Index

Abbreviated Injury Scale (AIS), 90–91
Accident avoidance, 28–46
  chassis design, 31–33
  development of integral functions, 78
  driver assistance systems, 37–46
  driver comfort, 30
  ergonomics, 30
  human factors, 28–29
  integrating with mitigation of injury, 72–78
  tire design, 31–33
  vehicle assistance systems, 34–37
Accident research, 17–24
  accident data, 18–21
  application of research data, 22–24
  fatalities, 1, 18–22
Accidents, see Collisions
Active safety systems, 25–27
Adaptive cruise control (ACC), 37
Adaptive front lighting system (AFS), 35–37
Adaptive occupant protection, 141–172
  and accident severity, 143–147
  age of occupants, 150–151
  airbag control concepts, 153–160
  based on accident situation, 141–143
  calculating equivalent accident severity, 168–170
  calculating virtual injury distribution in the field, 170
  effectiveness and benefit in the field, 171–172
  estimate of potential in real accident, 165–172
  front-seat passenger, 163–164
  individual protection, 143–152
  individuality of the occupants, 147–151
  injury probability, 165–167
  occupant- and accident severity–specific, 161–165
  and seat position, 149–150
  summary of adaptivity, 164–165
  transferring potential from simulation to reality, 167–168
  unbelted occupant, 162–163
  weighting of main influencing factors, 151–152
Airbags, 115–118, 121–122, 124–125
  and belt force switching, 158–159
  and front-seat passenger, 163–164
  and unbelted occupant, 162–163
  comparison of control concepts, 159–160
  control concepts, 153–160
  degressive vent control, 133–134, 157–158
  mass flow control, 153–155
  optimum profile of vent opening, 128–131
  precrash, 67–68
  vent control with constant pressure, 156–157
  vent control with switching belt force limiter, 161–162
  volume control, 156
Anti-glare high beam, 41–43
Antilock braking systems (ABS), 34
Automated driving intervention, 76
Automatic brake intervention, 64–66
  by vehicle-to-vehicle and sensor fusion, 82–85
Binary decision tree, 51
Biomechanics, 89–93
  external injuries, 91–92
  internal injuries, 93
  tolerance limits, 90–91
Blood alcohol content (BAC), 29
Body in white, quasi-static test requirements, 101–103
Brake assistant (BAS), 34
Braking, automatic intervention, 64–66, 82–85
Cameras, 55–56, 57–58
CarMatching, 84
Car-to-infrastructure safety, 79–86
automatic braking intervention by
vehicle-to-vehicle and sensor fusion, 82–85
car-to-car communication, 80–82
communication systems, 79–80
cooperative driving, 85–86
Car/truck collisions, 176–177
Chassis
design, 31–33
side impact lift system, 69–70
Child restraints, 114–115
Coefficient of drag (CD), 31
Collisions
calculating equivalent accident severity, 168–170
and driver error, 4–5, 28–29
dynamic simulation of, 103–110
frontal, 103–107
lateral, 107–109
rear-end, 109
rollover, 109–110
estimate of potential of adaptive restraint systems in, 165–172
frontal, 103–107, 141–143, 147, 187
effectiveness of adaptive restraint systems in, 171
tolerance limits, 94
unbelted occupant in, 118–119
precrash system, 68–71
test defined in the U.S. and Europe, 137–138
theoretical analysis of, 136–137
tolerance levels, 95
passenger car/truck, 176–177
pedestrian, 177–178
prediction of, 50–52
rear-end, 109, 188
severity of, 143–147
severity-specific adaptivity, 161–165
see also Crash simulation
Compatibility analyses, 175–178
Cooperative driving, 85–86
Crash prediction, 50–52
Crash pulse, 126, 128, 145, 147
Crash simulation, 185, 187–190
dynamic, 103–110
frontal impact, 187
lateral impacts, 187–188
rear-end collision, 188
rollover, 188–190
Crash tests, 22
Deceleration, 103, 119, 120–121, 125–128
Deceleration profile, 145–147
Deformation force, 105
steering column, 122–124, 133–134
