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Design and Development of New Passenger Seat for Electrical Multiple Unit Trains

Dr.G. Prasanthi
Professor, Dept of ME
JNTUA College of Engineering
Ananthapuramu, A.P, India
dr.smt.g.prasanthi@gmail.com

P. Vijaya Pavani
PG research scholar (product design), Dept ME
JNTUA College of Engineering
Ananthapuramu, A.P, India
pallapavani.jai@gmail.com

***Abstract*— The present existing Mild Steel Electrical Multiple Units (EMU's) running on sub-urban rail network are prone to corrosion, especially in harsh environmental conditions in coastal cities of Mumbai, Chennai & Kolkata. The interiors of the mild steel EMU'S are of conventional design. These coaches are fitted with Compreg wooden passenger seat cum back rest, it was found that these seats were uncomfortable for passengers commuting in the EMU's and also does not have an Aesthetic appeal. Passengers facing problem with improper seating arrangement leads to many back problems. Proper sitting contributes to the physical well-being of a passenger. As countries industrialized over the last few hundred years, previously isolated rural communities were scattered owing to improvement in transportation and to urbanization. As transportation has become main source for people in their day today life, so providing a comfortable seat is important. The aim of this study is to design & develop an innovative new passenger seats for SSEMU'S considering three major factors Technical, Ergonomics & Aesthetics with polycarbonate seat moulds fastened to the Stainless steel frame structure.**

Keywords—Technical, Ergonomics & Aesthetics.

I. INTRODUCTION

Ergonomics developed into a recognized field during the Second World War, when for the first time, technology and the human sciences were systematically applied in a co-ordinated manner. Physiologists, psychologists, anthropologists, medical doctors, work scientists and engineers together addressed the problems arising from the operation of complex military equipment. The results of this inter-disciplinary approach appeared so promising that the cooperation was pursued after the war, in industry. Interest in the approach grew rapidly, especially in Europe and the United States, leading to the foundation in England of the first ever national ergonomics society in 1949, which is when the term 'ergonomics' was adopted. This was followed in 1961 by the creation of the International Ergonomics Association (IEA). The word 'ergonomics' [4] is derived from the Greek words 'ergon' (work) and 'nomos' (law), Ergonomics (or human factors) is the scientific discipline concerned with understanding of the interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design, in order to optimize human well-being and overall system performance. In the design of work and everyday-life situations, the focus of ergonomics is man. An important ergonomic principle is that equipment, technical systems and tasks have to be designed in such a way that they are suited to every user. Examples of groups of users, who from an ergonomic perspective require additional attention, are short or tall persons, overweight people, the handicapped, the old, the young and pregnant women. Anthropometry is concerned with the size and proportions of the human body. Considering all these factors a pro-active step has been taken to replace the conventional Compreg wood seats with ergonomically designed an innovative new passenger seats.

A. Problem

On research and observations, it was found that these seats were uncomfortable for passengers commuting in the EMU's and also does not have an Aesthetic appeal.

B. Aim

The primary of the paper is to develop a new passenger seat for emus, mainly considering three factors, technical, ergonomics & aesthetics.

II. EXPERIMENTAL SETUP

The product development is the creation of products with new or different characteristics that offer new or additional benefits to the customer. Product development may involve modification of an existing product or its presentation, or formulation of entirely new product that satisfies a newly defined customer want .

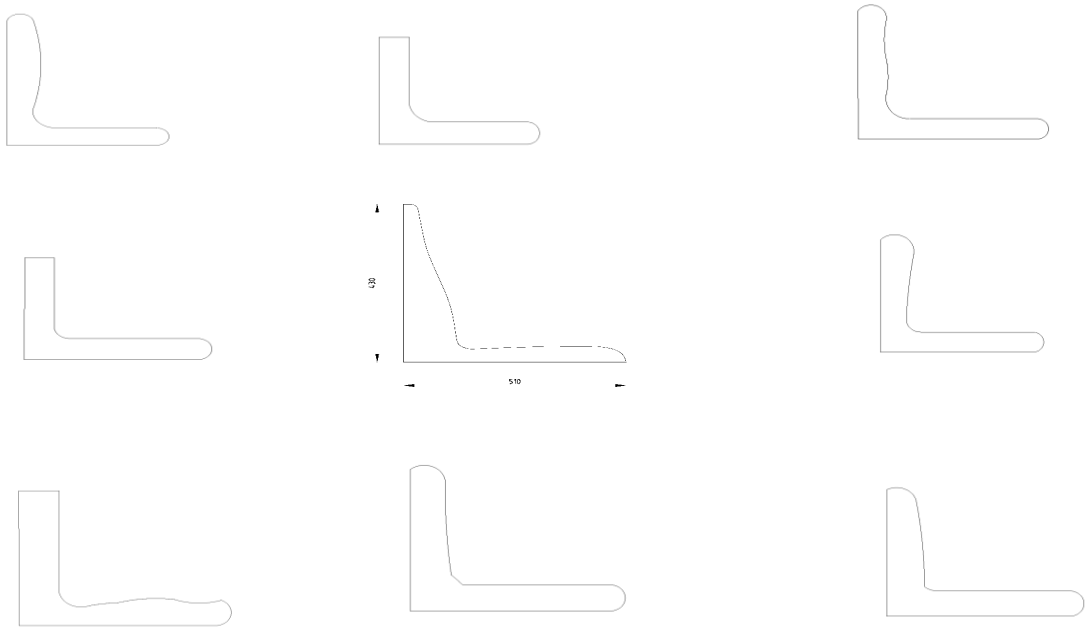

Figure 1. Concepts developed for new passenger seat

New product development steps

- Customers requirements
- Conceptual designs
- Detailed design
- Manufacturing drawings
- Production/manufacturing
- Testing
- End user

Conceptual design is the most critical stage of any product design and development process. It is the stage where major design decisions are made with vague and imprecise information, it is the stage where the product's fundamental features are determined. Decisions made early at this stage have a significant impact on other aspects of a product‘s life cycle such as quality, cost, and manufacturability. A design concept is the idea behind a design. The design concept becomes the framework for all design decisions. Conceptual design process transforms design specification.

