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SUMMIT 2015

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Automotive Hub of the World

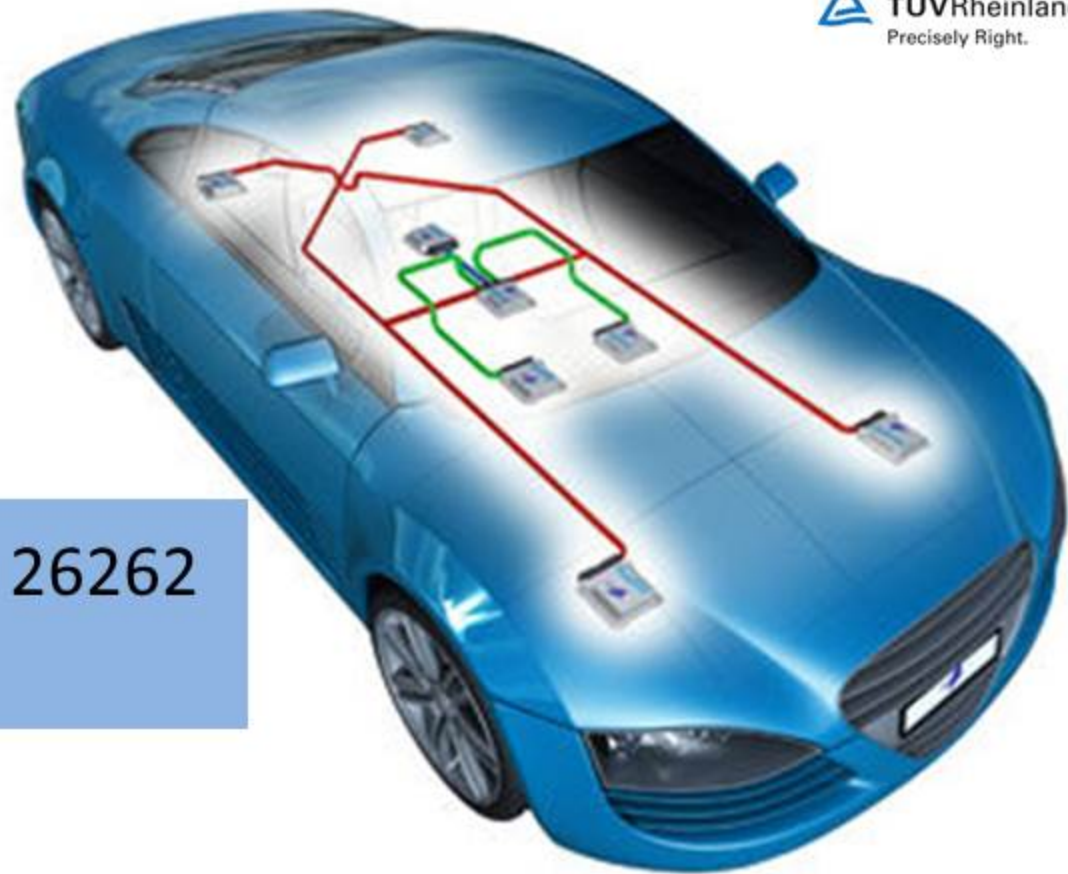
24th - 25th June 2015

Bitec Bangna, Bangkok

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Functional Safety with ISO 26262

Naim Husni, TUV Rheinland

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Agenda

- Brief about TUV Rheinland Group
- Introduction to Functional Safety
- Basic Concepts
- Automotive Safety Integrity Level (ASIL)
- Practical automotive application
- Now & Future - Functional Safety

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Technischer
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Verein

Technical
Inspections
Organizations



What is Rheinland?

Headquarter
Köln, Germany

Set up as third party organization
to inspect steam boilers in 1872



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INDUSTRIAL SERVICE	MOBILITY	PRODUCTS
- Pressure Equipment and Plant Technology - Elevator, Conveyor and Machine Technology - Electrical Engineering - Supply Chain Services - Civil Engineering - Energy & Environment - Project Management - NDT and maritime testing	- Periodical Technical Inspection - Driving licences - Car Services & Appraisal - Engineering & Type Approval - Rail - Intelligent Transport Systems - Aviation - Maritime	- Softlines - Hardlines - Electrical - Commercial - Medical - Solar/ Fuel Cell Technology - Food
ACADEMY & LIFE CARE	ICT & BUSINESS SOLUTIONS	SYSTEMS
- HR Development & Consulting Services - Professional Training - Corporate Health Management Occupational Health & Safety - Personnel Certification - Public Funded Training & Schools	- IT Services & Cyber Security - Business & Engineering Services - Management Consulting - R&D Management	- Certification of Management Systems - Customized Services

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Take the lead with tested safety standards.

