

Contents

Preface.....	ix
Part I: Factors Affecting Driver Perception	
Chapter 1: Introduction	3
<i>David Krauss and Paul Olson</i>	
1.1 Purpose and Scope	3
1.2 Human Factors in Accident Reconstruction	3
A. What is Human Factors?	3
B. Introduction to Human Factors and Motor Vehicles	3
C. History	4
D. Human Factors in Product Evaluation and Development	5
E. Applicability of Human Factors to Accident Reconstruction	6
F. What isn't Human Factors	7
1.3 Human Variability	7
A. The Problem	7
B. Descriptive Statistics	8
C. Correlation	11
D. Inferential Statistics	12
E. The Concept of Threshold	12
1.4 Expectancy	13
A. What It Is	13
B. Driver Expectancy	13
1.5 Chapter Overview	14
References	15
Chapter 2: Light and Its Measurement	17
<i>David Krauss and Paul Olson</i>	
2.1 Introduction	17
2.2 The Nature of Light	17
2.3 Definitions	18
A. Light-Reflecting Surfaces	18
1. Diffuse reflectors	18
2. Specular reflectors	18
3. Retroreflectors	19
B. Miscellaneous Visibility-Enhancing Materials	20
1. Fluorescent materials	20
2. Luminous materials	20
2.4 Photometry	20
A. Luminous Intensity and Illuminance	21
B. Luminance	21
C. Means of Measurement	22
D. Calculating Light Metrics Following Measurement	22
2.5 Chapter Overview	22
Reference	23
Chapter 3: Vision, Audition, Vibration and The Processing of Information.....	25
<i>David Krauss and Paul Olson</i>	
3.1 Introduction	25
3.2 Vision	25
A. Measurement of Visual Performance	25
1. Acuity	25
2. Contrast sensitivity function	27
3. Other measures of visual performance	27
4. Relationship between vision tests and driving performance	27
B. Structure and Performance of the Eye	28
1. Structure	28
2. The functioning of the visual system at different levels of illumination	30
3. Implications for vision due to the structure of the eye	32
C. Glare	34
1. Disability glare	34
2. Discomfort glare	35
D. The Useful Field of View	35
E. The Twilight Period	35
3.3 Auditory Issues	40
A. Problems with Sound	40
B. Noise	40
3.4 Vibration	41
3.5 Information Processing	42
3.6 Memory Questions	43
3.7 Chapter Overview	44
References	45
Chapter 4: Driver Eye Movements and Visual Attention.....	47
<i>David Krauss, Abtine Tavassoli, and Paul Olson</i>	
4.1 Introduction	47
A. Terminology	47
B. Methodology	48
4.2 Driver Eye Movements	49
4.3 Driver Experience	49
4.4 Negotiating Curves	49
4.5 Effects of Drugs and Alcohol	50

