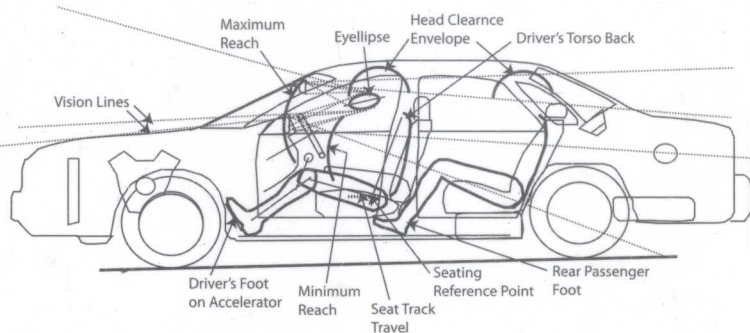
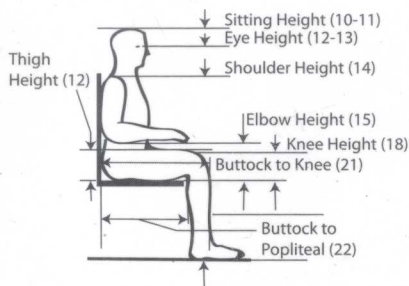
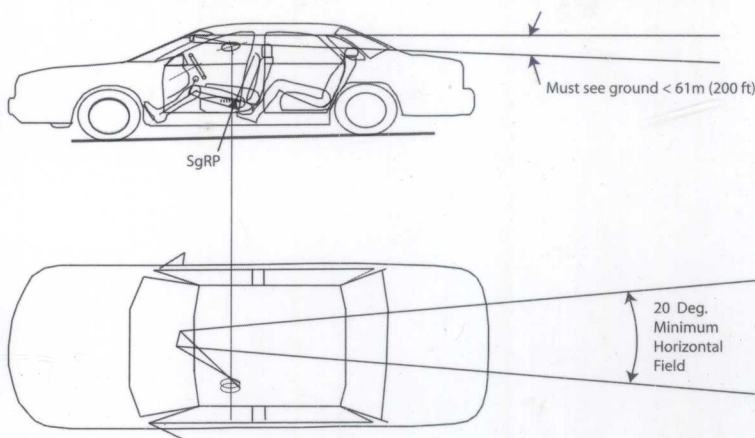
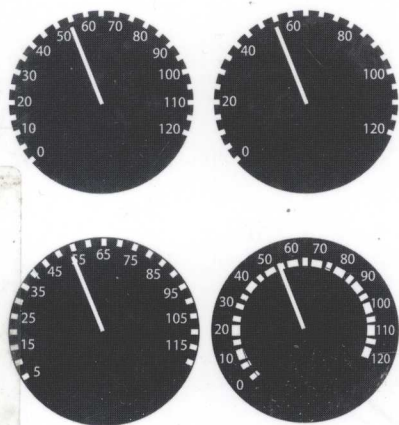




ERGONOMICS in the Automotive Design Process

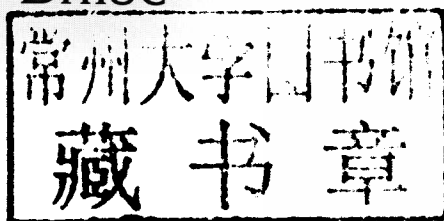
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ERGONOMICS in the **Automotive** **Design Process**

Preface

The purpose of this book is to provide a thorough understanding of ergonomic issues and to provide background information, principles, design guidelines, and tools and methods used in designing and evaluating automotive products. This book has been written to satisfy the needs of both students and professionals who are genuinely interested in improving the usability of automotive products. Undergraduate and graduate students in engineering and industrial design will gain an understanding of the ergonomics engineer's work and the complex coordination and teamwork of many professionals in the automotive product development process. Students will learn the importance of timely information and recommendations provided by the ergonomics engineers and the methods and tools that are available to improve user acceptance. The professionals in the industry will realize that the days of considering ergonomics as a "commonsense" science and simply "winging-in" quick fixes to achieve user-friendliness are over. The auto industry is facing tough competition and severe economic constraints. Their products need to be designed "right the first time" with the right combinations of features that not only satisfy the customers but continually please and delight them by providing increased functionality, comfort, convenience, safety, and craftsmanship.

