Design of Driver chair of a Passenger Car by Using Principle of Ergonomics

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Abstract: This study has been undertaken to de*sign of driver chair of a Passenger Car.The significance of ergonomics in the design of a driving chair, particularly for people with body measurements that differ from the usual range.Ergonomic principles are extremely important in any product, equipment, or work environment, especially because the majority of them are powered by muscular strength or involve physical contact.It's also important from a business standpoint if you want to gain a competitive advantage over your competition.It not only makes the product more enjoyable to use, but it also improves the quality and consistency of the outcome. The relationship between anthropometric data and the ergonomic design of specific products is also discussed in this paper.*

Index Terms - Ergonomics, Anthropometry, Musculoskeletal, Safety, Comfort.

I. INTRODUCTION

Nowadays, the term "ergonomics" is widely used. Due to increased customer desire for comfort, it has gained a lot of traction in the design world. A happy customer is a symbol of good design. Ergonomics has a long history dating back to the Stone Age. Better utilisation of tools and other small pieces of equipment leads to changes in their design in terms of human anatomy and ease of use. The phrase Ergonomics is made up of two Greek words: ergon, which means "labour," and nomoi, which means "natural laws," which means "work rules." Ergonomics is the study of enhancing product design in order to maximise and improve the user experience. Height, weight, and proportions, as well as other talents such as human hearing, sight, and temperature preferences, are all part of human anatomy and anthropology. Human factors engineering is another term for ergonomics. To promote optimal utilisation and comfort, ergonomic concepts are applied to design. Ergonomics is closely related to anthropometry, which is derived from the Greek words anthropos, which means "human," and "metron," which means "measure," and hence refers to the measures of the human body. It encompasses the assessment of physical qualities such as head width, organ limits and degrees of freedom, finger length, torso length, muscle power, visual and hearing capacities, as well as the study of variance in human physical traits. This level of detail is critical in the design and development of any product because it can help solve difficulties that arise as a result of human-machine interaction. Ergonomic principles are used to a product, system, or workplace to improve people's efficiency by making it easier and more comfortable to use the product or by meeting workplace needs. To put it another way, anthropometrics provides data on the typical human body measurement for the sake of ergonomic design, resulting in increased efficiency. For example, in the design of seating equipment, the age of the consumer, the purpose of the application, and the average human body dimensions serve as basic data so that seating chairs in public places, public transportation, the home, industry, and the workplace can be designed to provide greater comfort..[1] As a result, the issues caused by uncomfortable positions, as well as their instruments such as notes, books, tools, and keyboards, can be created to prevent stress and injuries. It is easier to design all components, such as the interior of the car, because it provides human body measurements.. The controls and indicators can be placed according to the length of the hands, legs, back, neck, visual, and hearing capabilities. This type of design will aid in improving driver safety, efficiency, and comfort.The understanding of ergonomics and anthropometry dates back thousands of years, and one can see the evolution of simple hand tools like the trowel, which is frequently employed in civil engineering. The original trowel, which is thought to have been used for gardening in the Neolithic era, some 10,000 years ago, hasn't changed much in the modern day, because it was also created with anthropometry and ergonomics in mind.

II. ERGONOMICS IN PRODUCT DESIGN

The product is essentially customised to meet the needs of the customer. The shape of the product, the materials used, the weight, and the texture utilised to make it handle right or made lighter/heavier are all examples of product customization. We come across various tools in our daily lives, whether at work or at home. The overhead grab handle in local trains is the best example of ergonomics in design, and it is something that every Mumbaikar encounters.. [Fig.01] This little object is nothing short of a masterwork of design. It has an ergonomic form that takes into account the average palm measurements of Indians. It has a lot of strength, and the designer made an effort to give it all six degrees of freedom, making it a one-of-a-kind design. [10]

If we consider an orthopaedic surgeon, who must be able to work with a wide range of tools, this is the case. There are useful and ineffective instruments. Ergonomically built products are beneficial because they are simple to use, cause less pain to the patient, and allow for efficient task completion.[Fig.02] [5][6]

Another example is a power drill, which has the proper weight, grip, and balance in the hand, as well as quick access to forward and reverse switches, sufficient power, and torque. It is a great combination of ergonomics with cutting-edge technology. A power drill with proper grip, balance, and well-placed switches is shown in the diagram below.