Our know-how for

- New automotive, engine and traffic concepts
- Traffic safety
- Qualifications of all participants on streets, rails and in the air.

Our expertise – Fuel for the mobile world.

- | | | |
|----------------------------|-----------------------|--------|
| ▪ Car Services & Appraisal | ▪ Homologation | ▪ Rail |
| ▪ Automotive engineering | ▪ Vehicle inspections | |

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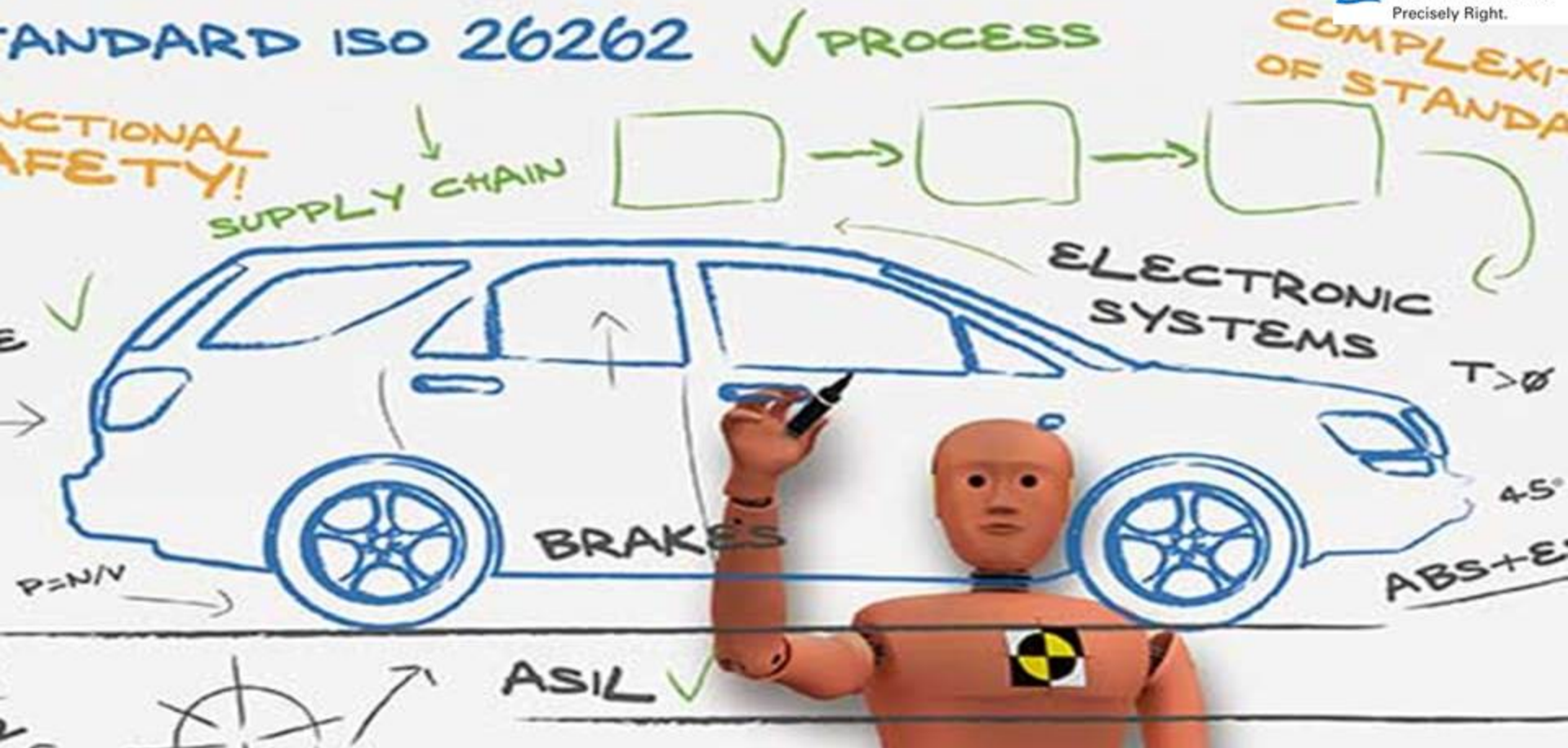
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Introduction to Functional Safety

Why Functional Safety?

- Safety is one of the key issues of future automobile development.
- Driver assistance, propulsion, in vehicle dynamics control and active and passive safety systems.
- With the trend of increasing technological complexity, software content and mechatronic implementation, there are increasing risks from systematic failures and random hardware failures.
- IEC 61508 as guidance to avoid these risks by providing appropriate requirements and processes.

