Evaluating the causes of traffic accidents due to human factors with ACAS

Thursday, 8th of May 2014

Bernd Pund, Michael Jänsch, Dietmar Otte
Injury severity over the years

1974: Frontal collision
Delta-V 45 km/h

Driver critically injured (MAIS 5)
Died within 7 days of accident
Injury severity over the years

1974: Frontal collision
Delta-V  45 km/h

2004: Frontal collision
Delta-V  45 km/h

Driver critically injured (MAIS 5)
Died within 7 days of accident

Driver moderately injured (MAIS 2)
Injury severity over the years

1974: Frontal collision
Delta-V 45 km/h

2004: Frontal collision
Delta-V 45 km/h

2014: Frontal collision
Delta-V > 50 km/h

Driver critically injured (MAIS 5) 
Died within 7 days of accident

Driver moderately injured (MAIS 2)

Driver slightly injured (MAIS 1)
Accident situation in Germany

357121 km²
80,6 Mio inhabitants
226 inhab/km²
49,3 Mio vehicles
700 Billion driving km pa

2.4 Mio Accidents p.a.
318,000 minor injured
66,000 severely injured
3600 fatalities
GIDAS Accident research units

Technical University Dresden

Hannover Medical School

cooperation

BAST / FAT

Common Database

1000 accidents

Annually

2000 accidents

1000 accidents
Hannover investigation area

Region Hannover (Part of Lower Saxony)

Radius approx. 60 km

2 291 km²
1.1 Mio inhabitants
486 inhab/km²
Dispatching centre

Sampling criteria:
Last notified accident for representative data collection
Purpose of accident data collection

- **National Government (BASg, Federal Ministry)**
  - Road Design, Legislation

- **EU Commission**
  - Legislation, Road Safety, ...

- **Vehicle Manufacturers and Supplier**
  - Active and Passive Safety of Vehicle

- **Medical Science**
  - Biomechanics, Injury Causation, Rescue Systems, Therapy
Working Process on Scene

- Interview of Police, Participants and Witnesses
- Documentation of changeable Traces
- Documentation of Rescue Systems and Injuries
- Vehicle Data and Equipment
- Vehicle Damages and Measurements
- Analysis of Pre-Crash Movements
- Documentation of Traffic Regulations
- Estimation of human factors (ACAS)
- Occupant Movements and Seat Belt Use
- True-to-Scale Plan of Scene
- Reconstruction of Accident
Scene measurement by LASER
Scene measurement by LASER

3D cloud of reflected LASER points
Scaled sketch of accident site
Deformation measurement by LASER

3D cloud of reflected LASER points
Case example
Case example - accident reconstruction

<table>
<thead>
<tr>
<th></th>
<th>Sharan</th>
<th>Golf</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_0$ [km/h]</td>
<td>73</td>
<td>75</td>
</tr>
<tr>
<td>$V_{k1}$ [km/h]</td>
<td>66</td>
<td>69</td>
</tr>
<tr>
<td>$\Delta v$ [km/h]</td>
<td>27,3</td>
<td>41,5</td>
</tr>
<tr>
<td>EES [km/h]</td>
<td>23</td>
<td>46</td>
</tr>
<tr>
<td>$V_{k2}$ [km/h]</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>$\Delta v$ [km/h]</td>
<td>9,7</td>
<td></td>
</tr>
<tr>
<td>EES [km/h]</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>$V_{k3}$ [km/h]</td>
<td>7,8</td>
<td></td>
</tr>
<tr>
<td>$\Delta v$ [km/h]</td>
<td>7,7</td>
<td></td>
</tr>
<tr>
<td>EES [km/h]</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Case example
Classification systems

- AIS Abbreviated Injury Scale
- Accident types
- Deformation CDC
- Human factor analysis
- Machine and environment
- Accident moderating conditions

ACAS
Accident Causation Analysis System
ACAS Code

In road traffic accident causes are found in 3 different areas:

- **Human**
  - Human accident causes
  - Group 1

- **Machine**
  - Factors from the vehicle technology
  - Group 2

- **Environment**
  - Factors from the environment and the infrastructure
  - Group 3

3 Groups:
1st digit of the code
## ACAS - Human Causation Factors

<table>
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<tr>
<th>Process (Road user)</th>
</tr>
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<tbody>
<tr>
<td>Perception</td>
</tr>
<tr>
<td>Information - processing</td>
</tr>
<tr>
<td>Decision</td>
</tr>
<tr>
<td>Execution of Action</td>
</tr>
</tbody>
</table>

Sequential flow of human basic functions
# ACAS - Human Causation Factors

<table>
<thead>
<tr>
<th>(Failure-) Categories</th>
<th>Process (Road user)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(1) Information access</strong> (Everything visible?)</td>
<td>Perception</td>
</tr>
<tr>
<td><strong>(2) Information admission</strong> (Distraction, Activation, Identification)</td>
<td>Information - processing</td>
</tr>
<tr>
<td><strong>(3) Evaluation</strong> (Expectation, Interpretation)</td>
<td>Decision</td>
</tr>
<tr>
<td><strong>(4) Planning</strong> (correct objective)</td>
<td>Execution of Action</td>
</tr>
<tr>
<td><strong>(5) Operation</strong> (correct operation, Performance handicaps?)</td>
<td></td>
</tr>
</tbody>
</table>

Sequential flow of human basic functions
Structure of ACAS

The causes of traffic accidents can be found in three different areas: Human factors, technical factors form the vehicle and factors from the infrastructure or environment. These areas present the three groups of the system.

The human factors consist of five categories. Chronological sequence of basic human functions from the perception, the judgment of the perceived situation to the resulting operation.

Group 1: Human factors

1. Information access
2. Information admission
3. Evaluation
4. Planning
5. Operation

Each category consists of specific criteria which specifies the factor within the category.

(1) Wrong expectation
(2) Misjudgement of others
(3) Misjudgement of own vehicle

Solely the human factors allow to further categorize the chosen criteria with specific indicators.

(1) Own speed
(2) Veh.-dynamics/behaviour
(3) Braking, Accelerating

Code of 4 numbers
ACAS analysis of GIDAS data

- Car (n=2349): 97% Human, 1% Machine, 2% Environment
- Truck (n=191): 96% Human, 4% Machine, 0% Environment
- Bus/Tram (n=38): 92% Human, 8% Machine, 0% Environment
- Motorcycle (n=341): 91% Human, 5% Machine, 4% Environment
- Bicycle (n=786): 94% Human, 3% Machine, 3% Environment
- Pedestrian (n=270): 100% Human, 0% Machine, 0% Environment
ACAS analysis of GIDAS data
ACAS analysis of GIDAS data

- **Frequent causes from Category 4**
  - 14032 Misjudgement of own vehicle – Driving behaviour (8% of all causes)
  - 14023 Misjudgement of other road users – Distance (6% of all causes)

- **Frequent causes from Category 5**
  - 15012 Decision errors – Wrong manoeuvre planned (6% of all causes)
  - 15022 Intentional breach of rules – Driving above speedlimit (4% of all causes)

- **Frequent causes from Category 6**
  - 16013 Reaction error – Too hard braking (3% of all causes)
Fit to Drive
8th International Traffic Expert Congress
08 to 09 May, 2014
Warsaw

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