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Ergonomics and Packaging feasibility study of driver Seat, Steering and Cluster using CATIA V5-R25 and RAMSIS.

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Abstract: - Within available package constraints, analyze the comfort for the driver position of a target vehicle and propose the changes required for a most optimal comfortable position. Along with overall discomforts in other body parts (legs and hands) also needs to be analyze at different positions to check the least discomfort position. Once an optimal seating position obtained, evaluate package parameters such as hand reach, A-pillar obscuration, visibility etc as per SAE standards.

Index Terms: 1 Introduction, 2. Methods of study, 3. Case studies, 4. Conclusion, 5. Discussion, 6. Acknowledgement, 7. References.
Keywords: H-point, Disscomfort assessment, Hand reach, Visibility zone, Cluster visibility zone.

1. INTRODUCTION

IN today's competitive environment, the requirement of market drives the automakers to release new models in very short development time. At the same time, the vehicles should retain high quality standards and the driving comfort is one of the most impacting parameter in vehicle selection.

The comfort definition of a vehicle is segment specific, i.e. weather it belongs to small car, hatchback, sedan class, trucks or population under consideration etc. Defining the comfort for specific segment of vehicle is very important to understand the customers' needs.

Hence, despite having SAE guidelines and standards, it is necessary to validate comfort parameters when we design a new vehicle, keeping in mind the needs of specific population and specific segment.

The bottom line for the project work is to analyze the comfort for the driver position of a target vehicle and propose the changes required for a most optimal comfortable position taking into account the available package constraints. Overall discomfort and discomforts in other bodily parts (legs and hands) needs to be analyze at different positions to check the least discomfort position.

Once an optimal seating position is obtained, following package parameters such as hand reach, A pillar obscuration, visibility etc.

Modifications required will then checked for feasibility and suggestions to given based.

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Seating Comfort.

Automotive seats need to accommodate a wide range of driver sizes over relatively long periods and provide isolation from vehicle vibration and shock. To fulfill these requirements, there have been remarkable advances in automotive seat design during the past decade incorporating seatback recliners, lumbar support, motorized multi-axes adjustments, and foam cushions. However, these added features have resulted in increased cost and used in only a limited number of seating environments

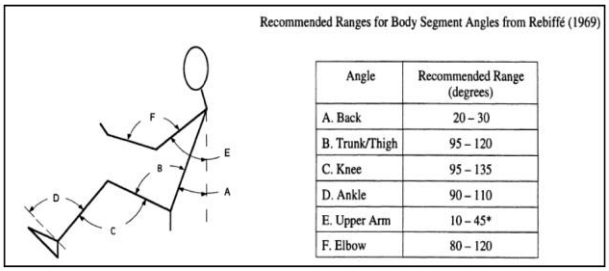
Body Segment Angles and Seat Adjustments: [13]

The posture of the body is describes the relative orientations of the various articulating segments that make up the body linkage. Reynolds (1993) stresses the usefulness of abstract linkage representations of the human body as design tools.

Hubbard et al. (1993) discuss computerized kinematics models that increase the fidelity of simple link models by including descriptive geometry for the links, e.g., legs, torso, and arms. Such link models are used to define joint angles that are associated with improved comfort, the assumption implicit in these joint angle recommendations is that the least discomfort will result when all joint angles are within a neutral range for which tissue stresses are minimized (Keegan 1953). These ranges are typically in the middle of the full passive range of motion for the joint, where muscles are approximately at their resting lengths.

Rebiffe (1969) presents a summary of recommendations for body segment angles in the automotive environment. Figure shows the definitions of body segment angles. The Rebiffe linkage expresses body posture in terms of line segments in a sagittal plane connecting joint centers. A line connecting the shoulder joint with the hip joint represents the trunk angle. The most important angles for comfort are the back, trunk/thigh, and knee angles, which represent the relative orientations of the trunk, thigh, and leg. The Rebiffe recommendations for 20- to 30-degree recline angles are consistent with the EMG-based recommendations of Anderson et al. and

contemporary practice. Angle B is the trunk/thigh angle, which Keegan (1953) demonstrated to have a strong effect on the lumbar curve. The Rebiffe recommendations for trunk/thigh angle fall short of the 135- degree angle cited by Keegan (1953) as producing a neutral spine curvature, but are in keeping with the recommendation by Grandjean (1980) of 100 degrees to 120 degrees. With specific reference to auto seating, Keegan (1964) specified a trunk/thigh angle of 105-115 degrees, with 115 degrees preferred for long-term comfort.