Degressive airbag vent control, 133–134, 157–158
Degressive restraint force, 128, 130–131
Development process of integral functions, 78
Door impact, 102
Drag coefficient (CD), 31
Driver adaptive system, 48–49
Driver assistance systems, 5, 22, 25
lateral guidance systems, 38–39
longitudinal guidance systems, 37–38
night assistance, 39–46
Driver comfort, 30
Driver education, 25
Driver modeling, 46–49
Driver protection, see Occupant protection
Driving simulator, 182
Dynamic simulation of vehicle collisions, 103–110
EC directives, 7–9
E-Call system, 77–78
Economic Commission for Europe (ECE) regulations, 7–9
Ejection mitigation, 118
Electronic stability control (ESC), 34–35
Environment detection, 53–59
Equivalent accident severity, 168–170
Ergonomics, 30
Escape light function, 45
Europe, 7–9
Evaluation, 52–53
Event data recorders (EDRs), 23–24
External injuries, 91–92
False alarm probability, 52–63
Fatalities, 1, 18–22
FMVSS standards, 8–9
Frontal collisions, 103–107, 141–143, 147, 187
effectiveness of adaptive restraint systems in, 171
tolerance limits, 94
unbelted occupant in, 118–119
Fusion of sensor sources, 58–59
German Federal Agency for Road Research (BAST), 17
German In Depth Accident Study (GIDAS), 17
Germany, 7, 17–18, 21
Global Technical Regulation, 177–178
Government authorities, responsibilities of, 195
GPS sensors, 56–57
Hardware-in-the-loop (HIL), 183
Head rests, 118
Head-injury-criteria (HIC), 93–94
Headlights, 30
  adaptive systems, 35–37
  anti-glare high beam, 41–43
  high beam assistance systems, 40–41
  light emitting diode (LED), 43–45
  masked high beam, 44
Human factors, 28–29
Human tolerance limits, 90–91
Infrastructure, 25
Injuries
  calculating virtual injury distribution in the field, 170
  external, 91–92
  internal, 93
Injury mitigation, see Mitigation of injury
Injury, probability of, 165–167
Integral pedestrian protection, 73–75
Integrated safety, 25–59
  accident avoidance, 28–46
  car-to-infrastructure safety, 79–86
  chassis and tire design, 31–33
  comfort and ergonomics, 30
  driver assistance systems, 37–46
  driver modeling, 46–49
  functions of, 63–86
  human factors, 28–29
  integrating avoidance and mitigation, 72–78
  precrash safety, 63–71
  vehicle assistance systems, 34–37
Interior, 110–111
Internal injuries, 93
International Federation of Automotive Engineering Societies (FISITA) summit, 1–3
International Road Traffic and Accident Database (IRTAD), 18
Irreversible restraint systems, 67–68
Lane assist, 38
Laser sensors, 55, 57
  chassis lift system, 69–70
  precrash system, 68–71
  test defined in the U.S. and Europe, 137–138
  theoretical analysis of, 136–137
  tolerance levels, 95
Lateral guidance systems, 38–39
Legislation, 6–11
Light emitting diode (LED), 43–45
Longitudinal guidance systems, 37–38
Main influencing factors, weighting of, 151–152
Man-machine interface, 181–182
Masked high beam, 44
Mitigation of injuries, 101–138
  development of integral functions, 78
  dynamic simulation of vehicle collisions, 103–110
  integrating with accident avoidance, 72–78
  interaction of restraint system and vehicle, 118–138
  occupant protection, 110–118
  quasi-static test requirements on the body in white, 101–103
  rescue and recovery, 77–78
Model-in-the-loop (MIL), 183
National Highway Traffic Safety Administration (NHTSA), 81
Neck injury criteria (NIC), 95
New Car Assessment Program (NCAP), 12–15
Night assistance systems, 39–46
Occupant protection, 110–118
  adaptive, see Adaptive occupant protection
  airbags, 115–118, 121–122
  precrash, 67–68
  belted occupant, 120–121
  child restraints, 114–115
  head rests, 118
  preventative, 72–73
  seat belts, 111–114
  seats, 101, 118
  and side impacts, 68–70
Index

