that helps releasing the brakes of that coach. The air pressure system again builds up air pressure and that releases all brakes of all coach and the train gets ready to depart.

This paper deals with the redesign of passenger emergency alarm system used in the Indian Railways. The redesign approach consists of diagnosing the existing system design, identifying conflicts, and resolving the conflicts. Conflicts are resolved by changing component attributes, replacing components, or changing the structure of the original design [7]. Han and Lee (2006), described a method for creating new design solutions from previous design concepts. The method extracts underlying design concepts from existing designs, creates conceptual building blocks from the derived information, and combines the conceptual building blocks into new design alternatives, using adaptation rules [8].

A. PRODUCT DESCRIPTION

The passenger emergency alarm system (Fig.1) is the product considered for redesign. There are two main components such as: Passenger Emergency Alarm Signal Device (PEASD) and Passenger Emergency Alarm Valve (PEAV) are used in railway coaches to give an indication to the driver that some passenger is in need to stop the train. The indication is transmitted from the coach when the passenger pulls the chain. Passenger emergency alarm signal device (PEASD) is a manually operated pilot vent valve. It is operated through mechanical force exerted by pulling the alarm chain provided inside the coaches for emergency use. 2D representation of Passenger emergency alarm system along with the labelled parts is shown in Fig.2.

PEASD are connected to the passenger emergency alarm valve PEAV through a 10 mm control pipe. BP pressure is fed to the PEAV through a 20mm branch pipe. In the event of alarm chain pull air is depleted from the control pipe connecting PEAV and PEASD causing BP pressure to exhaust through the 8mm choke in the PEAV. This causes partial application of brakes. This drop in pressure in the brake pipeline is also observed in the flow meter filled in the locomotive for the driver to stop the train. 2D representation of Passenger emergency alarm valve with detailed labelled parts is shown in Fig.3.

Fig.1 Pictorial view of Passenger Emergency Alarm System

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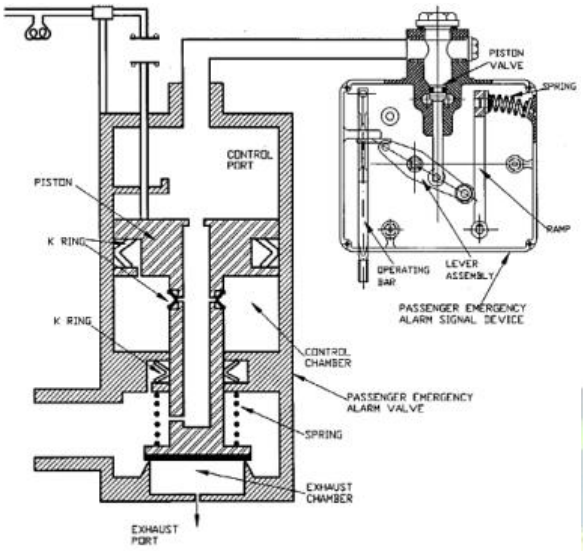

Fig.2 2D representation of Passenger Emergency Alarm System

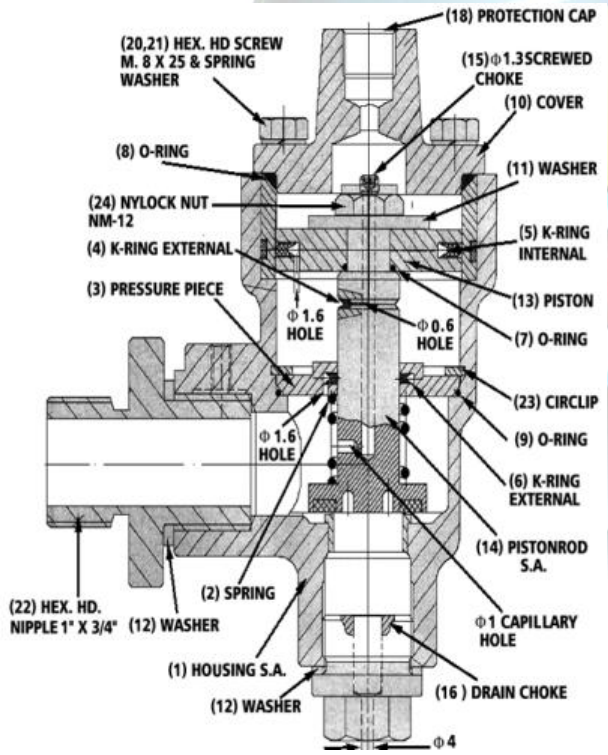

Fig.3 2D representation of Passenger Emergency Alarm Valve

B. *Working of Passenger Emergency Alarm System*

Whenever chain is pulled to stop the train, the rocker arm provided in PEASD slides and actuate the pilot valve to open the atmospheric hole, as a result the BP pressure is reduced in PEASD. As the PEAV is connected in series with PEASD resulting BP pressure is also reduced in upper chamber of the PEAV. Due to variation of BP pressure in both the chamber of PEAV the main valve floats from its position & relate the lower chamber with the atmosphere after opening of the modified choke (8 mm dia.) this fast venting of pressure create reduction of pressure in BP pipe of the said coach & brakes take place to stop the train.