Fig. 01. Overhead grab handle in local train

Fig. 02. Ergonomically Designed Surgical equipment

Office chairs are another essential product where ergonomics and anthropometry play a significant role. Due to its outstanding design, a comfortable office chair that allows you to work throughout the day without causing neck or back problems. To be ergonomic, a chair or mattress does not need to be labelled. All that is required is for it to be created with the user's comfort, body measurements, and safety in mind. As a result, ergonomics is applied to all products in the world, whether they are used on a daily basis or are one-of-a-kind.

Fig 03. Ergonomically Designed Power Drill

Fig. 04. Ergonomically Designed office chair

III. IMPORTANCE OF ERGONOMICS

Unsatisfactory operation of the designed product causes awkward/inaccurate posture and body vibration, resulting in musculoskeletal disorder. An unhealthy and unsafe workplace results in overall discomfort for the user. (2011) (Santos et al.). Ergonomic involvement can reduce the complexity of the operator's operation, allowing the task to be compatible with human capabilities. When designing the equipment, the operator's gender, age, health, and body type should all be taken into account. Because the designer just has an idea of the need and is uninformed of the skill of different consumers of the equipment or product, the design of equipment is always a compromise between the operator's physical abilities and the requirements of the equipment or product. Product design focuses factors such as comfort, safety, impression, feelings, and efficiency, whereas ergonomics stresses factors such as comfort, safety, impression, feelings, and efficiency. Understanding the relationship between subjective experiences and design aspects is difficult. Health-related issues are also intimately tied to ergonomics. Awkward body position, repetitive and boring work over a long period of time, and incompatibility between user and product or equipment are all factors that contribute to workplace health injuries. Physical and mental stress and exhaustion result from a design that ignores ergonomic considerations, resulting in decreased efficiency. Musculoskeletal Disorders (MSDs) are injuries to the joints, ligaments, muscles, nerves, tendons, and systems that support the limbs, neck, and back that are caused by poor workplace or product design. It is also in charge of abrupt effort and the repetition of the same muscle activity. MSDs have also been linked to some of the worst-case scenarios, such as a car accident or a loss of control over a machine or piece of equipment. MSDs can affect several regions of the body, including the upper and lower backs, necks, shoulders, and joints in the arms, legs, foot, and hands. [2], [12]

According to general observations, musculoskeletal problems are caused by bad working posture and irregular motions. As a result, it is critical to build a comfortable work zone for users and an optimum working posture for task performance, which will reduce tension and discomfort. Improved comfort in the work environment allows the operator to use his abilities more effectively, resulting in increased safety and a healthier atmosphere. The "lack of discomfort" is a simple definition of comfort. The inside of the vehicle is crucial because it must be designed to keep the driver fresh and decrease weariness. [12]

Textile engineering plays an equally essential function in motor vehicles as does mechanical engineering. significance. [13] When a buyer looks inside a vehicle, the first thing they notice is the textile. As a result, it becomes a significant factor. The

customer's most important parameters are design, performance, and efficiency. High strength, elasticity, porosity, abrasion resistance, flammability, UV resistance, and other qualities are required for this application. The material chosen for an airbag is also crucial because its qualities determine the level of safety. These materials must have certain characteristics, such as low air permeability and strong strength.[8]

IV. PROBLEM DEFINITION

Human fatigue creates a hazard that can lead to disastrous events in the workplace and environment. Fatigue is especially dangerous when a person is driving a car. Driver fatigue occurs when driving for an extended period of time because the body is motionless while sitting in a comfortable car seat. After a while, concentration wanes and drowsiness sets in, which the driver is unaware of. Truck drivers are advised to take a break after a certain number of kilometres driven, reducing the possibility of an accident. However, in the case of passenger cars, which are designed to drive at high speeds and require a high level of concentration.This results in car accidents with cars coming from the opposite direction or cars falling off the road. Psycho-fatigue is caused by an ergonomically unsuitable car seat or the driver's workplace. Because the driver's seat is adjusted to average anthropometric measurements of the human body, anyone who does not fit these measurements will have difficulty driving a car. Because shorter drivers have shorter limbs, they have difficulty reaching controls and seeing; similarly, taller drivers feel a lack of space and less space for vision. These issues can be mitigated by adjusting the seat in a linear direction, but this will not completely solve the problem. Airbags and seat belts cannot protect the driver if his or her anthropometric measurements differ from the norm. Because the inertia force of the upper part of the body is not directed towards the airbag centre, the body slides by alpha angle [Fig.05]. Similarly, a body with smaller or larger proportions than average slides more easily above or beneath the safety belt due to a shift that can be represented as b, g, and d angles according to [Fig.05]. One of the partial solutions for this problem is to install an additional air bag beneath the leg, which may aid in shifting the seat into a more suitable position for the driver. When the driver's workplace is adjusted to the anthropometric measurements of the driver who operates the motor vehicle, a solution can be anticipated..[9] Figure 05 depicts a change in body position during a direct car crash. The body moves forward due to inertia. There is a chance that the driver's head will collide with an already opened airbag. However, jerky head movements increase the risk of spine injury, which can be dangerous. If the driver has larger body measurements, the head will hit the upper part of the airbag, causing it to move more and the alpha angle to be larger, resulting in the head slipping off the airbag, especially if the body is in an incorrect posture at the time of the collision. If the driver is shorter and has smaller body measurements than the average, there is a chance that the vehicle will crash. The whole-body torso moves forward and detaches from the seat at a beta angle during the collision. Shifting the torso causes the knees and upper part of the leg to shift by a, d, and g angles. If the driver does not wear his or her seat belt, the body shift may be greater. This condition causes a sudden movement in the torso and is the source of injuries caused by collisions with hard car parts.

