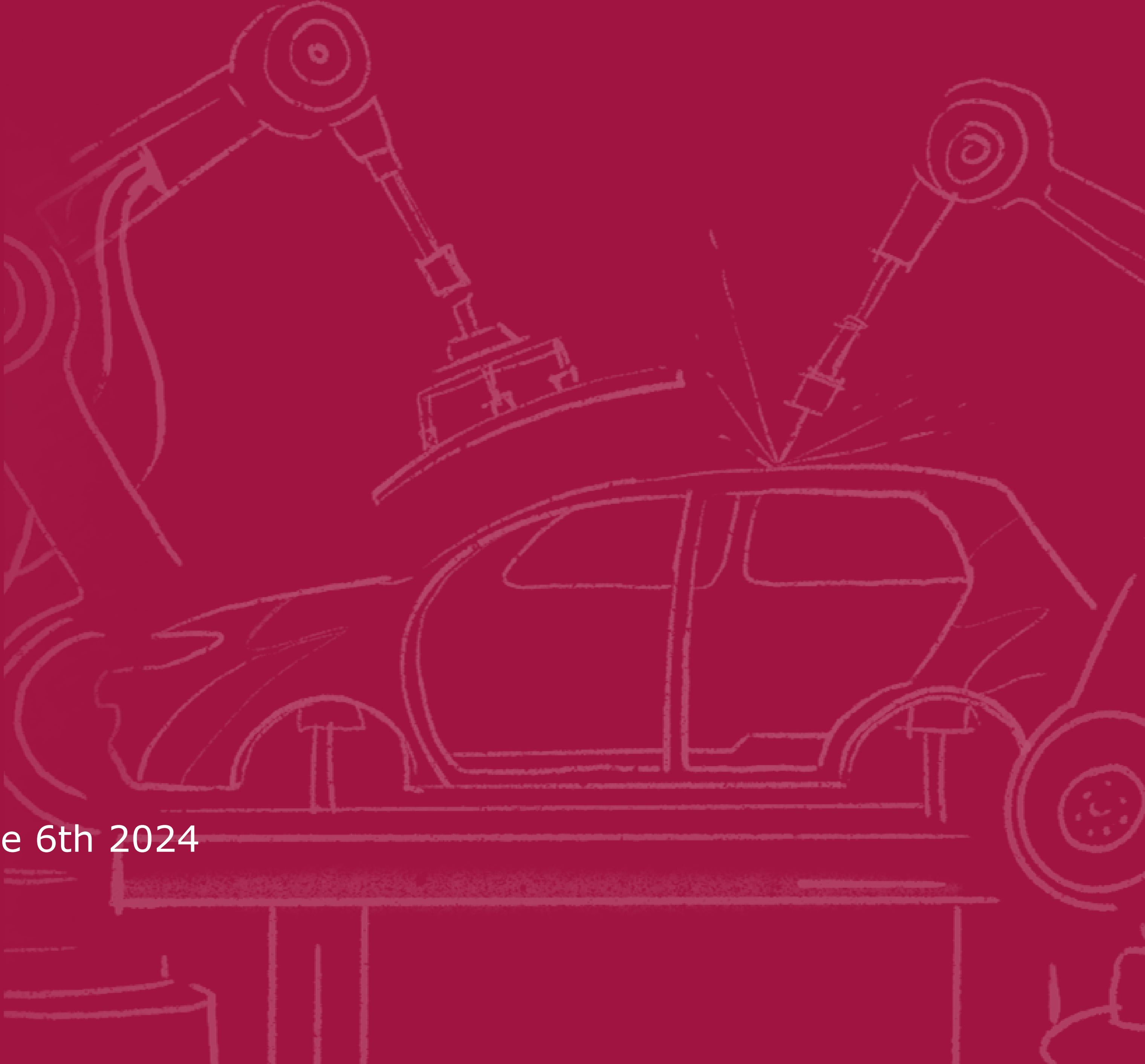
Applying STPA in car series production

Sebastian Kaiser, msg Plaut Austria, June 6th 2024



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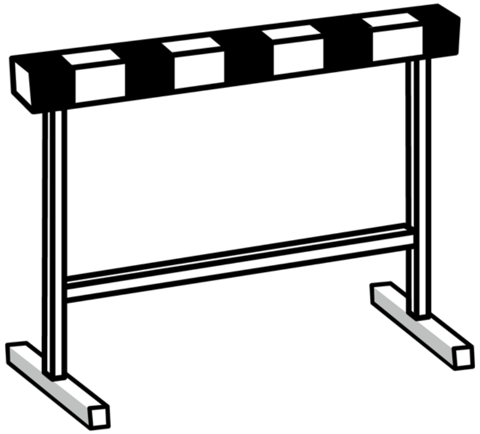
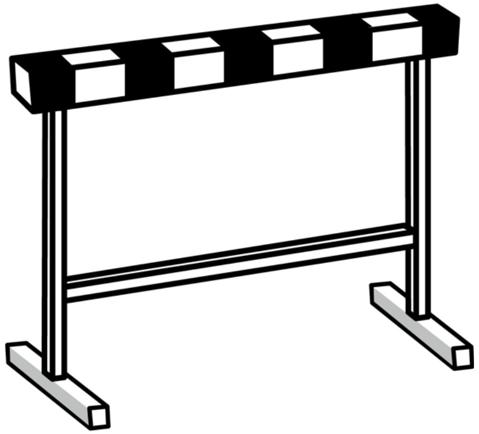
The challenges of STPA in European Automotive industry