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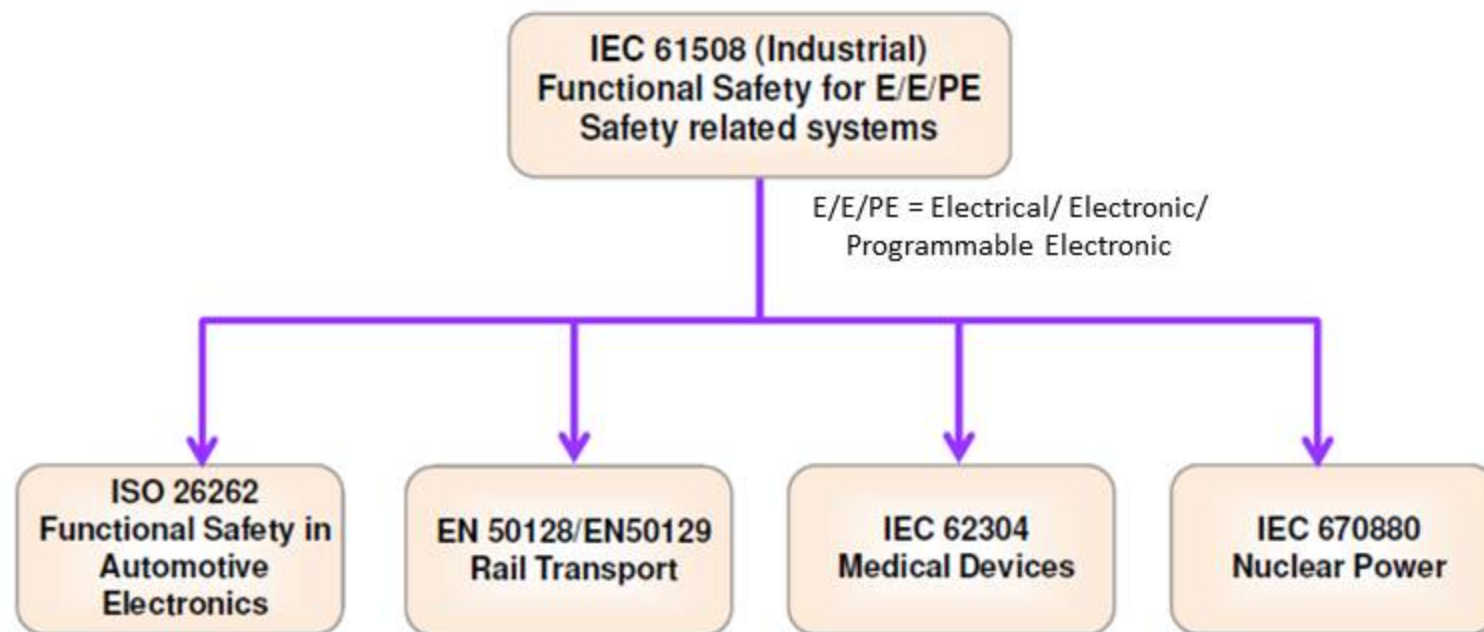


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Introduction to Functional Safety

- ISO 26262 is an adaptation of IEC 61508 for the automotive industry



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Introduction to Functional Safety

ISO 26262: Road vehicles – Functional safety

- ISO-26262 is an adaptation of IEC 61508 for the automotive industry.
- It applies to safety-related road vehicle **E/E systems**, and addresses hazards due to malfunctions, excluding nominal performances of active and passive safety systems.
- Risk is determined based on customer risk by identifying the so-called Automotive Safety Integrity Level (ASIL) associated with each undesired effects.
- Whole lifecycle of the E/E system (incl. H/w and S/w components).

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Introduction to Functional Safety

ISO 26262: Road vehicles – Functional safety

- E/E systems?
- Electrical and electronic system in vehicles
- Functional safety addresses simple system such as steering, braking, etc
- E.g: Brake Assist (BAS), EBS, EPS
- Complex example as adaptive cruise control, crash protection system, active body control, ESP.
- Risk of malfunction using severity, exposure and controllability.