Angle	Recommended Range (degrees)
A. Back	20 – 30
B. Trunk/Thigh	95 – 120
C. Knee	95 – 135
D. Ankle	90 – 110
E. Upper Arm	10 – 45*
F. Elbow	80 – 120

Fig. 1. Rebiffe recommended angles for Body segment.

Automotive Ergonomics:

Automotive ergonomics focuses on the role of human factors in the design and use of automobiles. This includes analysis of accommodation of driver and/or passengers; their comfort; vision inside and outside vehicle; control and display design; pedal behavior , information processing and cognitive load during driving etc.

In the present module attempt will made to discuss various physical aspect of occupant packaging for providing comfortable driving posture, clearance dimensions, proper view field, easy reach of the controls etc. to the driver.

This module highlights the following:

- Spatial accommodation
  - Seating Position
  - Leg Room
  - Head Clearance
  - Lateral Clearance
- Sitting comfort /discomfort
- Reach and limitations of human
- Visual field and Visual Obstruction

Reachability:

Reach and Limitation of Human. In many work situations, individuals perform their activity within a specified 3D space of fixed location, which refferes to as 'work-space envelope'. This envelope preferably circumscribed by the functional arm reach of the operator and most of the things they need to handle and arranged within this.

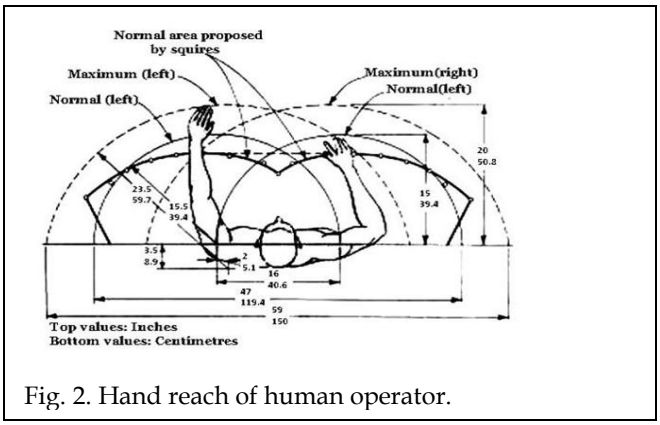


Fig. 2. Hand reach of human operator.

2. METHODS OF STUDY.

Different positions of seats evaluated as a way forward for the betterment of the ergonomics and evaluation done in digital form by using CATIA and RAMSIS software.

Based on the best feasible position, evaluation needs to done in buck and in physical vehicle. Results of the same where compared to Posture angles from Rebiffe to check the recommended range.

Proposed tools for work: CATIA V5-R25 and RAMSIS.

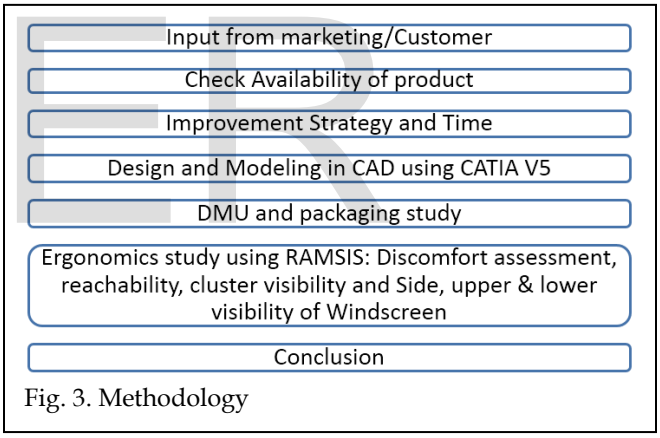


Fig. 3. Methodology

3. CASE STUDIES

3.1 Ergonomics study on mini truck:

3.1.1 Problem definition:

Subject vehicle had a complaint of discomfort in seating position with respect to front console, steering and pedals. Customer feedback, jury trails reported need for improvement in the seating ergonomics. Initial study: We tried different percentile people to evaluate the problem in the existing vehicle. Rating was on the scale 1-10 and most reported 6. (Higher the better).