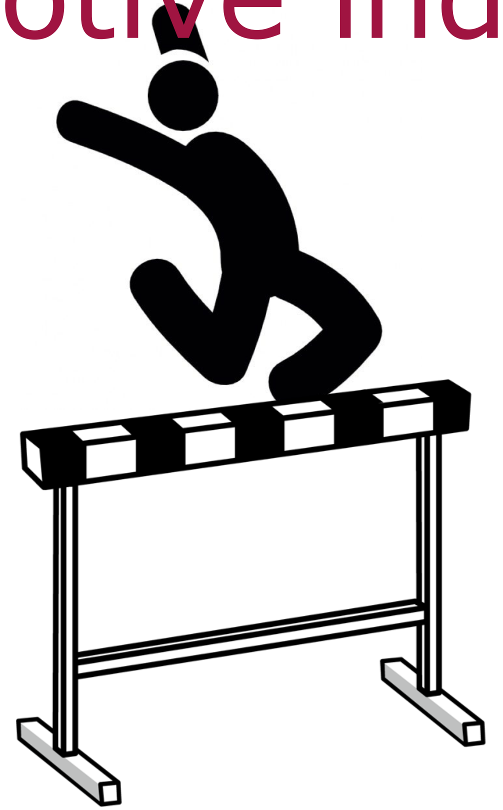


ISO 26262 obligatory for road approval



Overwhelmed by STPA outputs

The challenges of STPA in European Automotive industry



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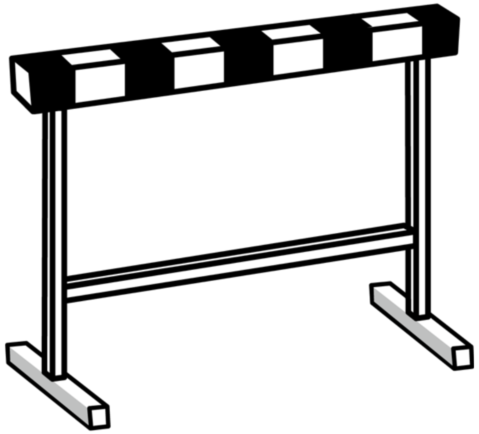

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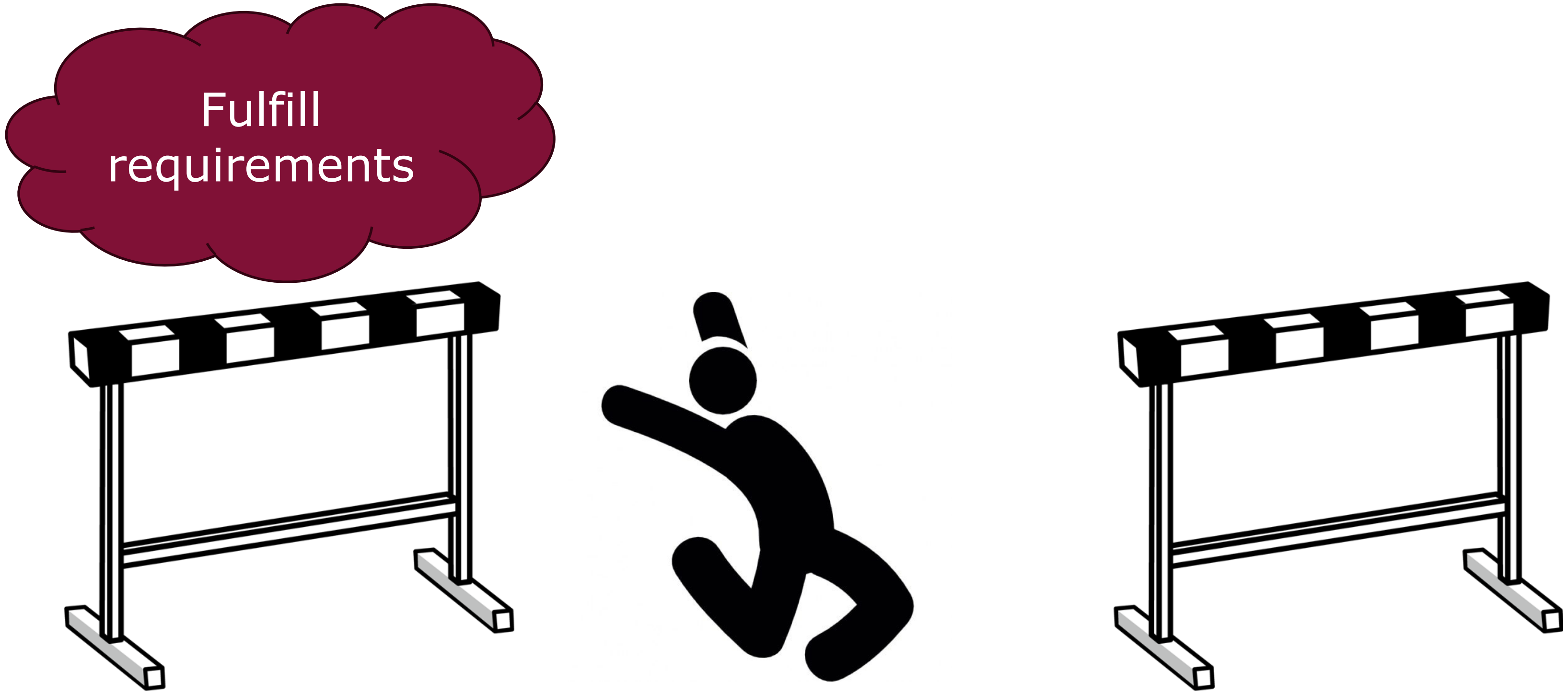
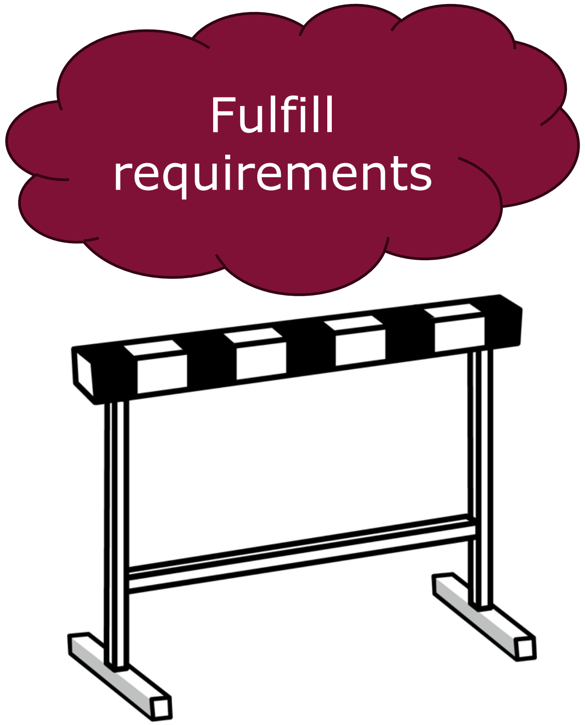