II. Problem Description

The two components PEASD and PEAV are to be redesigned into a single component. The two components are used to perform a single function i.e. fluctuate the air pressure in order to indicate the loco driver in the pressure indicator and to manually apply the brake. The major constraint in redesigning is the actual function should not be affected and also the redesign should be compact in size and with minimum parts.

III. Redesign using Structured Design Principles

Redesign approach consists of the following steps: choose target product, identify needs, choose reference products, identify components, extract key components, identify conflicts, apply design principles, and verify results [7].

A. *Choose target product*

In this study, the redesign for innovation chooses the Passenger Emergency Alarm System based on the maintenance report supported by the Southern Railways [10].

B. *Identify needs*

The need for the redesign is to reduce the PEAS assembly component into a single component with reduced operating parts and reduce the size to make it compact. In the existing model, passenger emergency alarm system, the PEAV components have more number of precise parts when compared to PEASD. Therefore the PEASD is considered for redesign.

C. *Choose reference products*

After determining the target product and the target functions, traditional redesign techniques choose a single reference product for redesign. A detailed study was conducted in identifying the reference products from which

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the design can be incorporated in the redesign process. Finally a retractable pen chosen as the reference product and a one of such commercialized pen is Parker jotter pen as shown in Fig.4.

Retractable pens (click pens) are pens which have a spring-loaded ink cartridge which retracts and extends outside a protective housing. By clicking downward on the top of the pen, the tip is extended and locks in place at the bottom of the housing for use. Pen clicking is repeated pressing of the button of a retractable pen which produces a clicking sound. A patent number 3819282 for a retractable pen was filed on November 2, 1972 (published on June 25, 1974) by Penn Corporation.

How a retractable pen works? A retractable pen has several parts to it: the frame, a thruster, two cams, a guide pin, a spring, an ink cartridge with ink, a ballpoint at the end of the cartridge, and other parts that may vary. The spring provides the tension required to retract the ink cartridge. The cams provide a bistable system where in one position the ink cartridge is retracted and in the other it is extended. When the button end of the pen is pressed, the system moves from one position to the other. The guide pin is typically molded into the frame of the pen [9]. A detailed parts included in the parker jotter pen is given below:

1. Ink cartridge, 2. Ball point, 3. Top spring, 4. Bottom spring, 5. Plastic tube, 6. Cam body, 7. Plunger, 8. Stop members, 9. Pen Bottom body cover, and 10. Pen Upper body cover.

Fig.4 Parker jotter pen

D. Identify components

In this step, the approach separates reference product into basic components with their functions as given in Table I. These individual functions are referenced as ideas in developing the redesign.

E. Extract key components

The primary function of PEASD, is to operate the piston through lever mechanism and generate a reduction in air pressure in the control port. This in-turn actuates the alarm value where the piston rods moves in up-down motion and allows the air from the brake pipe to escape through the drain choke. The above working continues till the PEASD is reset manually using a special key as shown in Fig.1. By comparing the key components of PEASD such as piston and a spring with the key components of reference product i.e. retractable pen such as springs, cam, plunger and stoppers.

TABLE I
REFERENCE PRODUCT FUNCTIONS

Si. No	Retractable Pen	Functions
1	Top spring	Apply push force to the ink cartridge
2	Bottom spring	Apply release force to the ink cartridge
3	Cam body	Generate linear movement according to the cam profile
4	Plunger	Transfer the click pressure to the ink cartridge
5	Stop members	Hold the ink cartridge at clicks, according to the cam profile hold positions

F. Identify conflicts

The conflicts are in designing a single component system, by removing the PEASD and mean while the function of PEASD to be incorporated in the redesign.

G. Apply design principles

It redesign device works on the basic principle behind the open coil helical spring as used in the retractable pens. The redesign device consists of a piston, side rod, two springs, two bolts and main body. The two bolts consists holes on the head, for piston forward and retard movement. This main body has a side hole for pressure drop and there are four holes on bottom of the device which is used to clamp with PEAV. Piston and side rod are made using brass material which is alloy of copper and zinc. The springs are made from the stainless steel which has a shear stress of 325 N/mm^2 and the modulus of rigidity is 0.7×105 N/mm^2. The main body and two bolts are made from cast alloy and there are washers used where ever needed, specifically a rubber washer at the piston head.