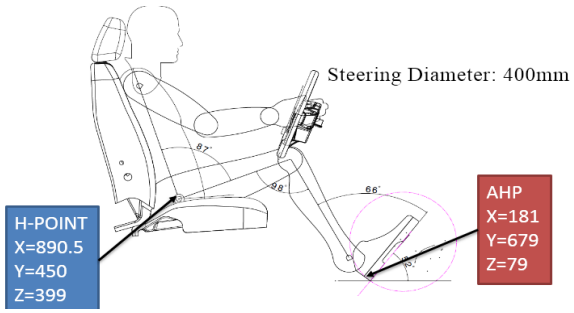


Fig. 4. Existing vehicle Input data. [2]

3.1.2 RAMSIS discomfort assessment analysis of driver at existing location:

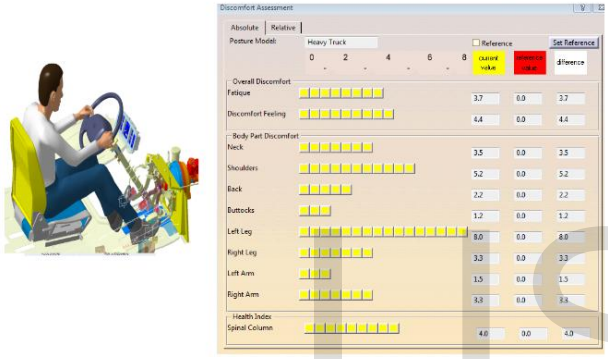


Fig. 5. RAMSIS disscomfirt assessment analysis of driver at existing location.

3.1.3. RAMSIS discomfort assessment analysis of driver seat H point shifted 30mm back in X direction:

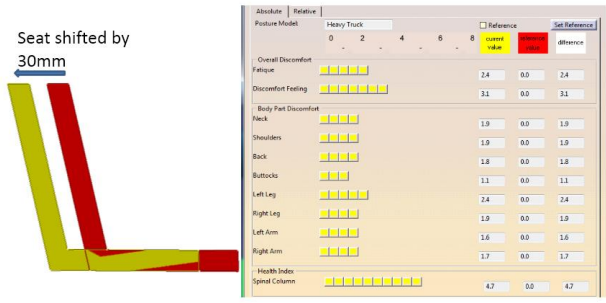


Fig. 6. RAMSIS disscomfirt assessment analysis of driver seat H point shifted 30mm back in X direction.

Improvemetnts needs in seatimg position for better comfort. Considering constraints and available packaging space, shift seat in X direction at several position and measure discomfort assessment.

Likewise, we shifted Seat in several position and got results as per below table.

TABLE 1
COMPARISON OF THE DISCOMFORT VALUES FOR ALL CONSIDERED BACKWARD MOVEMENT VALUES OF THE H POINT

Driver Seat	H point positions in X direction				
	X	X-30	X-60	X-90	X-165
Overall Discomfort Feeling	3.2	3.1	3.1	3	4.4
Right Leg	2.4	1.9	1.6	1.3	2.6
Left leg	1.6	1.6	1.7	1.9	2.4
Right Arm	1.7	1.7	1.6	1.5	2.4

At X-90 the values are much improved and within acceptable limits.

3.1.4. RAMSIS discomfort assessment analysis of driver seat H point shifted 90mm back in X direction:

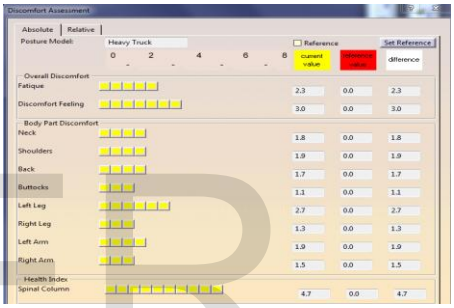


Fig. 5. RAMSIS disscomfirt assessment analysis of driver seat H point shifted 90mm back in X direction.