4.6 Effects of Fatigue	50	7.5 Speed Perception and Vehicle Size	90
4.7 Vehicle Characteristics	51	7.6 Chapter Overview	90
4.8 Age and Sex	51	References	90
4.9 Interior Glances	51	Chapter 8: The Driver's Field of View	93
4.10 Effect of In-Vehicle Devices	52	<i>David Krauss and Gene Farber</i>	
4.11 Use of Mirrors	52	8.1 Introduction	93
A. Duration of Routine Mirror Glances	52	8.2 What a Driver Must See	93
B. Duration of Mirror Glances in Connection with Merges and Lane Changes	52	8.3 Field-of-View Targets	94
C. Mirror and Direct Rearward Glances When Changing Lanes and Merging	52	8.4 Driver Eye Locations	94
D. The Timing of Rearward Glances with Respect to the Gore	53	8.5 Binocular and Ambinocular Vision	95
4.12 The Effect of Secondary Glances on Accident Avoidance	53	8.6 Obstruction of the Forward Field of View	95
4.13 Chapter Overview	54	8.7 A-Pillar Obstruction of Intersecting Vehicles	98
References	54	8.8 A-Pillar Obstruction of Pedestrians and Bicyclists	100
Chapter 5: Conspicuity.....	57	8.9 Measuring Pillar Obstructions in the Field	101
<i>David Krauss, J. Jay Todd, and Paul Olson</i>		A. Measuring the Ambinocular A-Pillar Obstruction of a Pedestrian	101
5.1 Introduction	57	B. Measuring the Ambinocular A-Pillar Obstruction of an Intersecting Vehicle	102
5.2 Motorcycle and Bicycle Conspicuity	58	8.10 Obstructions to the Side and Rear	103
5.3 The Conspicuity of Emergency Vehicles	61	A. A Note on Convex Mirrors (“Objects in Mirror Are Closer than They Appear”)	104
5.4 Truck Conspicuity	62	B. Mirrors and Overtaking Vehicles	104
5.5 Pedestrian and Pavement Delineation Conspicuity	64	C. Pillar Obstructions to the Side and Rear Direct Fields-of-View	105
5.6 Chapter Overview	64	8.11 The Field of View from Large Trucks	106
References	65	8.12 Measuring the Field of View in Large Trucks	107
Chapter 6: Driver Perception	67	8.13 Chapter Overview	107
<i>David Krauss, J. Jay Todd, Robert Dewar, and Paul Olson</i>		References	108
6.1 Introduction	67		
6.2 Perception as Contrasted to Sensation	67	Part II: Driving at Night	
A. Definition	67		
B. The Nature of Perception	68	Chapter 9: The Visibility Provided by Vehicle Lighting Systems.....	111
C. Visual Perceptual Principles of Grouping	68	<i>David Krauss and Paul Olson</i>	
D. Perceiving Space	69	9.1 Introduction	111
6.3 Misperception and Perceptual Set	71	9.2 The Importance of Target Contrast	112
6.4 Applications	73	A. Definition	112
6.5 Difficulties in Perception While Driving	75	B. Calculating Contrast	113
A. Problems with the Roadway	75	9.3 The Reflectivity of Objects in the Real World	114
B. Violations of Expectancy	76	9.4 Driver Vision at Night	117
C. Judging Distance to Lights	76	A. Vehicle Lighting Systems	117
6.6 The Intruding Vehicle	76	1. Technology used in automotive lighting	118
6.7 Positive Guidance	77	2. Enhanced vision systems	119
6.8 Eyewitness Testimony	78	3. Characteristics of U.S. headlamps	119
6.9 Chapter Overview	80	4. The intensity-visibility distance relationship	121
References	81	5. Implications	122
Chapter 7: Judgments of Speed and Distance.....	83	B. The Visibility Provided by Automotive Headlamps	122
<i>David Krauss, J. Jay Todd, and Paul Olson</i>		9.5 Nighttime Driving Speeds	129
7.1 Introduction	83	9.6 When Drivers “Overdrive” Their Headlamps	130
7.2 Perception of Distance	83	9.7 Chapter Overview	131
7.3 Perception of Speed	84	References	131
7.4 Threshold for Closing Speed	86		