The conceptual design process typically consist of several steps

- Understanding the main problem addressed by the requirements
- Understanding the requirements and why they qualify as requirements
- Identifying and exploring a broad range of alternative solutions that address the root problem and requirements
- Evaluating the alternative solutions and combining the best aspects of each
- Determining which solutions require invention versus engineering
- Selecting a combination of alternatives that best solve the root problem and satisfy the requirements of the product objectives

The result is a documented design approach to successfully solving the main problem in a manner consistent with the requirements. The final conceptual design must addresses all cross-functional disciplines that are essential aspects of the solution. As such It’s how we plan on solving the design problem. It’s the underlying logic, thinking, and reasoning for how we will design a product. The concept will lead to choices in color and type, it chooses aesthetic and determines the grid. Every design decision make will fall back on concept for direction, which is given as requirement list into one or more concepts that can satisfy these requirements for further development. The conceptual design serves as a common map for each of the technical disciplines as they embark on the subsequent detailed design.

Different concepts are developed that meet the customer needs

- Providing the comfortable material with different sizes and different seating arrangements
- Considering different shapes
- Considering different spacing’s from one seating arrangement to other

Different factors are selected and to give weightage to each factor for selecting the best concept

- Ease of use
- Back rest support
- Lumber support
- Manufacturability
- Slope
- Aesthetic appearance
- Surface unevenness
- Load bearing capacity

Concept selection process

The best concept is selected by using concept feasibility analysis, after selecting the concept dimensions are given to the concept, these dimensions are given to the concept from anthropometric data. The word 'anthropometry' means measurement of the human body. It is derived from the Greek words 'anthropos' (man) and 'metron' (measure). Anthropometric data are used in ergonomics to specify the physical dimensions of workspaces, equipment, furniture and clothing to ensure that physical mismatches between the dimensions of equipment and products and the corresponding user dimensions are avoided. Body size and proportion vary greatly between different populations, a fact that designers must never lose sight of when designing for an new product. The challenge of designing for the human body is that it comes in so many different sizes and shapes. As a result, a design that may be comfortable for one person can be inappropriate for others. Obviously clothes and shoes come in different sizes to accommodate these differences. Proper fit becomes much more important. To improve chair designers abilities to meet the needs of users several organization have compiled standards. Those in use in North America include the following:

- American National Standards Institute and the Human Factors and Ergonomics Society: ANSI/HFES 100-2007
- Business and Institutional Furniture Manufacturer's Association: BIFMA G1-2002
- Canadian General Standards Board: CGSB-44.232-2002
- International Standards Institute: ISO 9241-Part 5
- Canadian Standards Association: CSA-Z412-2000

The chair standards are intended as a reference and a starting point for design of new passenger seat for stainless steel EMU. The standards propose dimensional specifications based on body dimensions of the 5th percentile (small) female to the 95th percentile (large) male (refer to graph on page 4). This range covers only 95% of the population and is intended to meet the MINIMUM requirements of users. From 75th percentile &95th percentile dimensions of the concepts are derived.

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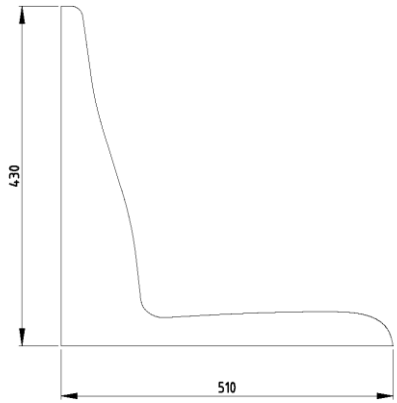
Figure 2. Human percentiles

III. EXPERIMENTAL RESULTS & DISCUSSION

The dimensions of seat profile is considered from Anthropometric data [8], from 75th &95th percentile we arrive the major dimensions of seat profile 515×520. The back rest profile of seat is considered from the superposition of human backbone [7]. Seat profile is considered from the ANTHROPOMETRIC DIMENSIONS, in reference with customer specifications. After giving dimensions to the given concept, this concept is presented in a neat drawing by using AUTOCADD, these drawings are directly given to the fabrication.



IV . CONCLUSION

In this emerging world of population transportation has become main source [5], comfortable passengers seat is important to be provided, the present existing suburban trains running on metropolitan cities are not provided with proper seating system which has lead to problem for passengers to overcome this problem development of new innovative passenger seat for SSS EMU [9] is made considering three major factors ie Technical, Aesthetic and Ergonomics.

- **T**echnical: Withstand the passenger weight
- **E**rgonomics: Increased passenger Comfort.
- **A**esthetics: Visually pleasing and to match the Interiors.

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