Motor Vehicle Safety
Technology Development

The Road Ahead
An Industry View

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Trends and Themes

Trends
- Market Growth
- Product Globalization with Local Variants
- Global Over Capacity and Pricing Challenges
- Market Demands

Themes
- Public Health Challenge in Human and Economic Cost
- Pace of Technological Change
- Technology Integration
- Government Industry Collaboration
Road Traffic Fatalities Projected to Almost Double & Become 3rd Leading Cause of Global Injury/Disease

<table>
<thead>
<tr>
<th>Rank</th>
<th>1998</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lower respir. infections</td>
<td>Ischaemic heart disease</td>
</tr>
<tr>
<td>2</td>
<td>Perinatal Conditions</td>
<td>Unipolar major depression</td>
</tr>
<tr>
<td>3</td>
<td>Diarrhoeal Diseases</td>
<td>Road traffic crashes</td>
</tr>
<tr>
<td>4</td>
<td>HIV / AIDS</td>
<td>Cerebrovascular Disease</td>
</tr>
<tr>
<td>5</td>
<td>Unipolar depression</td>
<td>COPD</td>
</tr>
<tr>
<td>6</td>
<td>Ischaemic heart disease</td>
<td>Lower respir. infections</td>
</tr>
<tr>
<td>7</td>
<td>Cerebrovascular Disease</td>
<td>Tuberculosis</td>
</tr>
<tr>
<td>8</td>
<td>Malaria</td>
<td>War</td>
</tr>
<tr>
<td>9</td>
<td>Road traffic crashes</td>
<td>Diarrhoeal Disease:</td>
</tr>
<tr>
<td>10</td>
<td>Tuberculosis</td>
<td>HIV / AIDS</td>
</tr>
</tbody>
</table>

Mortality rate (per 100,000)

- No data
- 29.2–34.5
- 18.9–29.1
- 16.2–18.8
- 11.2–16.1

Source: Murray and Lopes, The Global Burden of Disease

Sources: World Health Organization (WHO), The Injury Chart Book, 2002; WHO / World Bank / GRSP, World report on road traffic injury prevention, April, 2004; A 5-year WHO strategy for road traffic injury prevention, 2002

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Vision Statement

Zero Fatalities
Continuous Improvement

Zero Crashes
Target Reductions
Injury Triangle and Antidote Development

Field data
Scholarly research

Technology invention and development

Voluntary initiatives
Regulatory initiatives

Countermeasure deployment

Host
Environment
Vehicle
## Haddon Matrix (modified)
### Vehicle Dimension Only

<table>
<thead>
<tr>
<th>Pre-Collision</th>
<th>Collision</th>
<th>Post-Collision</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal Driving:</strong></td>
<td>Safety Belts</td>
<td>ACN</td>
</tr>
<tr>
<td>Navigational Aid</td>
<td>Frontal Air Bags</td>
<td>AACN</td>
</tr>
<tr>
<td>Traffic Information</td>
<td>Side Air Bags</td>
<td>Emergency Services</td>
</tr>
<tr>
<td>Dynamic Route Guidance</td>
<td>Roof Rail Air Bags</td>
<td></td>
</tr>
<tr>
<td>Adaptive Cruise Control</td>
<td>Rollover RRAB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pretensioners</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Knee Air Bags</td>
<td></td>
</tr>
</tbody>
</table>

| **Avoidable Crashes:** | | |
| DRLs | | |
| ABS, Traction Control, ESC | | |
| Longitudinal Control Functions | | |
| Belt Pretension | | |

| **Non-Avoidable Crashes:** | | |
| Brake Assist | | |
| Vehicle Preconditioning | | |
Crashes by Type

Share of Crashes by Type for All Vehicles

Distribution of Pre-Crash Scenarios for Rear-End Crashes of Light Vehicles

Distribution of Pre-Crash Scenarios for Cross Path Crashes of Light Vehicles

Analysis of Light Vehicle Crashes and Pre-Crash Scenarios Based on the 2000 General Estimates System
Technologies To Help Avoid A Crash

Frequency Base

- Vehicle Stability Enhancements (28.7%)
- Forward Radar & Braking Enhancements * (27.2%)
- Vision and Conspicuity Enhancements * (21.0%)
- Vehicle to Vehicle / Infrastructure Communications (16.2%)
- Lane Departure Warning (1%)
- Not Influenced By Technology (5.9%)

Societal Harm

- Vehicle Stability Enhancements (50.5%)
- Forward Radar & Braking Enhancements * (14.9%)
- Vision and Conspicuity Enhancements * (16.3%)
- Vehicle to Vehicle / Infrastructure Communications * (10.7%)
- Lane Departure Warning (3.4%)
- Not Influenced By Technology (4.3%)