Chapter 10: Factors That Affect Driver Visibility Under Nighttime Driving Conditions.....	133
<i>David Krauss and Paul Olson</i>	
10.1 Introduction	133
10.2 PCDETECT	133
10.3 The Distance-Squared Law and Visibility Level ...	135
10.4 Comparisons	135
A. Target Reflectance	136
B. Target Location	137
C. Target Size	137
D. Driver Age	137
E. Contrast Sensitivity	139
F. Headlamp Misaim	139
G. Headlamp Intensity	139
H. Glare	139
I. Lamp Mounting Height	140
J. Lateral Separation	141
10.5 Other Factors	142
10.6 Chapter Overview	142
References	142
Chapter 11: Lighting Sources Other Than Vehicle Headlamps	145
<i>David Krauss and Paul Olson</i>	
11.1 Introduction	145
11.2 Fixed Lighting Sources	145
A. Mercury	146
B. High-Pressure Sodium	146
C. Metal Halide	146
D. Fluorescent	146
E. Low-Pressure Sodium	146
F. Light-Emitting Diodes (LED)	146
11.3 The Distribution of Illuminance from Street Lamps	146
11.4 Loss in Performance of Light Sources	148
11.5 The Scene When Illuminated by Fixed Sources ...	148
11.6 Research on the Performance of Fixed Lighting Systems	149
11.7 Recommendations for Street Lighting	152
11.8 Assessment of Visibility in a Field Investigation ..	154
11.9 Chapter Overview	155
References	155
Chapter 12: Evaluation of Visibility in the Field	157
<i>David Krauss and Paul Olson</i>	
12.1 Introduction	157
12.2 Why Do a Field Investigation?	157
12.3 Preparatory Phase	158
A. Physical Facilities	158
B. Vehicles	160
C. Vehicle Lighting and Marking Equipment	160
1. Type or manufacturer of lamps	160
2. Headlamp aim	161
3. Lamp output	162
4. Dirt on glass surfaces	163
5. Headlamp photometry	163
6. Environmental conditions	164
7. Lighting conditions	164
8. Observer age	165
12.4 Execution Stage	165
12.5 Analysis and Interpretation	165
12.6 Chapter Overview	166
References	167
Chapter 13: Use of Visual Demonstratives to Represent Visibility Conditions	169
<i>David Krauss, J. Jay Todd, and Paul Olson</i>	
13.1 Introduction	169
13.2 Limitations in the Camera System	171
13.3 Limitations and Appropriate Applications of Video and Animation for Representations of Conspicuity...173	
13.4 Perceptual-Cognitive Issues	173
A. Field of View	175
B. Viewing Time	175
C. Adaptation Level	175
D. Image Size	175
E. Depth Perception	176
F. Glare	176
G. Observer Expectancy	176
13.6 Implications	177
13.7 Chapter Overview	177
References	178

Part III: Roadway Issues

Chapter 14: Roadway Design and the Driver	181
<i>David Krauss, Andrew Kwasniak, and Robert Dewar</i>	
14.1 Introduction	181
14.2 Perception of the Road	182
14.3 Visual Search	182
14.4 Driver Workload	183
14.5 Sight Distance	183
A. Decision Sight Distance	183
B. Stopping Sight Distance	184
C. Passing Sight Distance	184
D. Intersection Sight Distance	185
E. Additional Sight Distance Factors	185
14.6 Roadway Design	185
A. Roadway Width	185
B. Intersections	185
C. Roundabouts	187
D. Curves	188
14.7 Traffic Calming	191
14.8 Road Safety Assessments	191
14.9 Chapter Overview	191
References	192