Fulfill requirements

ISO 26262 obligatory for road approval

Overwhelmed by STPA outputs

The challenges of STPA in European Automotive industry



Fulfill requirements

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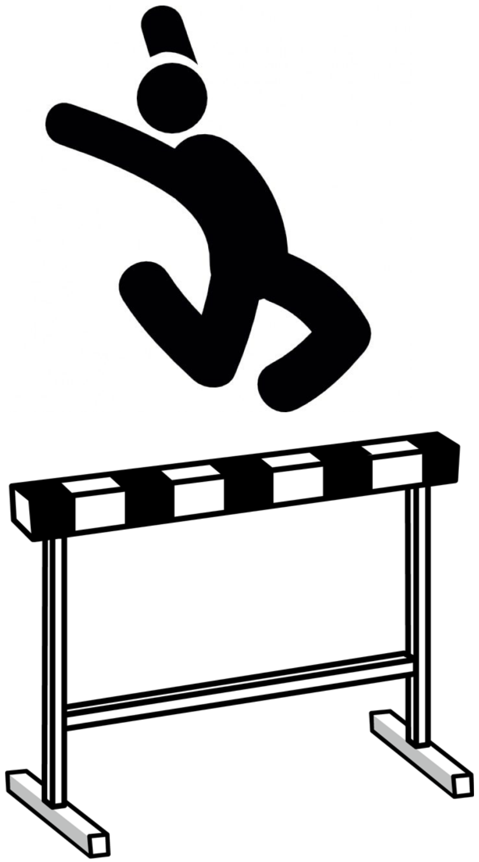
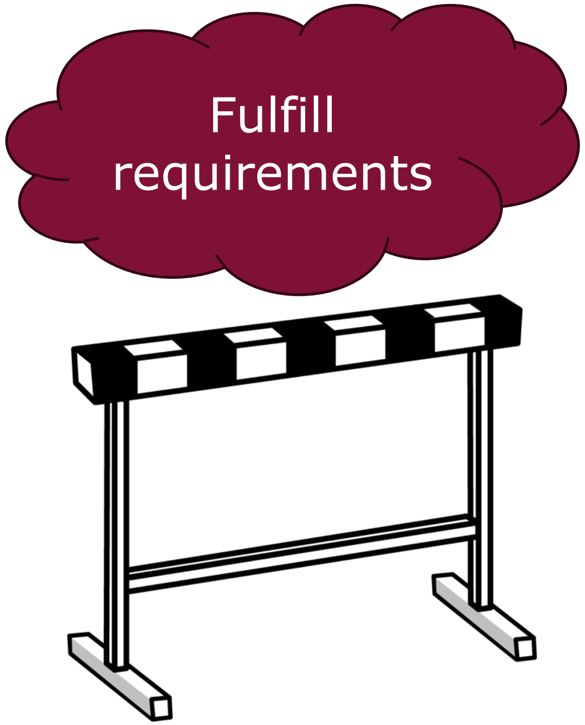