The book is based on my more than 40 years of experience as a human factors researcher, engineer, manager, and teacher who has performed numerous studies and analyses designed to provide answers to designers, engineers, and managers involved in designing car and truck products, primarily for the markets in the United States and Europe. The book is not like many ergonomics textbooks that compile a lot of information from a large number of references reported in the human factors and ergonomics literature. I have included only the topics and materials that I found to be useful in designing car and truck products, and I concentrated on the ergonomic issues generally discussed in the automotive design studios and product development teams. The book is really about what an ergonomics engineer should know and do after he or she becomes a member of an automotive product development team and is asked to create an ergonomically superior vehicle.

The book begins with the definitions and goals of ergonomics, historic background, and ergonomics approaches. It covers important human characteristics, capabilities, and limitations considered in vehicle design in key areas such as anthropometry, biomechanics, and human information processing. Next, the reader is led in understanding how the driver and the occupants are positioned in the vehicle space and how package drawings and/or computer-aided design models are created from key vehicle dimensions used in the automobile industry. Various design tools used in the industry for occupant packaging, driver vision, and applications of other psychophysical methods are described. The book covers important driver information processing concepts and models and driver error categories to understand key considerations and principles used in designing controls, displays, and their usages, including current issues related to driver workload and driver distractions.

A vehicle's interior dimensions are related to its exterior dimensions in terms of the required fields of view from the driver's eye points through various window openings and other indirect vision devices (e.g., mirrors, cameras). Various field-of-view measurements, analysis techniques, visibility requirements, and design areas such as windshield wiper zones, obscurations caused by car pillars, and the required indirect fields of views are described along with many trade-off considerations. To understand the basics of headlamp beam pattern design and signal lighting performance and their photometric requirements, human factor considerations and night visibility issues are presented. Other customer/user concerns and comfort issues related to entering and exiting the vehicle, seating, loading and unloading cargo, and other service-related issues (engine and trunk compartment, refueling the vehicle, etc.) are covered. They provide insights into user considerations

in designing vehicle body and mechanical packaging in terms of important vehicle dimensions related to body/door openings, roof, rocker panels, and clearances for the user's hands, legs, feet, torso, head, and so on.

A chapter on craftsmanship covers a relatively new technical and increasingly important area for ergonomics engineers. The whole idea behind craftsmanship is that the vehicle should be designed and built such that the customers will perceive the vehicle to be built with a lot of attention to details by craftsmen who apply their skills to enhance the pleasing perceptual characteristics of the product related to its appearance, touch, feel, sounds, and ease during operations. Several examples of research studies on measurement of craftsmanship and relating product perception measures to physical characteristics of interior materials are presented.

In addition, for researchers, the second part of the book includes chapters on driver behavioral and performance measurement, vehicle evaluation methods, modeling of driver vision (which illustrates how the target detection distances and legibility of displays can be predicted to evaluate vehicle lighting and display systems), and driver workload to evaluate in-vehicle devices. Discussions on ergonomic issues for development of new technological features in areas such as telematics, night vision, and other driver-safety- and comfort-related devices are included. The second part of the book also presents data and discusses many issues associated with designing for different population segments, such as older drivers, women drivers, and drivers in different geographic parts of the world. Finally, the last chapter is focused on various issues related to future research needs in several specialized areas of ergonomics as well as vehicle systems and on implementation of available ergonomic design guidelines and tools at different stages of the automotive product design process.

The book can be used to form the basis of two courses in vehicle ergonomics. The first course would cover the basic ergonomic considerations needed in designing and evaluating vehicles that are included in Part I—the first eleven chapters of this book. The remaining chapters covered in Part II can be used for an advanced and more research-oriented course.

Website Materials

The following files are in the Download section of this book's web page on the CRC Press website (<http://crcpress.com/product/isbn/9781439842102>).

A. Computer programs and models

1. Computations of percentile value of normal distribution
2. Driver package parameters computations
3. Reaction time measurement program
4. Legibility model
5. Visibility prediction model
6. Discomfort glare and dimming request prediction model

B. Slides for lectures 1–17 (corresponding to Chapters 1–17)

Acknowledgments

This book is a culmination of my education, experience, and interactions with many individuals from the automotive industry, academia, and government agencies. While it is impossible for me to thank all the people who influenced my career and thinking, I must acknowledge the contributions of the following individuals.