Chapter 15: Work Zones	195
<i>David Krauss, Andrew Kwasniak, and Robert Dewar</i>	
15.1 Introduction	195
15.2 Driver Information Needs in Work Zones	195
15.3 Driver Distraction	196
15.4 Nighttime Conditions	197
15.5 Visibility of Workers	198
15.6 Trucks	199
15.7 Traffic Control in Work Zones	199
15.8 Chapter Overview	200
References	201
Chapter 16: Railroad Grade Crossings	203
<i>David Krauss and Robert Dewar</i>	
16.1 Introduction	203
16.2 Driver Perception of Railroad Crossing Hazards ..	203
16.3 Recognition Errors	204
16.4 Decision Errors	206
16.5 Action Errors	207
16.6 Traffic Control at Crossings	208
16.7 Major Problems and the Need for Further Research	210
16.8 Chapter Overview	210
References	211
Chapter 17: Roadway Signage.....	213
<i>David Krauss, Andrew Kwasniak, and Robert Dewar</i>	
17.1 Introduction	213
17.2 Sign Criteria	214
17.3 Problems with Signs	215
17.4 Regulatory Signs	215
17.5 Compliance with Regulatory Signs	215
17.6 Warning Signs	216
17.7 Supplemental Warning Sign Information	217
17.8 Guide Signs	217
17.9 Abbreviations	218
17.10 Bilingual Signs	218
17.11 Nighttime Conditions	218
17.12 Environmental Factors	219
17.13 Changeable Message Signs	219
17.14 Sign Conspicuity	221
17.15 Driver Age	222
17.16 Traffic Signs and IVIS	224
17.17 Traffic Signs and Traffic Accidents	224
17.18 Traffic Signals	226
17.19 Chapter Overview	226
References	227
Part IV: Driver Issues	
Chapter 18: Driver Perception-Response Time	233
<i>David Krauss, J. Jay Todd, and Paul Olson</i>	
18.1 Introduction	233
18.2 Background	235
A. Definition	235
B. Stages of Perception-Response Time	236
18.3 Human Perception-Response Time	237
A. Background	237
B. Driver Perception-Response Time	238
1. Analyses of data from the experimental literature	238
2. Studies using motorists who are unaware of measures being taken	239
3. Controlled, in-car studies	242
4. Studies conducted in simulators	247
5. Computer modeling	248
18.4 Decision Sight Distance	251
18.5 Overview of Research	252
18.6 Factors Affecting Perception-Response Time	253
A. Detection	254
B. Identification	255
C. Decision	255
D. Response	255
E. Night vs. Day	256
F. Chemicals, Driver Fatigue	256
G. Age and Gender	257
H. Cognitive Load	258
I. Angular Position of the Target	259
18.7 The “Critical Window”: Available Time vs. Required Time	261
18.8 Situations that Do Not Fit the Perception-Response Model	261
A. No Clearly Defined Entry	261
B. Erroneous Assumption or Identification	262
18.9 Chapter Overview	263
References	264
Chapter 19: Weather and Driving.....	269
<i>David Krauss and Robert Dewar</i>	
19.1 Adverse Weather	269
A. Rain	270
B. Snow	271
C. Fog	272
D. Glare	274
19.2 Traffic Control Devices	276
19.3 Pedestrian Behavior	276
19.4 Chapter Overview	277
References	277
Chapter 20: The Older Driver	279
<i>David Krauss, Robert Dewar, and Paul Olson</i>	
20.1 Older Drivers: Who Are These Guys?	279
20.2 Driving by the Elderly	280
20.3 Sensory Changes	283
A. Vision	283
B. Other Senses	285
20.4 Judgment of Closing Speed—Gap Acceptance	285
20.5 Cognitive and Motor Performance	286

A. Attention and Cognition	286
B. Perception of Roadway Hazards	287
C. Motor Performance	287
D. Older Drivers and Pedal Errors	288
20.6 Strategies for Improvement	288
20.7 Chapter Overview	288
References	289

Chapter 21: Driver Distraction.....293*David Krauss, David Cades, and Robert Dewar*

21.1 Introduction	293
21.2 What is Driver Distraction?	293
21.3 Distraction and Inattention	293
21.4 Useful Field of View	295
21.5 Sources of Distraction	295
A. Various Sources	295
B. Visual Clutter	296
C. Roadside Advertising	296
D. Driving When Phoning	297
E. Distraction from Technology	298
21.6 Consequences of Distraction	299
21.7 Driver Characteristics and Condition	299
A. Age	300
B. Gender	300
C. Emotions	300
D. Alcohol	301
21.8 Chapter Overview	301
References	301

Chapter 22: In-Vehicle Technology and the Driver ..307*David Cades, Robyn Kim, and David Krauss*

22.1 Introduction	307
22.2 Types of In-Vehicle Technology	307
A. Non-Driving-Related Technology	307
B. Driving-Related Technology	308
22.3 Effects of In-Vehicle Technology on Driver Behavior	309
A. Driver Assistance	309
B. Negative Effects on Driver Behavior	310
22.4 System Design Guidelines for In-vehicle Electronic Devices	313
A. Comparison of Guidelines	313
B. Guidelines for Message Display and Appearance	313
C. Guidelines for Usability	314
D. Guidelines for Testing	315
22.5 Chapter Overview	315
References	316

About the Authors.....321**Index.....323**