Overwhelmed by STPA outputs

The challenges of STPA in European Automotive industry



Fulfill requirements

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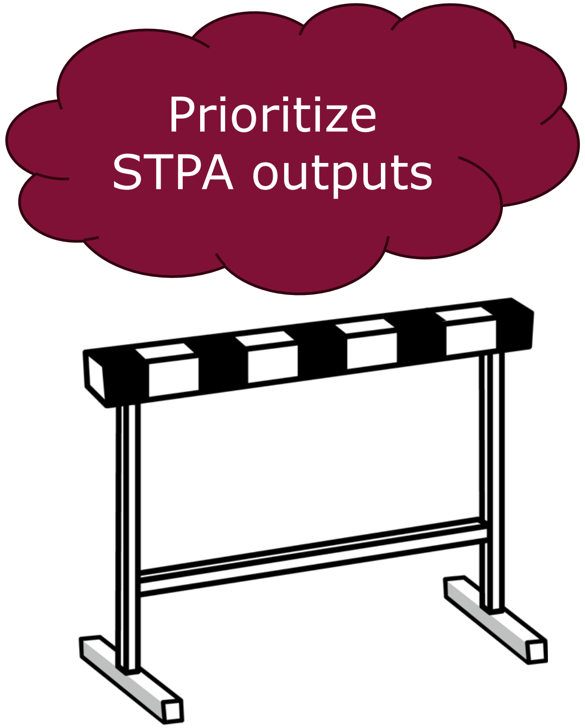
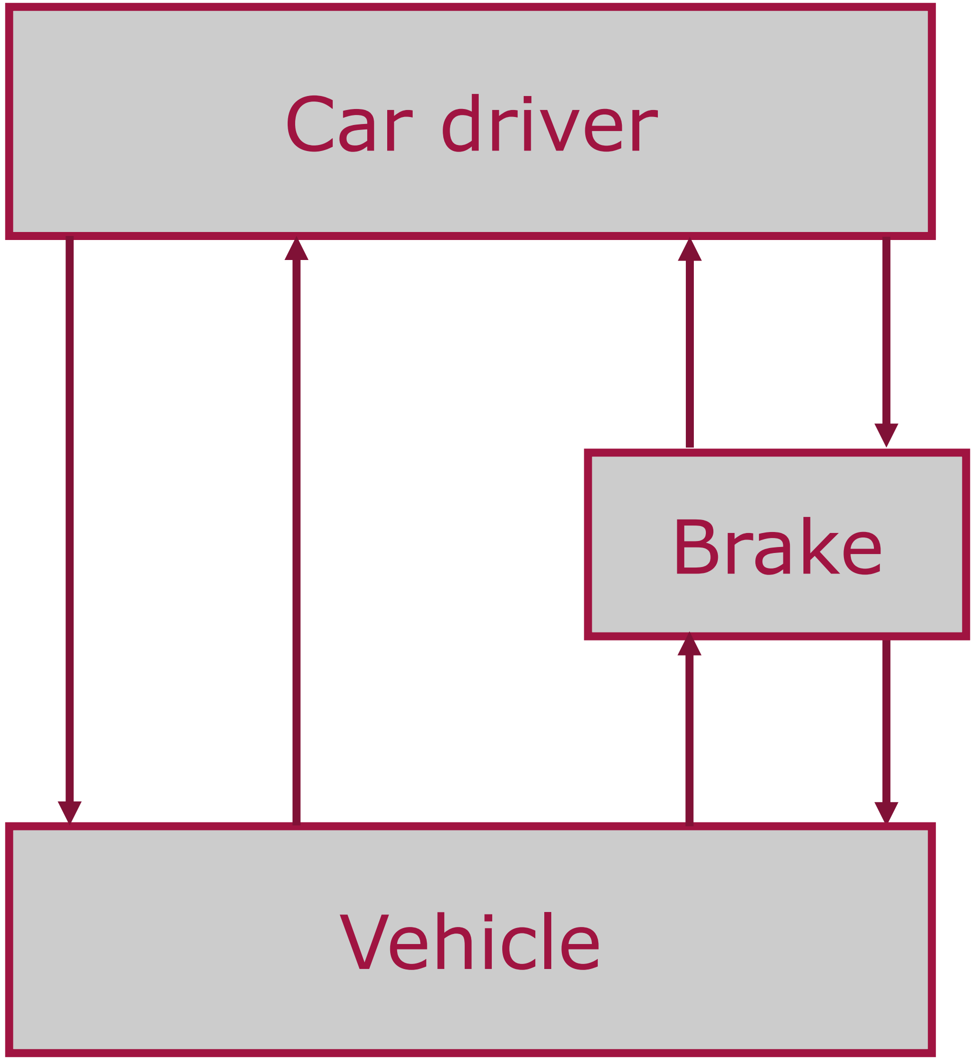