Occupant protection (cont.)
steering column deformation force, 122–124
unbelted occupant in frontal collision, 118–119
vehicle interior, 110–111
see also Driver protection
Overall Abbreviated Injury Scale (OAIS), 90

Park assist, 39
Passenger car/truck collisions, 176–177
Passive safety systems, 25–27
Patrick, Larry, 91, 93
Pedestrian protection
Global Technical Regulation, 177–178
integral, 73–75
pedestrian collisions, 177–178
Powertrain systems, 195
Percrash safety, 63–71
automatic brake intervention, 64–66
definition of percrash phase, 63–64
irreversible restraint systems, 67–68
side precrash system, 68–71
Predictive safety systems, 182–184
Preventative occupant protection, 72–73
Product liability, 15
Protection criteria, 94–99
PyroBrake, 65–66

Radar, 53–55, 57
Rear-end collisions, 109, 188
Regulation, 6–11
Europe, 7–9
Global Technical Regulation, 177–178
U.S., 6, 10–11
Rescue and recovery, 77–78
Restraint effect, ideal, 125–128
RestRAINT force, 128, 130–131, 157, 158
RestRAINT systems
adaptive, see Adaptive restraint systems
intelligent, 25–26
interaction with vehicle, 118–138
irreversible, 67–68
optimizing function of, 124–135
see also Airbags, Seat belts
Road safety, 1–15
definitions of common terms, 3–4
human factor in, 2–3, 28–29
infrastructure vs. vehicle technology, 2
Rollovers, 109–110, 188–190
Roof strength, 101–102

Safety
general trends in, 193–194
see also Car-to-infrastructure safety,
Integrated safety, Road safety,
Vehicle safety
Seat belts, 111–114, 124–125
anchorage points, 101
belted occupant, 120–121
optimum profile of belt force, 128–133
self-adaptation of belt force for different
occupants, 162
switchable belt force limiter, 158–159
switching belt force limiter, 161–162
Seats, 101, 118
position of, 149–150
Sensor fusion, 82–85
Side impact, see Lateral collisions
Side structures, 102–103
Simulations, 181–190
component, 190
crash, 185, 187–190
driving simulator, 182
dynamic simulation of vehicle collisions,
103–110
man-machine interface, 181–182
of predictive safety systems, 182–184
Software-in-the-loop (SIL), 183
Stapp, John, 89–90
Steering column deformation force, 122–124
with degressive airbag vent control,
133–134
Steering support, 75–76
Steering wheel, 110
StVZO road traffic licensing regulations, 7–9
SUVs, and side impact, 68–70
Test dummies, 94–99, 147–148
Test requirements on body in white, quasistatic, 101–103
Tibia index, 95
Time to collision (TTC), 48–49
Tire design, 31–33
Truck/passenger car collisions, 176–177
United Nations Economic Commission for
Europe (ECE), 7–9
United Nations Road Safety Collaboration
(UNRSC), 3
United States, 6, 10–12
V2V-Communication, 80–81
Vehicle, interaction of restraint system and, 118–138
Vehicle assistance systems, 34–37
Vehicle communication systems, 79
Vehicle data and perception, 49–59
Vehicle-in-the-loop (VIL), 184–185
Vehicle interior, 110–111
Vehicle safety, 25
driving forces for increasing, 6–15
future of, 194–195
legislation, 6–11
limits of technology, 2
New Car Assessment Program (NCAP), 12–15
and product liability, 15
technological progress, 11–12
Virtual injury distribution, calculation in the field, 170
About the Authors

Professor Dr.-Ing. Ulrich Seiffert currently is acting chairman of WiTech Engineering GmbH, member of the board of ITS Niedersachsen, member of the board of VDI Vehicle Technology, member of the Helmholtz Senat, member of the Royal Swedish Academy of Engineering Sciences (IVA) and acatech.

Until the end of 1995, Dr. Seiffert was a member of the board for research and development of Volkswagen AG in Germany. He is a board member of several industry, research and social organizations. He also holds a number of patents in the safety area and for vehicle and traffic technology and has received awards for his work in the field of safety and environmental engineering. He is the author of a large number of books and has published more than 350 technical papers.

Dr. -Ing. Mark Gonter, head of integrated safety and light in the group research at Volkswagen, has been professor of integrated vehicle safety at the University of Braunschweig, Germany, since 2008. Furthermore, he is a lecturer at the Autouni of Volkswagen. Dr. Gonter has worked for the Volkswagen Group since 1999. His previous roles include head of integrated safety, project manager of adaptive occupant safety, and accident researcher. In 2007 he received a doctorate of engineering in intelligent restraint systems from Dresden University of Technology in Germany. He has published a large number of technical papers in the field of active and passive safety and holds a number of patents that pertain to automotive vehicle safety.