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Basic Concepts

Concepts and Examples

ESP

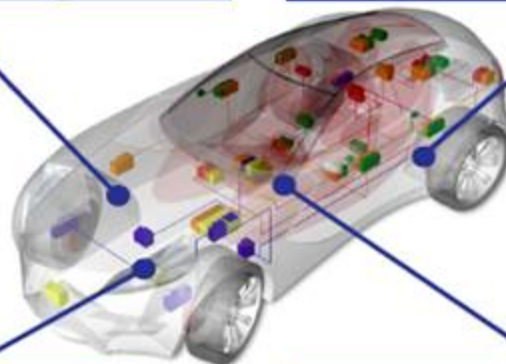


⚡ Unintended, single-sided
brake effect on straight lane

Electronic Park Brake



⚡ Unintended activation in
motion



Collision Avoidance



⚡ Acceleration instead of
deceleration in traffic

Airbag



⚡ Delayed deployment after
crash detection

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Basic Concepts

Concepts and Examples

Problems with switch:
Brake lights either don't light up
or light up continuously
Korean OEM

Problems with acceleration:
Car unintentionally
accelerates thus causing
personal damage
Japanese OEM

Problem with automatic
gear control:
Gear is unintentionally
switched to neutral
American OEM

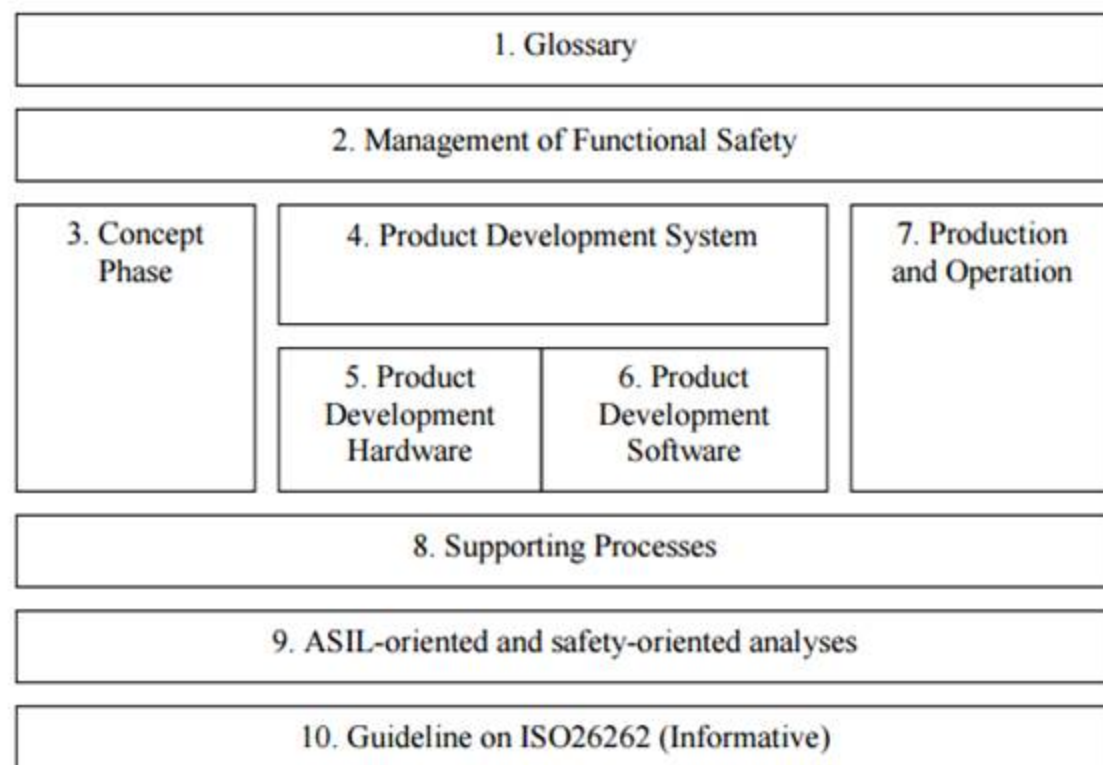
Problems with airbag control:
Airbags and seat belt
pre-tensioner are not or
too late activated
German OEM