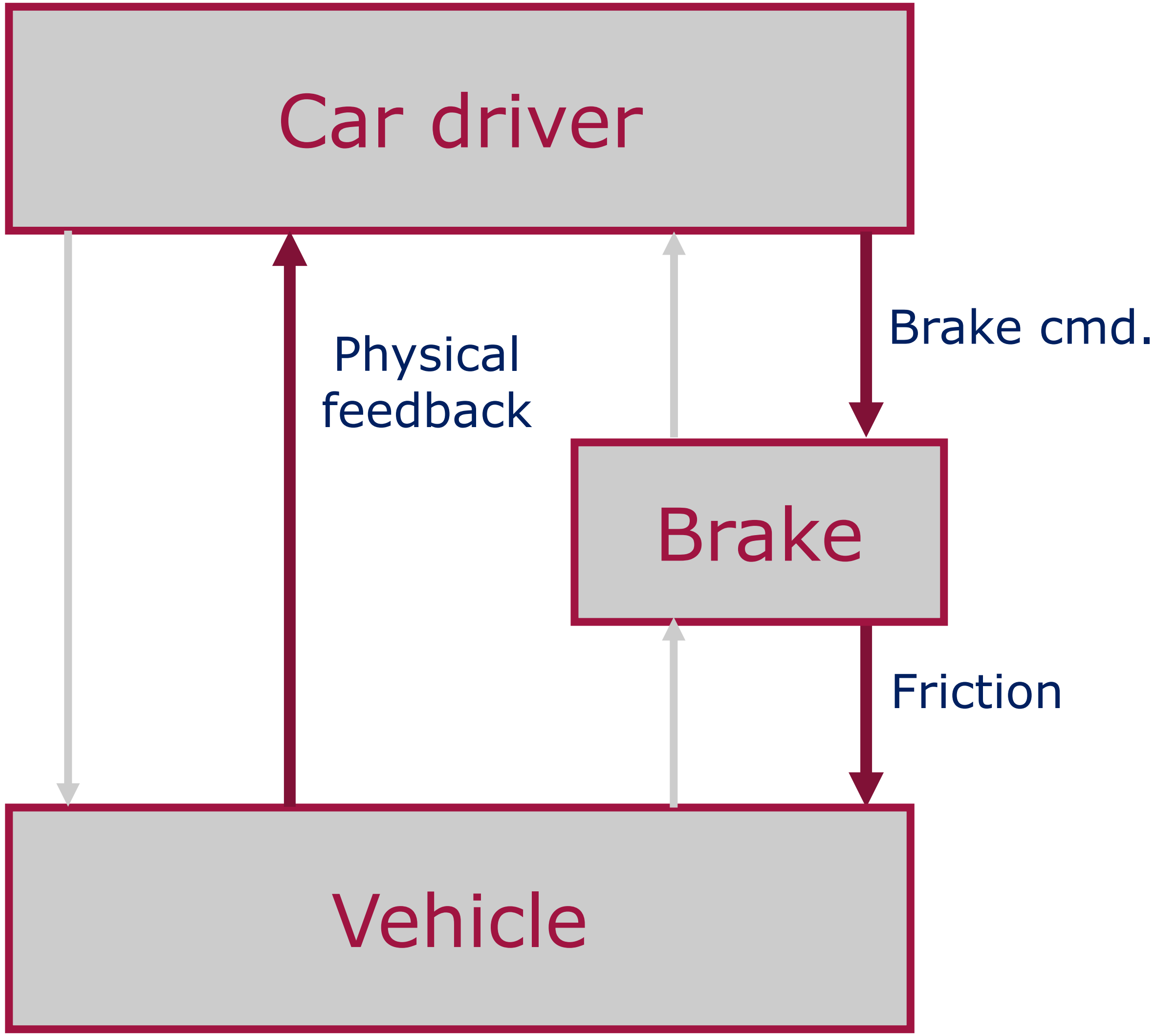
Prioritize STPA outputs

Overwhelmed by STPA outputs

Control Structure – Automotive example



Control Structure – Automotive example



Solving the issue with STPA!

System-level hazard

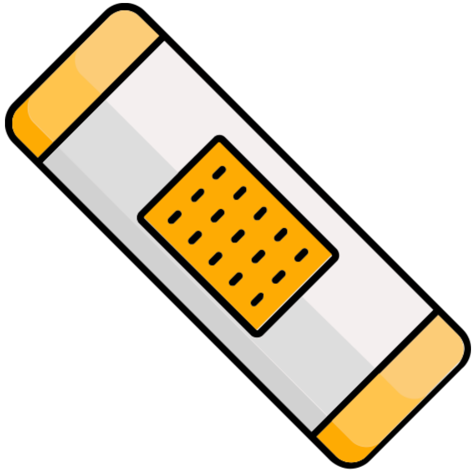
H-1: The vehicle violates the minimum separation from other persons or objects while driving [L-x]

System state to be prevented

System-level Constraint

SC-1: The vehicle must satisfy the minimum separation from other persons or objects while driving [H-1]

Parameter S: required by ISO 26262!



Severity

LOW
S0
S1
S2
S3
HIGH

How bad is it?

Solving the issue with STPA!

Sub-Hazards

H-1.1: The vehicle violates the minimum separation from other persons or objects **while driving at a very low speed (< 5 mph)**

→ **Less kinetic energy**

H-1.3: The vehicle violates the minimum separation from other persons or objects **while driving at high speed (> 30 mph)**

→ **Higher kinetic energy**

Solving the issue with STPA!

Sub-Hazards

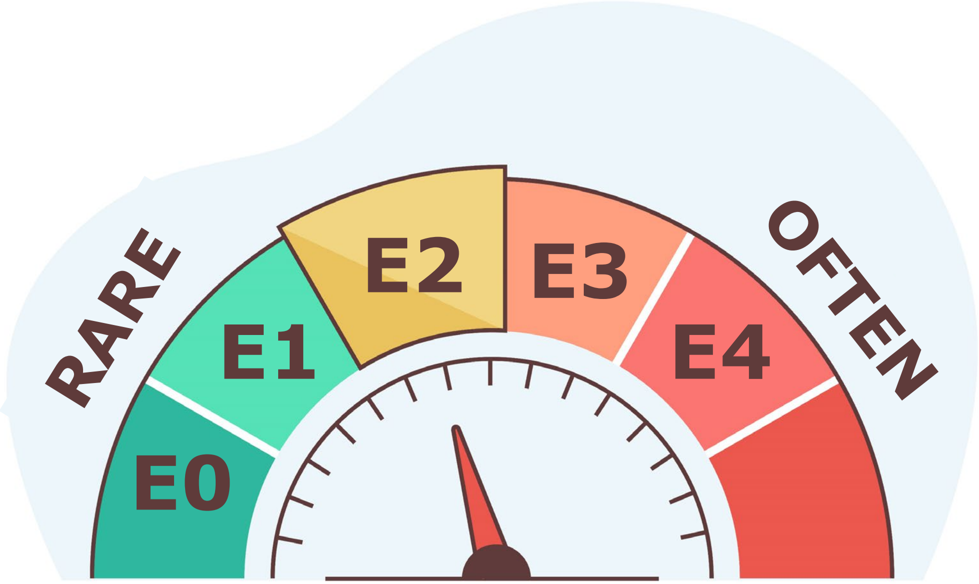
H-1.1: The vehicle violates the minimum separation from other persons or objects **while driving at a very low speed (< 5 mph)**

Less kinetic energy → **S2** (e.g. rear-end collision with low speed)

H-1.3: The vehicle violates the minimum separation from other persons or objects **while driving at high speed (> 30 mph)**

Higher kinetic energy → **S3** (e.g. front collision with high speed)

Parameter E: required by ISO 26262!