There is a joint pipe from the B.P, which is connected to the passenger emergency alarm valve (PEAV). The pressure from the B.P is filled to the joint pipe and it passes through the (PEAV) piston, where the three chambers are now filled with air at a pressure of 5 kg/cm^2. Now, the three chambers do not have any direct contact with each other. The pressures in three chambers are maintained at equilibrium. The piston is placed firmly in its position by using a compression

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spring which ensures there is no leakage of air and reduction in air pressure. During emergency, the passenger pulls the chain, the cam Rod rotates and lifts the piston up against the compression force of the spring. Simultaneously, the side rod slides and compresses the compression spring held along the side rod. When the piston lifts upto a specified height, the side rod retains its original position. At this point the side rod holds the piston and doesn't allow it to come down. Simultaneously the pressure starts passing out through the 6 mm side hole. At this time (PEAV) piston starts to fluctuate. When it fluctuates the air pressure from the joint pipe escapes directly through the 8 mm choke. A partial application of brake takes place. There by indicating a pressure drop in the pressure indicator. This indication is seen by the driver and he applies the brake. Thus the operation which was prevailing before is not changed but only the mechanism is changed in the redesign. The complete redesign model in 2D along with dimensions is shown in the Fig.5. The assembled and cut sectioned redesign is shown in Fig.6. The isometric view of the redesign model in 3D view is sown in Fig.7. The SOLIDWORKS Design software was used in developing the idea into a virtual model.

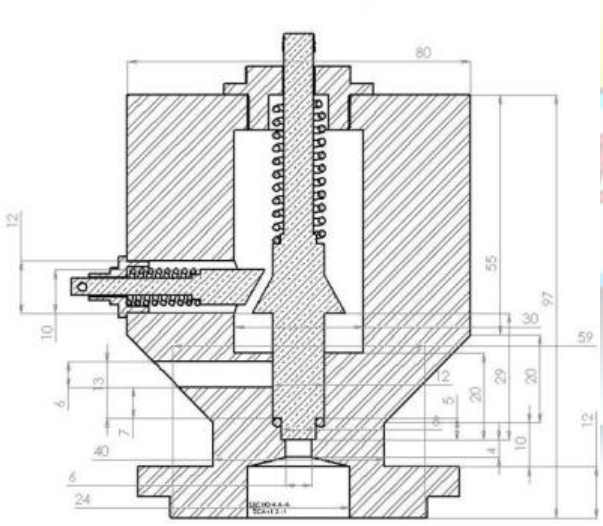

Fig.5 2D Assembly Cut Section View of redesign model

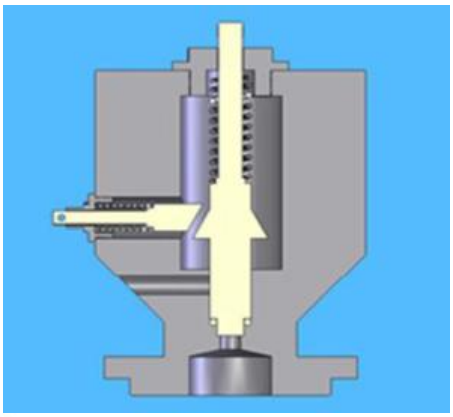

Fig.6 3D View of Assembly Cut Section of redesign model

Fig.7 3D Isometric View of Assembled redesign model

H. Verifying results

The redesign model was verified through theoretical design calculations for designing the spring wire diameter, the no of coil rotations and spring diameter. The springs were designed with safety considerations, such that to function under the maximum load applied while lifting the piston.

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IV. CONCLUSION

The redesign of passenger emergency alarm system is successfully developed using structured design principles. The redesign steps as described provides a clear vision for the design engineers to proceed during the redesign/design process. The redesign model has increased the compactness of the emergency alarm system and reduced the number of parts. This redesign model needs less maintenance and as the parts are not exposed to atmospheric conditions, it is not affected by the corrosion.

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REFERENCES

[1] Stephane Vial, Philosophy applied to design: A design research teaching method, Design Studies 37 (2015) 59-66.
[2] Bruce A. Blonigen, Christopher R. Knittel, Anson Soderbery, Keeping it fresh: Strategic product redesigns and welfare, International Journal of Industrial Organization 53 (2017) 170–214.
[3] J CHRISTOPHER JONES, Continuous design and redesign, Design Studies, vol 4 no 1, 1983, pp 53-60.
[4] Christine A. Toh and Scarlett R. Miller, How engineering teams select design concepts: A view through the lens of creativity, Design Studies 38 (2015) 111-138.
[5] Lingyun Sun, Creative Segment: A descriptive theory applied to computer-aided sketching, Design Studies (2013).
[6] Sangwon Lee, Jin Yan, The impact of 3D CAD interfaces on user ideation: A comparative analysis using SketchUp and Silhouette Modeler, Design Studies 44 (2016) 52-73.
[7] Shana Smith, Gregory Smith and Ying-Ting Shen, Redesign for product innovation, Design Studies, Volume 33, Issue 2, 2012, pp 160–184.
[8] Han, Y. H., & Lee, K. (2006). A case-based framework for reuse of previous design concepts in conceptual synthesis of mechanisms. Computers in Industry, 57(4), 305-318.
[9] Retractable pens, Wikipedia [online]. Available: https://en.wikipedia.org/wiki/Retractable_pen#How_a_retractable_pen_works.
[10] Maintenance of Passenger emergency alarm system of coaching stock dataset, Ministry of Railways, Govt. of India.