Source: autoservicepraxis.de

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Basic Concepts



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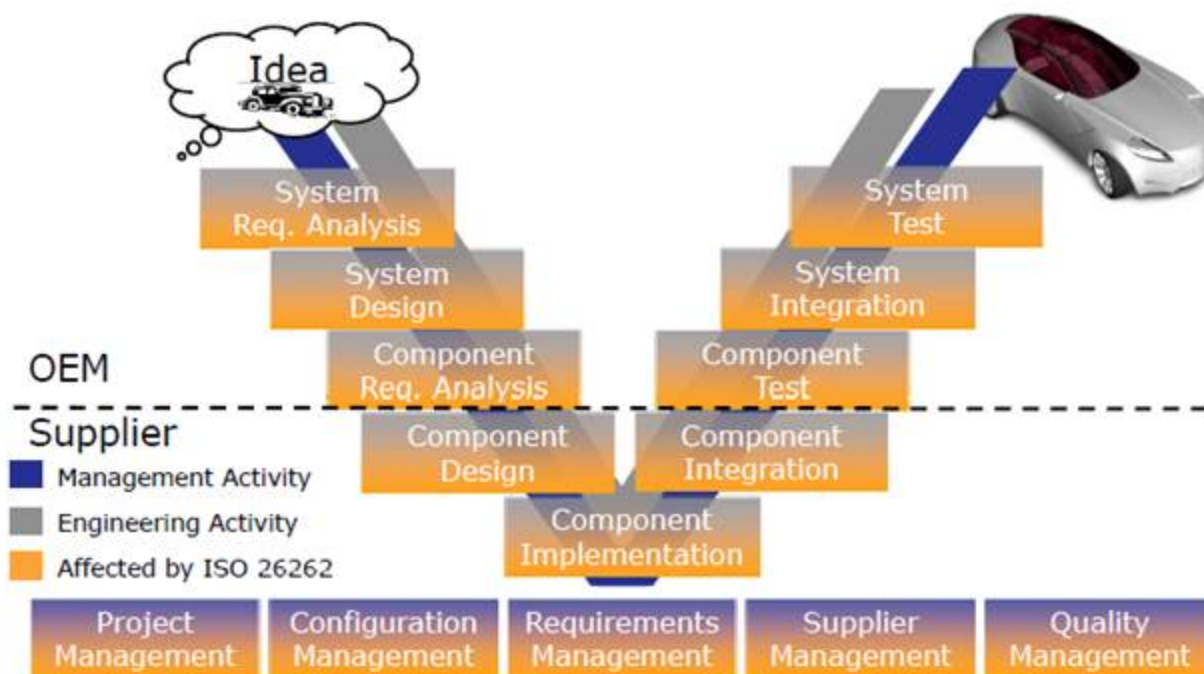
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Basic Concepts

OEM & Supplier Functional Safety



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Automotive Safety Integrity Level (ASIL)

ISO 26262: Road vehicles – Functional safety

- Part 3 : Concept phase
- ASIL shall be determined for each hazardous event using the proper combination of parameters, and the levels would be from A-D, with D being the most demanding.
- 3 parameters: severity, probability and controllability.

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Automotive Safety Integrity Level (ASIL)

ISO 26262: Road vehicles – Functional safety

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Automotive Safety Integrity Level (ASIL)

The probability of **exposure** scale is the following:

	E1	E2	E3	E4
Description	Very low probability	Low probability	Medium probability	High probability
Definition of probability of exposure	Not specified	< 1% of average operating time	1% - 10% of average operating time	> 10% of average operating time
Informative examples	• Mountain pass – driving down hill with the engine off • Jump start • Garage – vehicle on roller rig	• Pulling a trailer • Driving with roof rack • Driving backwards • Overtaking • Slippery roads	• Tunnels • Night driving on roads without streetlights • Wet roads • City driving – one way street	• Accelerating • Braking • Steering • Driving on highways • Highway – changing lane

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Automotive Safety Integrity Level (ASIL)

The **severity** scale is the following:

	S0	S1	S2	S3
Description	No injuries	Light and moderate injuries	Severe injuries, possibly life threatening, survival probable	Life-threatening injuries (survival uncertain) or fatal injuries
Reference for single injuries (AIS scale)	Damage that cannot be classified safety-related, e.g. bumps with roadside infrastructure.	More than 10% probability of AIS 1-6	More than 10% probability of AIS 3-6	More than 10% probability of AIS 5-6

AIS = Abbreviated Injury Scale

AIS Score	Injury	AIS Score	Injury
1	Minor	4	Severe
2	Moderate	5	Critical
3	Serious	6	Unsurvivable

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Automotive Safety Integrity Level (ASIL)

The **severity** scale is the following:

	S0	S1	S2	S3
Informative Examples	• Light collision • Light grazing damage • Damage while when parking	Front collision between two passenger cars: $\Delta v < 20 \text{ km/h}$	Front collision between two passenger cars: $15 \text{ km/h} < \Delta v < 40 \text{ km/h}$	Front collision between two passenger cars: $\Delta v > 40 \text{ km/h}$
		• Side collision with a tree: $\Delta v < 15 \text{ km/h}$	• Side collision with a tree: $15 \text{ km/h} < \Delta v < 25 \text{ km/h}$	• Side collision with a tree: $\Delta v > 25 \text{ km/h}$

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Automotive Safety Integrity Level (ASIL)

The **controllability** scale is the following:

	C0	C1	C2	C3
Description	Controllable in general	Simply controllable	Normally controllable	Difficult to control or uncontrollable
Reference for single injuries (AIS scale)	Controllable in general	99% or more of all drivers or other traffic participants are usually able to avoid a specific harm.	90% or more of all drivers or other traffic participants are usually able to avoid a specific harm.	Less than 90% of all drivers or other traffic participants are usually able, or barely able, to avoid a specific harm.
Informative Examples	- Unexpected increase in radio volume - Situations that are considered distracting	Faulty adjustment of seats while driving	Departing from the lane in case of a failure of ABS during emergency braking.	Departing from the lane on snow or ice on a bend in case of a failure of ABS during emergency braking.