Exposure

How often does it happen?

Solving the issue with STPA!

Sub-Hazards

H-1.1: The vehicle violates the minimum separation from other persons or objects**while driving at a very low speed (< 5 mph)**

H-1.3: The vehicle violates the minimum separation from other persons or objects**while driving at high speed (> 30 mph)**

Solving the issue with STPA!

Sub-Hazards

H-1.1: The vehicle violates the minimum separation from other persons or objects

while driving at a very low speed (< 5 mph)

H-1.3: The vehicle violates the minimum separation from other persons or objects

while driving at high speed (> 30 mph)

Solving the issue with STPA!

Sub-Hazards

H-1.1: The vehicle violates the minimum separation from other persons or objects**while driving at a very low speed (< 5 mph)**

→ **Happens less often**

H-1.3: The vehicle violates the minimum separation from other persons or objects**while driving at high speed (> 30 mph)**

→ **Happens more often**

Solving the issue with STPA!

Sub-Hazards

H-1.1: The vehicle violates the minimum separation from other persons or objects **while driving at a very low speed (< 5 mph)**

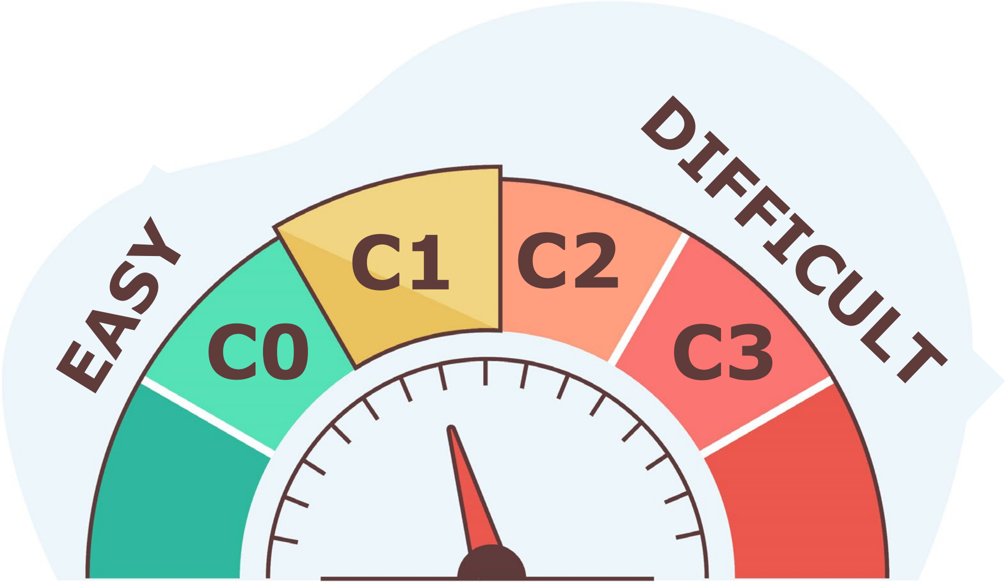
Happens less often → **E2** (e.g. Parking lot)

H-1.3: The vehicle violates the minimum separation from other persons or objects **while driving at high speed (> 30 mph)**

Happens more often → **E4** (e.g. regular drive in a city)

Parameter C: required by ISO 26262!