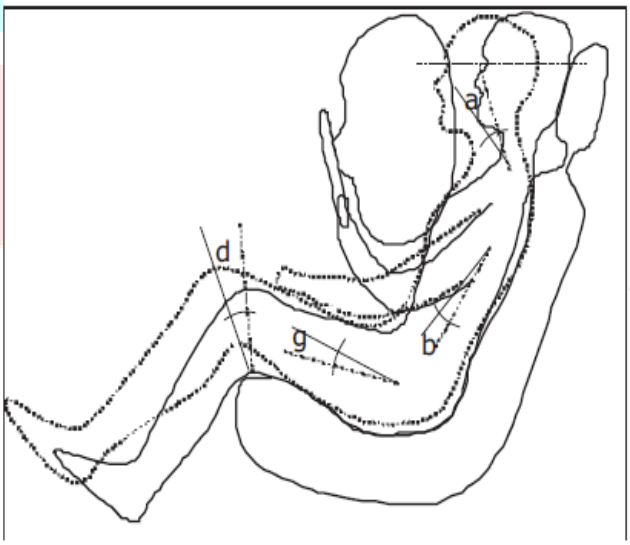

Fig. 05. Shift of the driver's body at the time of collision.

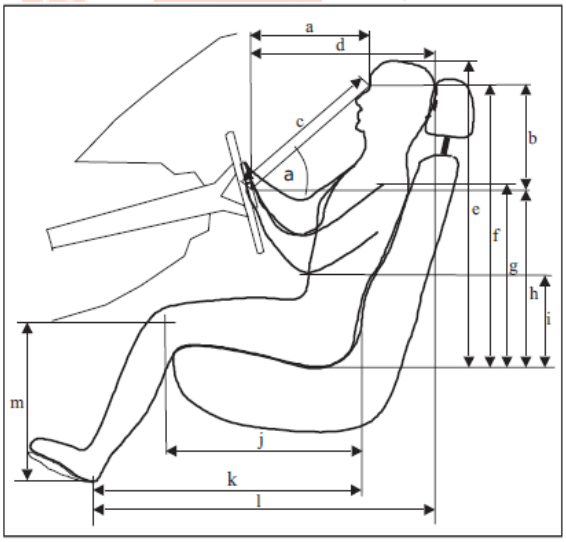

Fig. 06. Driver's anthropometric measurements in the car

TABLE 1 ANTHROPOMETRIC MEASUREMENTS OF MALES AND FEMALES ACCORDING TO BODY HEIGHTS

Sizes according to Fig. 1	Anthropometric measurements in females (cm)			Anthropometric measurements in males (cm)			Average (cm)
	Body height (cm)						
	155	165	175	175	185	195	175
a	38.4	38.3	38.7	39.4	39.7	39.8	39.1
b	14.8	14.8	15.0	15.2	15.7	16.9	15.4
c	34.6	34.8	35.3	35.3	36.6	38.1	35.8
d	47.4	47.5	47.7	48.2	48.4	48.4	47.9
e	78.2	83.7	88.0	88.3	93.7	98.1	88.3
f	69.1	72.2	76.1	76.3	82.6	88.4	77.5
g	51.3	54.4	56.6	60.9	62.4	64.9	58.4
h	50.5	50.5	50.5	50.5	50.5	50.5	50.5
i	20.4	21.7	24.3	24.0	24.7	24.0	23.2
j	44.0	45.7	48.8	48.1	50.3	52.5	48.2
k	52.4	52.6	53.2	53.3	53.5	53.4	53.1
l	57.7	58.1	58.5	58.8	59.6	59.8	58.8
m	39.9	43.2	45.5	45.4	47.8	50.7	45.4