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Automotive Safety Integrity Level (ASIL)

$$\begin{array}{ccccccc} \text{Risk} & & \text{Severity} & & \text{Probability} & & \\ & & & & \text{Exposure} & \text{Controllability} & \text{Integrity} \\ R & = & S & \times & P_E & \times & P_C & \times & P_I \\ & & & & \text{Exposure} & \text{Controllability} & \text{Integrity} & & \text{ASIL} \end{array}$$

Automotive Safety Integrity Level
(= required integrity of a function)

S: Severity
E: Exposure
C: Controllability
I: necessary Integrity
QM: Quality Management



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Automotive Safety Integrity Level (ASIL)

Assigning categories of ASIL (Automotive Safety Integrity Level)

		C1	C2	C3
S1	E1	QM	QM	QM
	E2	QM	QM	QM
	E3	QM	QM	A
	E4	QM	A	B
S2	E1	QM	QM	QM
	E2	QM	QM	A
	E3	QM	A	B
	E4	A	B	C
S3	E1	QM	QM	A
	E2	QM	A	B
	E3	A	B	C
	E4	B	C	D

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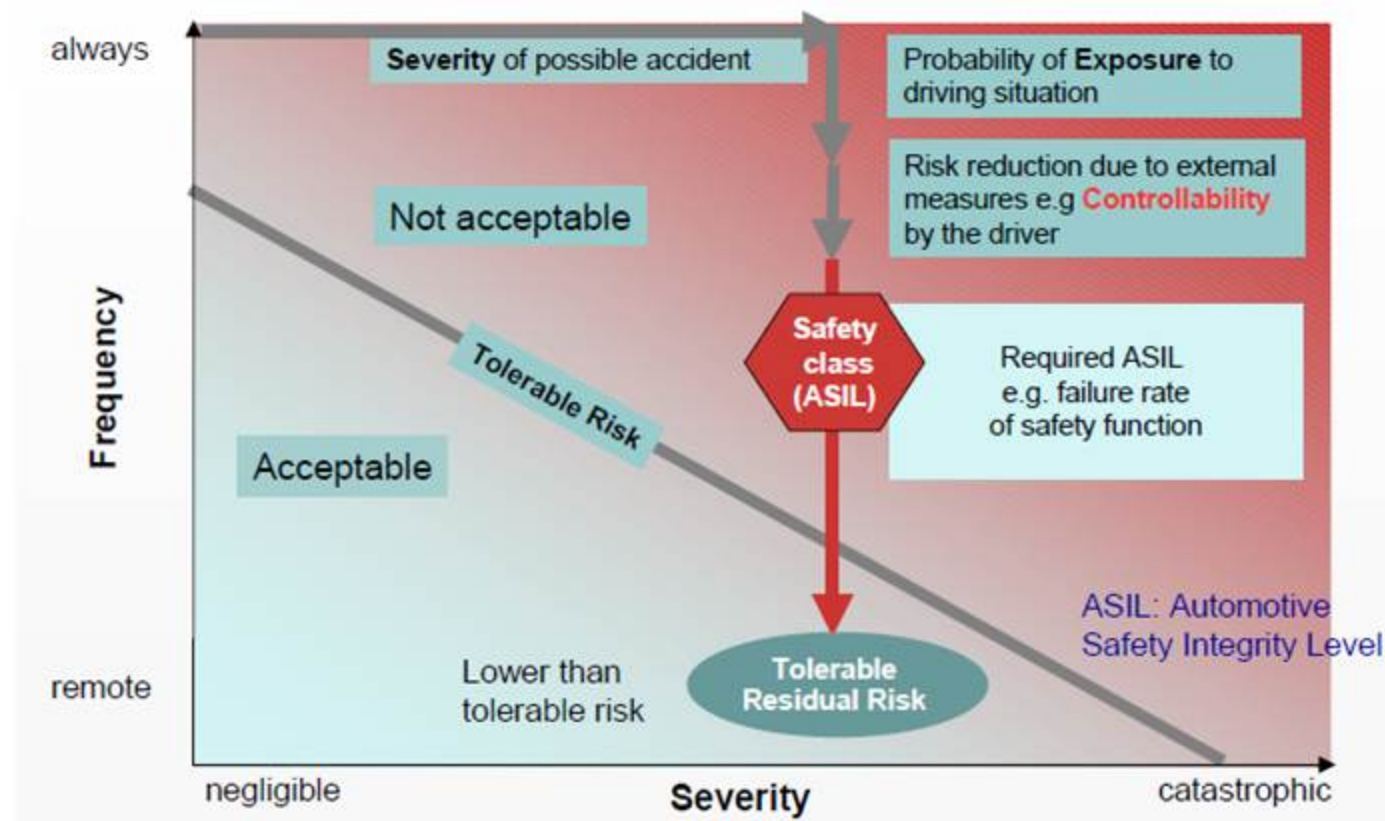
Failure Mode	Vehicle State	Road Condition	Environment Condition	E	C	S	ASIL
No Braking Effect	> 100 km/h	Wet	Highway	E3	C3	S3	C
Unexpected Braking Effect	> 50 km/h < 100 km/h	Dry	Main Road	E4	C2	S3	C
Asymmetric Braking Effect	Parking < 10 km/h	Dry	Side Road	E4	C2	S1	A