My greatest thanks go to Professor Thomas H. Rockwell of the Ohio State University. Tom got me interested in human factors engineering and driving research. He was my advisor and mentor during my doctoral program. I learned many skills on how to conduct research studies, analyze data, and more important, he had me introduced to the technical committees of the Transportation Research Board and the Society of Automotive Engineers, Inc.

I would like to thank Lyman Forbes, Dave Turner, and Bob Himes from the Ford Motor Company. Lyman Forbes, manager of the Human Factors Engineering and Ergonomics Department at the Ford Motor Company in Dearborn, Michigan, spent hours with me discussing various approaches and methods of conducting research studies on various crash-avoidance research issues related to the development of motor vehicle safety standards. Dave Turner from the Advanced Design Studios helped anchoring ergonomics in the automotive design process and also created an environment to establish a human factors group in Europe. Bob Himes of the advanced vehicle engineering staff helped in incorporating ergonomics and vehicle packaging as a vehicle attribute in the vehicle development process.

The University of Michigan–Dearborn campus provided me with unique opportunities to develop and teach various courses. Our automotive systems engineering and engineering management programs allowed me to interact with hundreds of students who in turn implemented many of the techniques taught in our graduate programs in solving problems within many other automotive original equipment manufacturers and supplier companies. I would like to thank Professors Adnan Aswad, Munna Kachhal, and Armen Zakarian for giving me opportunities to develop and teach many courses in industrial and manufacturing systems engineering and Dean Subrata Sengupta for supporting the creation of the Vehicle Ergonomics Laboratory in the new Institute for Advanced Vehicle Systems Building. Roger Schulze, director of the Institute for Advanced Vehicle Systems, got me interested in working on a number of multidisciplinary programs in vehicle design. Together, we developed a number of vehicle concepts such as the low-mass vehicle, a new Model T concept for Ford's 100th anniversary, and a reconfigurable electric vehicle. We also created a number of design projects by forming teams of our engineering students with students from the College for Creative Studies in Detroit, Michigan. My special thanks also go to James Dowd from Collins and Aikman and team members of the Advanced Cockpit Enablers (ACE) for sponsoring a number of research projects on various automotive interior components and creation of a driving simulator to evaluate a number of advanced concepts in vehicle interiors.

Over the past 40-plus years, I was also fortunate to meet and discuss many automotive design issues with members of many committees of the Society of Automotive Engineers, Inc., the Motor Vehicle Manufacturers Association, the Transportation Research Board, and the Human Factors and Ergonomics Society.

I would like to also thank Cindy Carelli of CRC Press—a Taylor & Francis Company—for encouragement in preparing the proposal for this book and Ed Curtis and his production group for turning the manuscript into this book. My thanks also go to Louis Tijerina, Anjan Vincent, and Calvin Matle for reviewing the manuscript and providing valuable suggestions to improve this book.

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Author

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During 1973 to 2001, he held a number of management and research positions at the Ford Motor Company in Dearborn, Michigan. He was the manager of Consumer Ergonomics Strategy and Technology within the Corporate Quality Office and the manager of the Human Factors Engineering and Ergonomics in the Corporate Design of the Ford Motor Company, where he was responsible for the ergonomics attribute in the design of car and truck products.

Dr. Bhise has taught graduate courses in vehicle ergonomics, vehicle package engineering, automotive systems engineering, human factors engineering, total quality management and Six Sigma, product design and evaluations, and safety engineering over the past 30 years (1980–2001 as an adjunct professor and 2001–2009 as a professor) at the University of Michigan–Dearborn. He also worked on a number of research projects on human factors with Professor Thomas Rockwell at the Driving Research Laboratory at the Ohio State University (1968–1973). His publications include more than 100 technical papers in the design and evaluation of automotive interiors, vehicle lighting systems, field of view from vehicles, and modeling of human performance in different driver/user tasks.

He received the Human Factors Society's A. R. Lauer Award for outstanding contributions to the understanding of driver behavior in 1987. He has served on a number of committees of the Society of Automotive Engineers Inc., Vehicle Manufacturers Association, Human Factors Society, and Transportation Research Board of the National Academies. He is a member of the Human Factors and Ergonomics Society, the Society of Automotive Engineers Inc., and Alpha Pi Mu.

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