Controllability

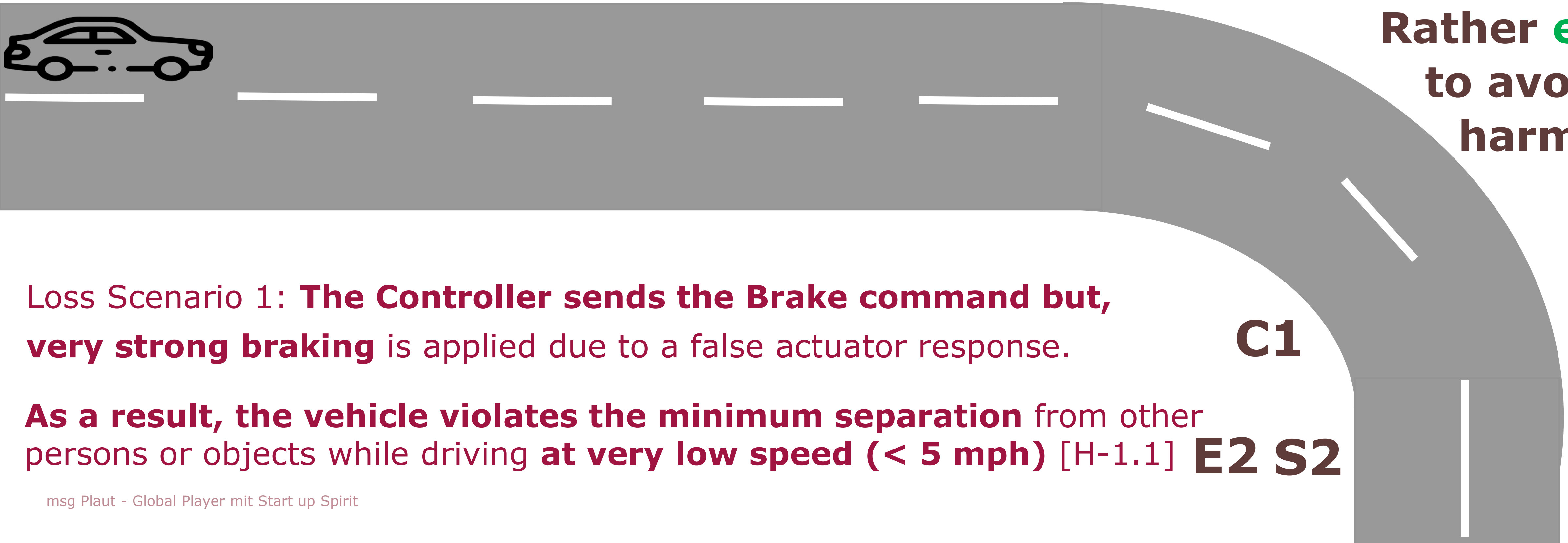


Can you avoid harm?

Assessing the controllability!

Undesired strong
breaking
is applied

Scenario 1



Rather easy to avoid harm

C1

Loss Scenario 1: **The Controller sends the Brake command but, very strong braking** is applied due to a false actuator response.

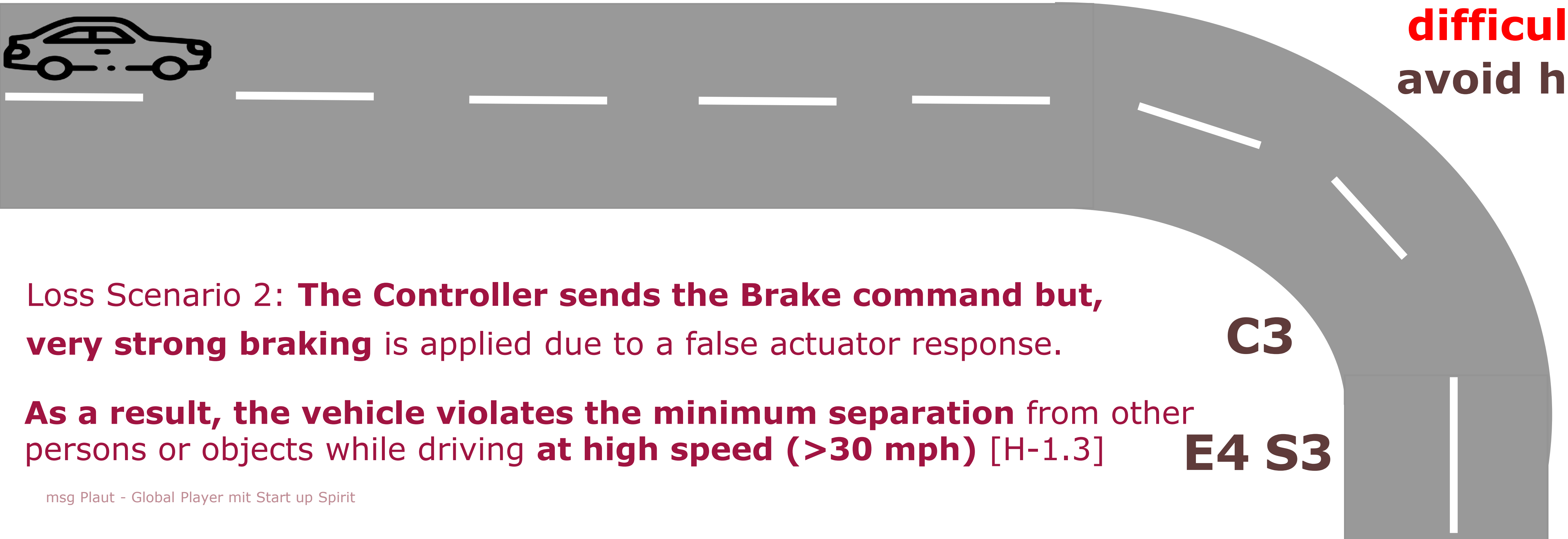
As a result, the vehicle violates the minimum separation from other persons or objects while driving **at very low speed (< 5 mph)** [H-1.1]

E2 S2

Assessing the controllability!

Undesired strong
breaking
is applied

Scenario 2



Rather difficult to avoid harm

Loss Scenario 2: **The Controller sends the Brake command but, very strong braking** is applied due to a false actuator response.