- ▶ Exposure:
 - ▶ E3: 1-10% of average operating time
 - ▶ E4: >10% of average operation time
- ▶ Controllability (Average Driver):
 - ▶ C2: Hazardous situation is usually controllable
 - ▶ C3: Hazardous situation is usually not controllable
- ▶ Severity:
 - ▶ S1: Light to moderate injuries
 - ▶ S3: Critical injuries

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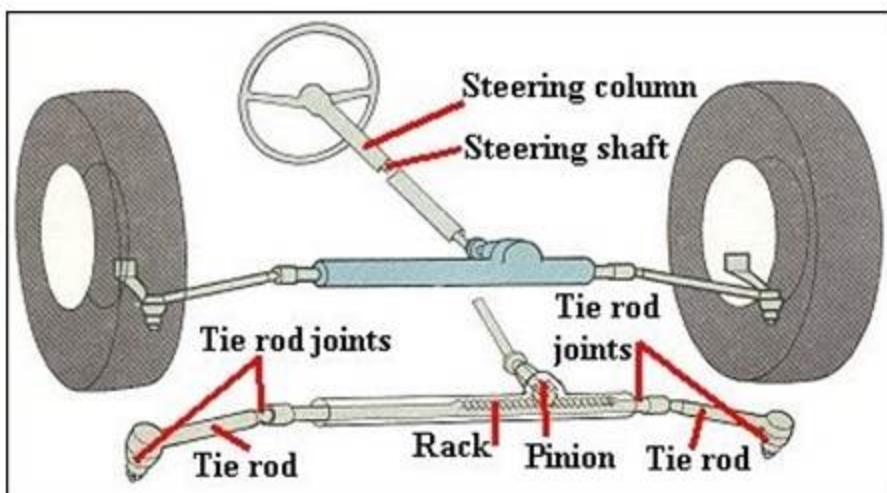
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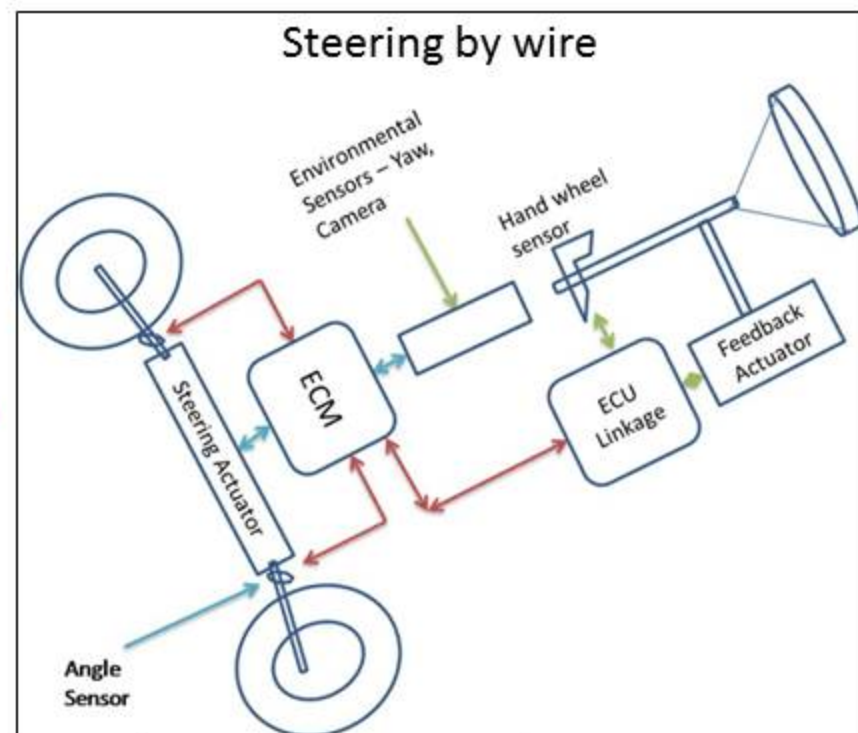
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Practical Application of Functional Safety

Steering Mechanism



VS.