V. EXPERIMENT & DISCUSSION

Varied body dimensions of three female and three male candidates with heights of 155, 165, 175 and 175, 185, and 195 cm are taken and listed in Table I, and different body dimensions as shown in [Fig.06] are listed in . [Fig. 07] [9]

For driver safety, airbag and safety belt effectiveness, ergonomic seat posture and anthropometric measurements are very significant. [Fig.05]. When driving a car, short drivers (less than 155 cm) and tall drivers (more than 195 cm) experience a variety of issues, including increased weariness, challenging driving conditions, a tight feeling, and controls that are too far away. The issue of adjusting the driver's seat to the driver's anthropometric proportions has not been fully resolved. A disparity in the driver's anthropometric measurements and the surrounding measurements within the car may be discovered based on the measurement results received. [Table I, Fig. 07]. However, there are instances where the anthropometric measures of particular body parts are larger in short people than in tall people, and vice versa. [Table 1, j and m]. When men and women are of equal height, anthropometric measurements are frequently different. This was validated in these measures as well, with measurement (g) being higher in men and measurement (j) being higher in women of the same height of 175 cm. According to these studies, anthropometric measures have an impact on the driver's body posture in the automobile and the effectiveness of car safety gear. For a motorist with large anthropometric measures to feel comfortable and safe while driving, a larger area is required.

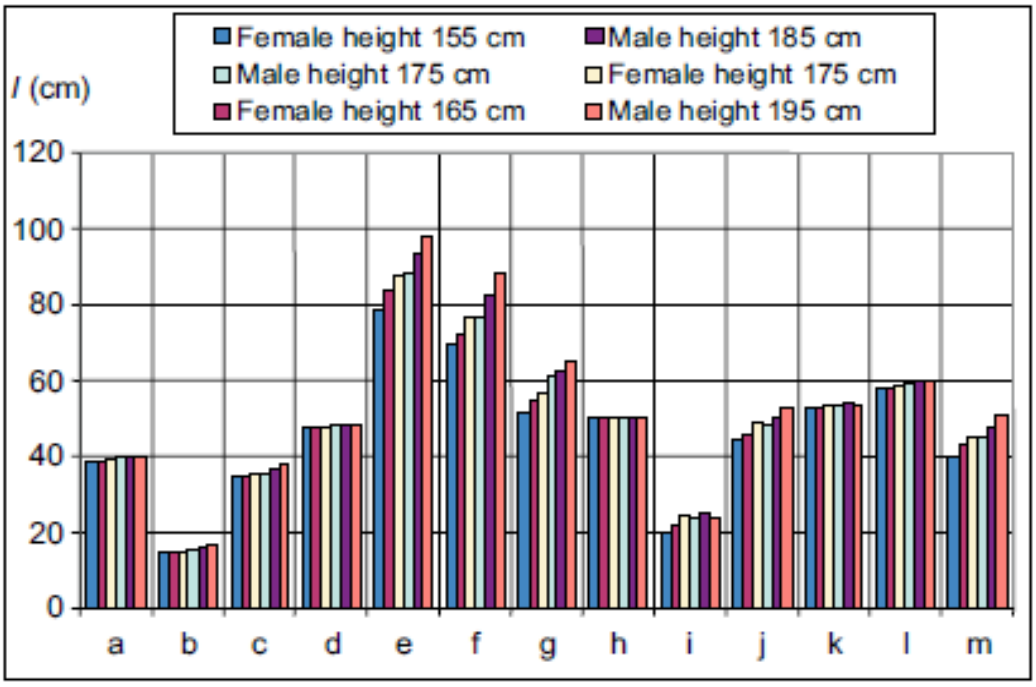

Fig. 07. Anthropometric measurements.

CONCLUSIONS

A vehicle seat that is created with anthropometric data and ergonomic considerations can help to prevent driver fatigue and provide a safe driving experience. Proper arrangement, which allows for stress-free body posture, as well as the use of safety belts and airbags, would improve safety and reduce the likelihood of accidents and hazards. A driver with a height that is less than average has had insufficient vision space. Because safety equipment such as seatbelts and airbags are ineffective, the risk of injury is higher. Due to the ineffectiveness of safety systems such as belts and airbags, a motorist with a height greater than the usual height will have body cramps, increasing the risk of injury.As a result, there are damage to the head and spine.Sensors will likely be used in future designs to help alter workplaces based on anthropometric data.

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