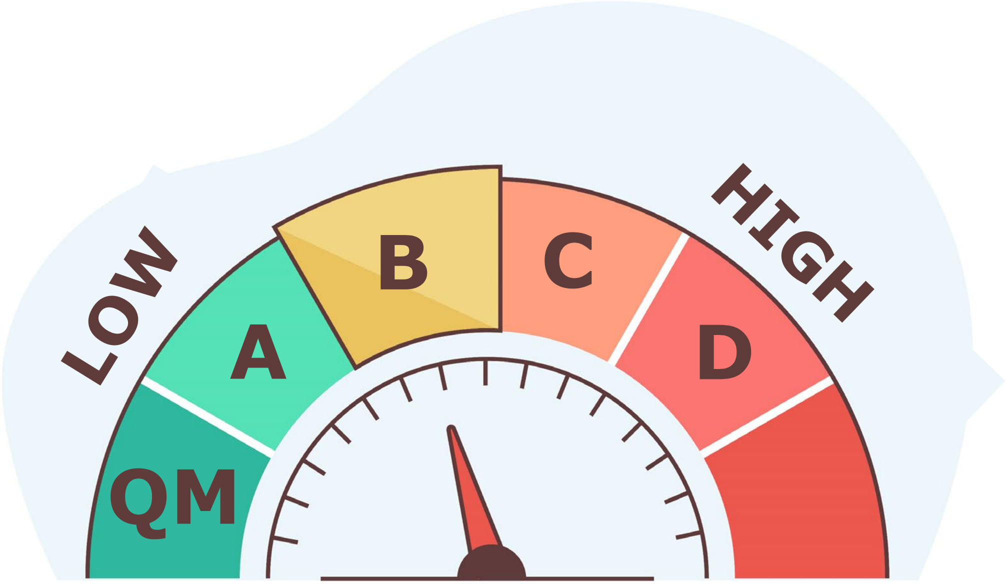
As a result, the vehicle violates the minimum separation from other persons or objects while driving **at high speed (>30 mph)** [H-1.3]

C3

E4 S3

ASIL derived from S, E, C combination

Risk assessment



How much effort?

Prioritize the outputs of STPA!

Sub-Hazard

H-1.1

Loss Scenario

Scenario 1

$$\underbrace{\textbf{S2}\quad\textbf{E2}\qquad\qquad\textbf{C1}}_{\textbf{[QM]}}$$

Constraint

SC-1.1: The vehicle **must satisfy the minimu distance** from other objects and persons while driving **at a very low speed**.

Sub-Hazard

H-1.3

Loss Scenario

Scenario 2

$$\underbrace{\textbf{S3}\quad\textbf{E4}\qquad\qquad\textbf{C3}}_{\textbf{[ASIL D]}}$$

Constraint

SC-1.3: The vehicle **must satisfy the minimu distance** from other objects and persons while driving **at high speed**.

Prioritize the outputs of STPA!

Sub-Hazard **Loss Scenario**

H-1.1 Scenario 1

S2 E2 C1

Constraint

SC-1.1: The vehicle **must satisfy the minimu** **distance** from other objects and persons while driving **at a very low speed**.

[QM]

Sub-Hazard **Loss Scenario**

H-1.3 Scenario 2

S3 E4 C3

Constraint

SC-1.3: The vehicle **must satisfy the minimu** **distance** from other objects and persons while driving **at high speed**.

[ASIL D]

Prioritize the outputs of STPA!

Sub-Hazard **Loss Scenario** **Constraint**

H-1.1 Scenario 1

S2 E2 C1

SC-1.1: The vehicle **must satisfy the minimu** **distance** from other objects and persons while driving **at a very low speed.** **[QM]**

Sub-Hazard **Loss Scenario** **Constraint**

H-1.3 Scenario 2

S3 E4 C3

SC-1.3: The vehicle **must satisfy the minimu** **distance** from other objects and persons while driving **at high speed** **[ASIL D]**

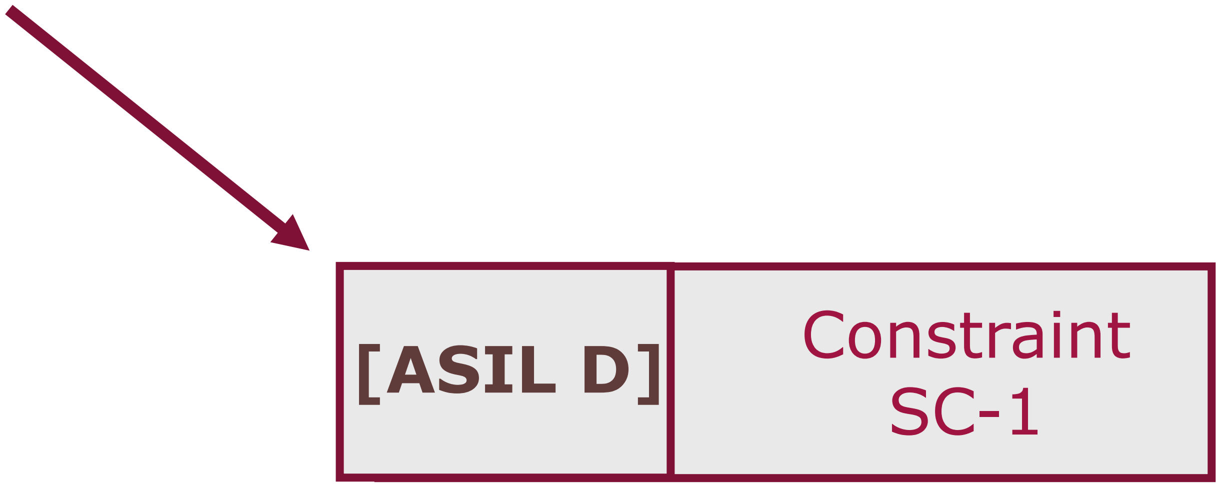
Prioritize the outputs of STPA!

Constraint

SC-1.1: The vehicle **must satisfy the minimum distance** from other objects and persons while driving **at a very low speed** **[QM]**

Constraint

SC-1.3: The vehicle **must satisfy the minimu** **distance** from other objects and persons while driving **at high speed.** **[ASIL D]**



[ASIL D]

Constraint
SC-1

The advantages of our procedure!

- Fulfill standards in order to get road approval!
- Overall better results by STPA application!
- Prioritization in line with Automotive procedures!

Thank you for you attention!

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