After-accident vehicle inspection

- Vehicle identification
- Collection of relevant data about the conditions in the moment of accident, police report, etc.
- Examination of active safety systems: tyres and wheels, brakes, steering system, suspension system, lights, mirrors
- Examination of passive safety systems: airbags, belts, seats
- Other important findings: body damage and scratches, controls, instruments readings...

The examples of the components inspection will be later illustrated through few case studies
Examination of failed subsystem (e.g. engine)

- System identification
- Collection of relevant data about the conditions in the moment of failure, about maintenance, working conditions etc.
- Examination of damaged parts
- Examination of relevant components for the processes that contribute to the damage
- Examination of undamaged parts - they often indicate progression or path of failure
Methods in vehicle forensic engineering

- Visual examination - the most important tool of forensic engineer are his (her) eyes!
- Measurements - size, wear, deformation,...
- Microscopic examination - damaged surface, scratches...
- Trasology - reading the marks
- Engineering calculations or simulations
- Experimental techniques - replicating the situation or conditions
- etc...
Methods in vehicle forensic engineering

- Measurements - position, size, wear, deformation, chemical analysis...
Methods in vehicle forensic engineering

- Microscopic examination - damaged surface, tachograph...
Methods in vehicle forensic engineering

- Trasology - reading the marks
Methods in vehicle forensic engineering

- Engineering calculations or simulations

Modern software offers comprehensive way for visualisation of the accident: a few examples...
Methods in vehicle forensic engineering

• Experimental techniques - replicating the situation or conditions, accident reconstruction

Example of video record: bus luggage compartment door
Forensic engineer report

• Procedure and direction of investigation is based on court's question
• Overview of evidence materials and findings that is used for the report
• Analysis of available material using engineering know-how and objective approach
• Opinion about the conditions and causes of damage or failure
• Conclusion as an answer on court's question
• Appendices for better explanation of certain results
Forensics in Automotive Engineering

Vehicle Components Damages
Basic characteristics of damaged parts and recognition of damage type

The several modes of unwanted change of components that can cause some kind of malfunctioning:

• Regular or premature or abnormal wear, seizing etc.
• Fatigue failure
• Overload (static, dynamic, shock), mechanical damage caused by another body in irregular contact
• Chemical reactions, thermal processes...
• Combination of above mentioned (very often)...
Basic characteristics of damaged parts and recognition of damage type

Regular or premature or abnormal wear, etc.

Simplified distribution of failure probability during the working life

Period of nominal characteristics

Running-in period

1 + 2 + 3

End of life

3. Wear

User’s influence

Manufacturing error

km or hrs

Failure probability
Basic characteristics of damaged parts and recognition of damage type

Regular or premature or abnormal wear, etc.

Worn out wheel bearing journal - this must not happen during the working life!

Wear of camshaft bearings and tappets - the wear is expectable.
Basic characteristics of damaged parts and recognition of damage type

Material fatigue and fatigue failure:
Gradual material degradation and eventual failure that occur under loads which vary with time, and which are lower than the static strength.

Typical Stress/number of cycle to failure diagram (Pook L., Metal fatigue, 2007)
Basic characteristics of damaged parts and recognition of damage type

Fatigue failure: due to dynamic load, caused by initial microcrack, for example

Typical fatigue failure of crankshaft
Basic characteristics of damaged parts and recognition of damage type

Overload: results in deformation and/or destruction
- Static overload: for example mobile cranes, working machine
- Dynamic and shock: outer excitation (road, another object) or internal (engine, etc.)

Front wheel arm bent and broken due to collision with another vehicle
Basic characteristics of damaged parts and recognition of damage type

Overload: results in deformation and/or destruction

• Static overload: for example mobile cranes, working machine
• Dynamic and shock: outer excitation (road, another object) or internal (engine, etc.)

Piston broken due to shock overload
Significance of damages/failures

Regarding the influence on the case that is being investigated, it is important to make distinction between:

- Failure that caused the accident
- Existing damage or failure that contributed to the accident
- Existing damage or failure that did not contribute to the accident
- Damage or failure relevant for active safety originated in the accident
Significance of damages/failures - examples

- Failure that caused the accident: rear RH wheel fall out during overtaking, causing the loss of control and vehicle rollover with fatal consequences
Significance of damages/failures - examples

- Failure that caused the accident: the thread was stripped on bearing journal resulting in rear wheel detachment.
Significance of damages/failures - examples

• Existing damage or failure that contributed to the accident: questionable conditions of truck rear marking

The left rear light and long cargo marking were not found at accident location - was the truck sufficiently visible from the rear side?
Significance of damages/failures - examples

- Existing damage or failure that did not contribute to the accident

The front left tyre was worn out on the outer side - irrelevant because the car suffered side impact
Significance of damages/failures - examples

- Existing damage or failure that did not contribute to the accident

Parking brake was not functional (steel cable was not connected) - irrelevant because the car suffered front offset impact with the vehicle that changed lane
Significance of damages/failures - examples

• Damage or failure relevant for active safety originated in the accident

Steering tie rod was bent and detached at the spherical joint within damages occurred in collision with the three - consequence, not a cause of accident!
Significance of damages/failures - examples

- Damage or failure relevant for active safety originated in the accident

Steering tie rod was bent and detached at the spherical joint within damages occurred in collision with the three - consequence, not a cause of accident!
Forensics in Automotive Engineering

Case study
Example of vehicle examination
Lateral impact of passenger car in rear end of semitrailer

**What happened?** Passenger car Mercedes suddenly loses control on highway and collide first with roadside guard then laterally with rear end of stationary semi-trailer

Environmental conditions: Night, dry, highway
**Case type:** criminal investigation

**Task:** to determine the technical condition of the car in the moment of the accident, i.e. to investigate the possible technical reasons for sudden loss of control
Available material:
• the vehicle
• the accident report and photos

Supplemental material:
• technical documentation

The vehicle on location (depot) for examination
The sketch from police accident report