SYNOPSIS

Various market surveys show cars are purchased based on initial cost, running cost and driving comfort. Driving fatigue is major cause for delayed response resulting in accident situations. User surveys show people easily identify and report discomfort where they find very complex to explain exact cause of good comfort. This is due to the fact that comfort is a derivative of many factors which user analyses based on past experience. Vehicles are designed for a large range of users which vary in anthropometric dimensions, body weights, cultures, past experience and traffic conditions. To fulfill these requirements, remarkable advances are observed in automobile technology during the past decade, like incorporating seatback recliners, lumber support, motorized multi-axes adjustments, and dual density foam cushions. These added features resulted in increased comfort but have also increased costs.

Prototype vehicles are tested to assess the new vehicle through subjective rating with reference to benchmark vehicle on many technical attributes. In spite of lot of advances in technology, analysis and testing, many drivers still continue to experience discomfort while driving. Subjective evaluation is generated using prototype vehicles and it is too late or expensive to modify designs at that stage.

The objective of this thesis is to (i) understand thought process of drivers for giving subjective assessment comfort rating (ii) understand key factors affecting driving perceived comfort (iii) derive objective measurement of these factors through various experimentations (iv) establish relation of these factors with each other and overall comfort (v) consider effective method of Monte-Carlo Simulation using random number to find the manufacturing effectiveness of each these factors to generate global optima for overall comfort (vi) evaluate and
establish a correlation between subjective comfort rating and simulated findings and check possibility of prediction of subjective comfort rating well ahead of the vehicle design and development program.

The thesis dwells on the application of various proven methodologies developed by international experts related to sub topics of this study like Analytic Hierarchical process (AHP) and R³I. In addition to this a new algorithm is developed to identify the ‘Threshold Comfort Index’ which can be used to predict comfort level of the vehicle. An attempt has been to establish logical approach to the problem and formulate the component level computer aided analysis or physical experiments well ahead of development to predict subjective rating driver or user may give for driving comfort on the vehicle.

The thesis consists of 11 chapters in all. While chapter 1 introduces the identification, selection of the problem with detailed objectives and discusses the type of the situation being followed at present and its limitations, chapter 2 presents up to date information regarding the existing literature spread over a period of nearly last three decades.

The initial part of the chapter 2 deals with existing process followed by automobile designer to placement of various mechanical aggregates around the driver, the tools, software used. The author has summarized the work done by various researchers published in national and international Journals. A critical appreciation of the state-of-art presented, based on more than 80 research papers, and has been done with the objective of evolving the strategy of work to be done to bridge some of the gaps existing in the present day passenger car driver comfort evaluation, vehicle package, testing methodologies.

The third chapter collects results of few published market surveys about customer perceptions about various cars available in Indian market. It also shows results of similar market survey conducted on 10 passenger cars to understand
user views about these cars from driving perspective. It covers output of a brainstorming session conducted with a group of automobile designers and test engineers to list down factors related to driving comfort. These factors then grouped and arranged based on their interrelation. After creation of hierarchical chart the group was asked to rate based on their past experience. Using Analytical Hierarchy process author calculated all these factors relative worth. The study output revealed that although more than 50 factors related to driving comfort were listed important five factors covered 70% population. These key factors were driver's posture, seat parameters, vibrations, weight distribution and frontal visibility. It also defines ranking of 10 benchmark cars for above key comfort factors using R³I technique. The study also defines priority matrix of these cars against all benchmark cars from user's comfort perspective.

Chapter 4 discusses the industry practice followed by automobile designers to define driver's posture. Present day procedure with its limitations is debated. Passenger cars are used by large population ranging from short lady to tall male driver with large range of limb dimensions. To make whole range of drivers comfortable, postural aspects and key body hard points are defined using standard anthropometric data. These key dimensions are also measured from physical vehicles. Difference between calculated and measured values gave postural error index.

Chapter 5 shows measurement of important seat physical properties of benchmark cars. The chapter also shows few new test procedures to define seat attributes like foam versus deflection skewness index.

Chapter 6 deals with vibration transmissibility of the driver's seat. In this chapter standard test procedures like ISO 2631 for counting effect of vibrations, is used to understand how various benchmark seats behave for input vibration dose from vehicle structure. The experimental data is analyzed to define transmissibility, RMS acceleration and crest index for every car seat.
The way automobile users vary for their standing height, gender, there is also large variation of user body weight the seat needs to take cars. Chapter 7 debates effect of human body weight, its distribution across cushion and back rest. Good seat show uniform pressure distribution where as bad seats show local pressure peaks. These peaks result in local sour points restricting blood circulation resulting in temporary or permanent numbness. The author has also converted large measurement data to few attribute index values like pressure factor, comfort factor.

Chapter 8 touches aspects of frontal visibility through bench mark car measurements for clear visibility through windscreen, obscuration angles by front A pillars.

In the concluding chapter 9 the author summarizes the results obtained from various experiments and their findings. As there are too many factors with vast range and their interrelation is not always linear, no mathematical formulation can be used to establish combined factor.

To get combined global maxima which can define comfort index the author used simulation techniques. First the data is normalized, multiplied by individual attribute weightage and then maximized using random number theory to get combined number of all attributes this number is defined as 'Threshold Comfort Index” with its theoretical standard deviation. Any car having Cumulative Comfort Index lower than this number can be considered as uncomfortable car where as cumulative comfort index higher than Threshold Comfort Index reveals the car is comfortable. The chapter also calculates Cumulative Comfort Index of all bench mark cars and checks their correlation with subjective rating already collected in chapter 3 study. The comparison shows linear relation which means the new method derived for calculating “Threshold Comfort Index and Cumulative Comfort Index” can be used to predict its perceived comfort rating.
mathematical model was formulated as linear programming model. The maximum value comfort was identified using different interacting constraints.

Final chapter summarizes the findings and defines future scope, how this process can be further refined, extended to other category vehicles.

The references at the end show the literature used, data collected through various experiments.

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