3.1.5. A pillar obscuration and upper and lower visibility. [1]

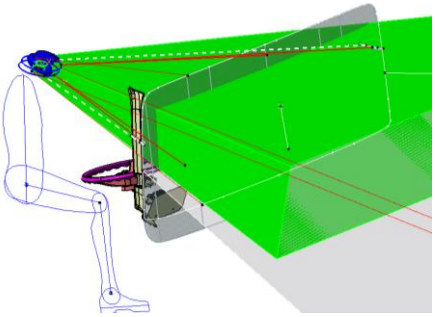


Fig. 6. Visibility zone.

Results:
Right pillar obscuration angle= 2.99deg < 6, Compliance
Left pillar Obscuration angle= 1.01deg < 6, Compliance
Side Visibility angle= 22.81deg > 17, Compliance
Downward visibility angle= 16.04deg >5, compliance
Top visibility angle= 13.49deg > 7, Compliance

3.1.6. Hand reach: [6]

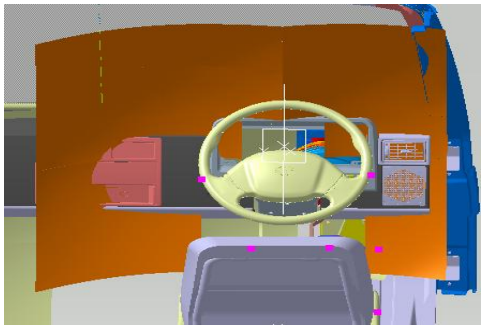


Fig. 7.Hand reach zone.

3.1.7. Cluster Visibility: [7]

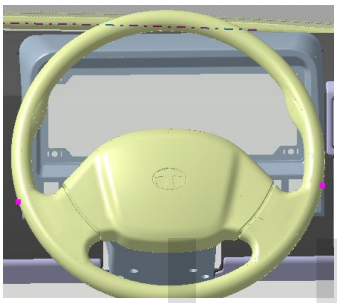


Fig. 8.Cluster Visibility zone.

3.2. Ergonomics study on mini truck:

3.2.1 Problem definition:

Subject vehicle had a complaint of discomfort in seating position with respect to front console, steering and pedals, Visibility need to improve front windscreen. Customer feedback, jury trails reported need for improvement in the seating ergonomics. Initial study: We tried different percentile people to evaluate the problem in the existing vehicle. Rating was on the scale 1-10 and most reported 6. (Higher the better)

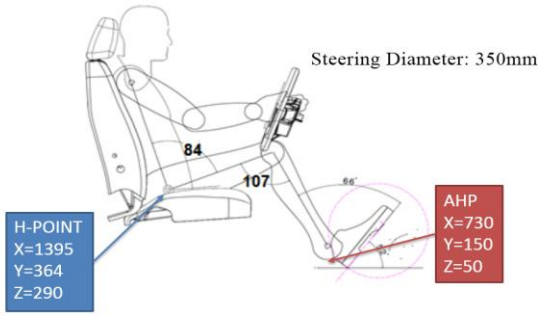


Fig. 9. Existing vehicle Input data. [2]

3.2.2 RAMSIS discomfort assessment analysis of driver at existing location:

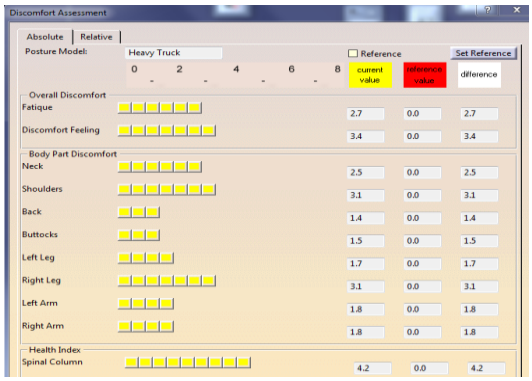


Fig. 10. RAMSIS disscomfirt assessment analysis of driver at existing location.

TABLE 2
Comparison of the discomfort values for all considered movement values of the H point

H point moved in x (mm)	H point moved in z (mm)	Torso angle (deg.)	A pillar obscuration angle rh	Remark
1395	290+55	18	7.74	Upper and lower visibility iproves & not meeting a pillar obscuration
		19	7.45	
		20	7.18	
		22	6.7	
1395+55	290+55	18	6.53	Not meeting a pillar obscuration
		19	6.32	
		20	6.13	Seat is fouling with rear wall
1395+60	290+55	18	6.44	Not meeting a pillar obscuration
		19	6.24	
		20	6.05	Seat is fouling with rear wall
1395+65	290+55	18	6.35	Not meeting a pillar obscuration & seat is fouling with rear wall
		19	6.15	
		20	5.97	

Improvemetnts needs in seatimg position for better comfort. Considering constraints and available packaging space, shift seat in X direction at several position and measure discomfort assessment.