* inter-related

Estimates based on ‘44 Crashes’ Version 3.0 January 1997
The Vision

### Assessment of ESC Effectiveness

<table>
<thead>
<tr>
<th></th>
<th>Passenger Cars (NHTSA)</th>
<th>SUVs (NHTSA)</th>
<th>Passenger Cars &amp; SUVs (IIHS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent reduction in single vehicle crashes</td>
<td>35%</td>
<td>67%</td>
<td>41%</td>
</tr>
<tr>
<td>Percent reduction in fatal single vehicle crashes</td>
<td>30%</td>
<td>63%</td>
<td>56%</td>
</tr>
</tbody>
</table>


Source: *Effects of Electronic Stability Control on Automobile Crash Risks*. Insurance Institute for Highway Safety, 2004

All GM SUVs and vans will have StabiliTrak standard by the end of 2007. It will be standard on all GM cars and trucks sold to retail customers by the end of 2010.
Forward Collision Warning

Surprise Trial Studies
(Task 2 & 3a)

TTC Judgment Study
(Task 2)

First Look Study
(Task 2)
# Warning and Assist Functions

## Seamless Longitudinal Warning & Assist Functions

<table>
<thead>
<tr>
<th>Sensors</th>
<th>Actuators</th>
<th>Enabled functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Range Object Detection</td>
<td>Maps</td>
<td>Vision</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>ACC Stop</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>FOW</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>ACC S&amp;F</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>ACC S&amp;F</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>ACC S&amp;F</td>
</tr>
<tr>
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<td>ACC S&amp;F</td>
</tr>
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<td>x</td>
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</tr>
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<td>x</td>
<td>x</td>
<td>ACC S&amp;F</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>ACC S&amp;F</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>FOW</td>
</tr>
</tbody>
</table>

## Lateral Warning Functions

<table>
<thead>
<tr>
<th>Sensors</th>
<th>Actuators</th>
<th>Enabled functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rear Vision Object Detection</td>
<td>Side Short Range Object Detection</td>
<td>Side Long Range Object Detection</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

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Lateral and Longitudinal Control Technologies

- Forward Collision Alert (FCA)
- Adaptive Cruise Control with Alert (ACC)
- Lane Departure Warning (LDW)
- Side Blind Zone Alert (SBZA)
- Rear Object Detection (ROD)
- Rear Park Assist (RPA)
- Forward Park Assist (FPA)
Identified potential benefits of vehicle safety applications enabled or enhanced by short range communication technologies.

Assessed the communication requirements, including vehicle-vehicle and vehicle-infrastructure modes.

Contributed to DSRC standards to ensure they effectively support safety (IEEE lower layer & SAE message set).

Developed ‘Next Generation’ DSRC Testing Platform.

Conducted testing to assess proposed DSRC standards for potential to effectively support vehicle safety applications.
Safety Use Cases

Communications Between Vehicle and Infrastructure

- Blind Merge Warning
- **Curve Speed Warning**
- Emergency Vehicle Signal Preemption
- Highway/Rail Collision Warning
- Intersection Collision Warning
- In Vehicle Amber Alert
- In-Vehicle Signage
- Just-In-Time Repair Notification
- **Left Turn Assistant**
- Low Bridge Warning
- Low Parking Structure Warning
- Pedestrian Crossing Information at Intersection
- Road Condition Warning
- Safety Recall Notice
- SOS Services
- **Stop Sign Movement Assistance**
- Stop Sign Violation Warning
- **Traffic Signal Violation Warning**
- Work Zone Warning

Communications Between Vehicles

- Approaching Emergency Vehicle Warning
- Blind Spot Warning
- Cooperative Adaptive Cruise Control
- Cooperative Collision Warning
- **Cooperative Forward Collision Warning**
- Cooperative Vehicle-Highway Automation System
- **Emergency Electronic Brake Lights**
- Highway Merge Assistant
- **Lane Change Warning**
- Post-Crash Warning
- **Pre-Crash Sensing**
- Vehicle-Based Road Condition Warning
- Vehicle-to-Vehicle Road Feature Notification
- Visibility Enhancer
- Wrong Way Driver Warning

*Highest ranking applications based on safety benefit estimates using ‘44 Crashes’*

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Vehicle Infrastructure Integration

Creating an “enabling communication infrastructure”

Basic Premise

• All new vehicles would be equipped with DSRC at 5.9GHZ and GPS.
• A nationwide roadway based communications network will be created.

Intersection Collision Avoidance

Traffic Management

Traveler Information

Weather Sensing