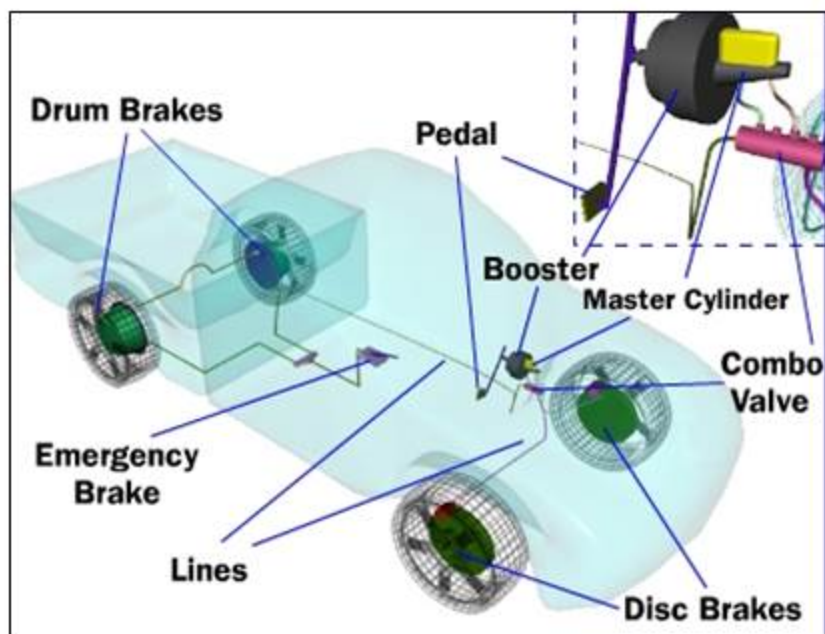
No mechanical connection for steering system

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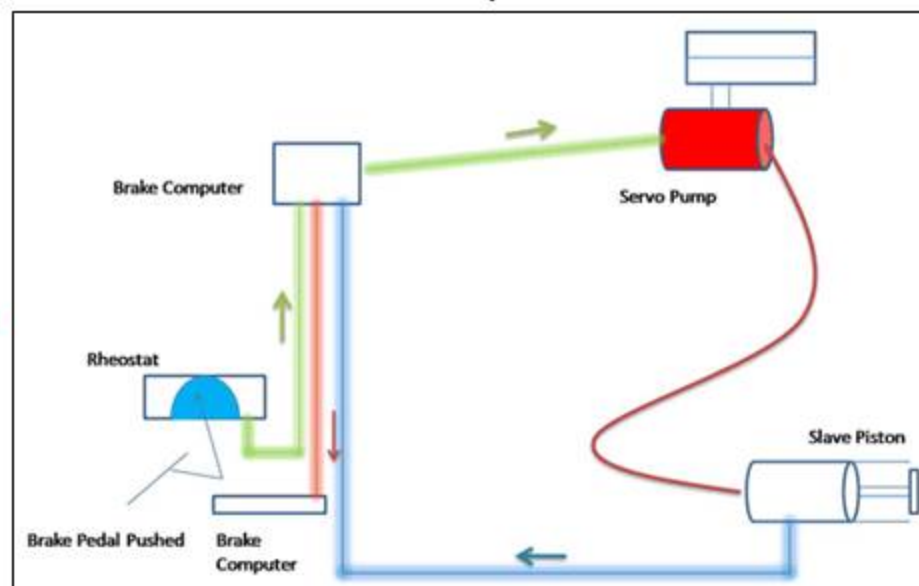
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Braking Mechanism



VS.

Brake by wire



No mechanical connection for braking system

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Practical Application of Functional Safety

Test :

- Number of components
- Testing to be done individually
- Electronic function - hardware
- E.g: Airbag deployment after crash.

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Now - Functional Safety

- Driver Assistance, Lane Departure Warning, etc.
- Complex functionality
- New safety concepts
- Support of high-performance micro-controllers
- Support of high-performance software development

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Future - Functional Safety

- Extension of scope for buses and trucks
- Improved safety analysis methods for software
- More detailed requirements for semi-conductors, security, etc.

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