From above tableand packaging constraints in existing vehicle, we go ahead with first trial that H-point shift in Z by 55mm upward.

3.2.3. RAMSIS discomfort assessment analysis of driver seat H point shifted 55mm up in Z direction:

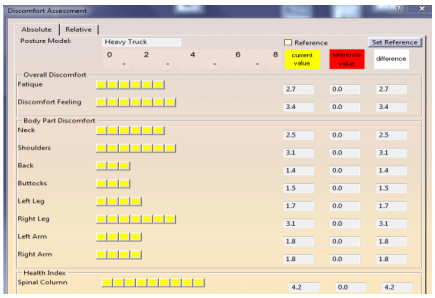


Fig. 11. RAMSIS disscomfirt assessment analysis of driver seat H point shifted 55mm up in Z direction.

3.2.4. A pillar obscuration and upper and lower visibility. [1]

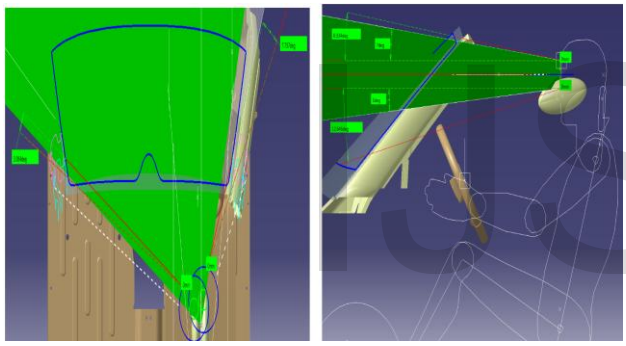


Fig. 12. Visibility zone.

Results:
Right pillar obscuration angle= 7deg > 6, Non Compliance
Left pillar Obscuration angle= 3.08deg < 6, Compliance
Side Visibility angle= 22.65deg > 17, Compliance
Downward visibility angle= 12.65deg >5, compliance
Top visibility angle= 8.33deg > 7, Compliance

3.2.6. Hand reach: [6]

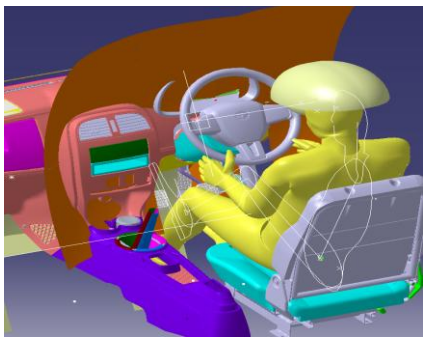


Fig. 13.Hand reach zone.

3.2.7. Cluster Visibility: [7]

Fig. 14.Cluster Visibility zone.

4. Conclusion

Ergonomics study done on mini truck and pick-up commercial vehicle. After getting the data from styling and initial engineering position of driver seat, we got optimized comfortable position of driver seat, steering position and instrumental cluster in addition, a-pillar obstruction visibility of driver for upper and lower side and hand reach position of driver is properly set.

5. Discussion

Ergonomically comfortable position proposed in this analysis needs to be evaluated in the buck along with jury trails to be take to confirm the same.

Other requirement's such as seat travel backward and its clearances needs an improvement with this proposed position.

6. Acknowledgement

While bringing out this project to its final form, I came across a number of people whose contributions in various ways helped my field of research and they deserve special thanks. It is a pleasure to convey my gratitude to all of them. First and foremost, I would like to express my deep sense of gratitude and indebtedness to my supervisor and Guide Prof. S. M. Gaikwad, ME coordinator Prof. M. A. Mohite and H.O.D. Dr. V. V. Shinde for his invaluable encouragement, suggestions and support from an early stage of this project and providing me extraordinary experiences throughout the work. Above all, his priceless and meticulous supervision at each phase of work inspired me in innumerable ways. I specially acknowledge him for his advice, supervision, and the vital contribution as and when required during this project.

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