- Project Partners
- Definition of Technical Feasibility
- Methodology of Technical Feasibility Evaluation
- Process
- Results

- Project Partners

ACEA

Vehicle models and EEVC impactor test results

MAE (MATRA)

Vehicle modification (FE) and expertise on technical feasibility

FE pedestrian impactor test simulation

TNO

Comparison of protection level offered by base and modified cars

using MADYMO full body simulation

- Definition of Technical Feasibility

The Directive on Pedestrian Protection will be a subject of vehicle type approval for the relevant vehicles.

The legislative tests and their criteria have to be met with a confidence level to the limits (usually 80%)
- by all models and variants
- for all possible versions (worst case condition)
- without any exception

Technical Feasibility is given if design solutions can be provided for all relevant vehicle types that fulfil pedestrian protection legislation without exception and simultaneously meet all other legislative and functional requirements that must be met for an introduction to the market.

- Methodology of Technical Feasibility Evaluation

Vehicle Classes

The four main passenger car classes were studied on the basis of FE simulation:

- Super Mini Car
- Executive Car
- Sport Utility Vehicle(SUV)
- Sport´s Car

Technical modifications were developed for these cars in order to comply with EEVC WG17 requirements to the maximum possible level considering vehicle functional requirements and target conflicts.

• Methodology of Technical Feasibility Evaluation

Vehicle Functional Requirements – Examples:

- Vehicle ramp angle
- Field of vision
- Front light output area
- Engine cooling – air intake area
- Damageabilty by
  - Normal vehicle use like bonnet slam, car wash etc.
  - Low speed impacts (RCAR)
- Wind load and vibration regarding durability
- Fuel consumption and exhaust emission
- Other passive vehicle safety requirements

• Methodology of Technical Feasibility Evaluation

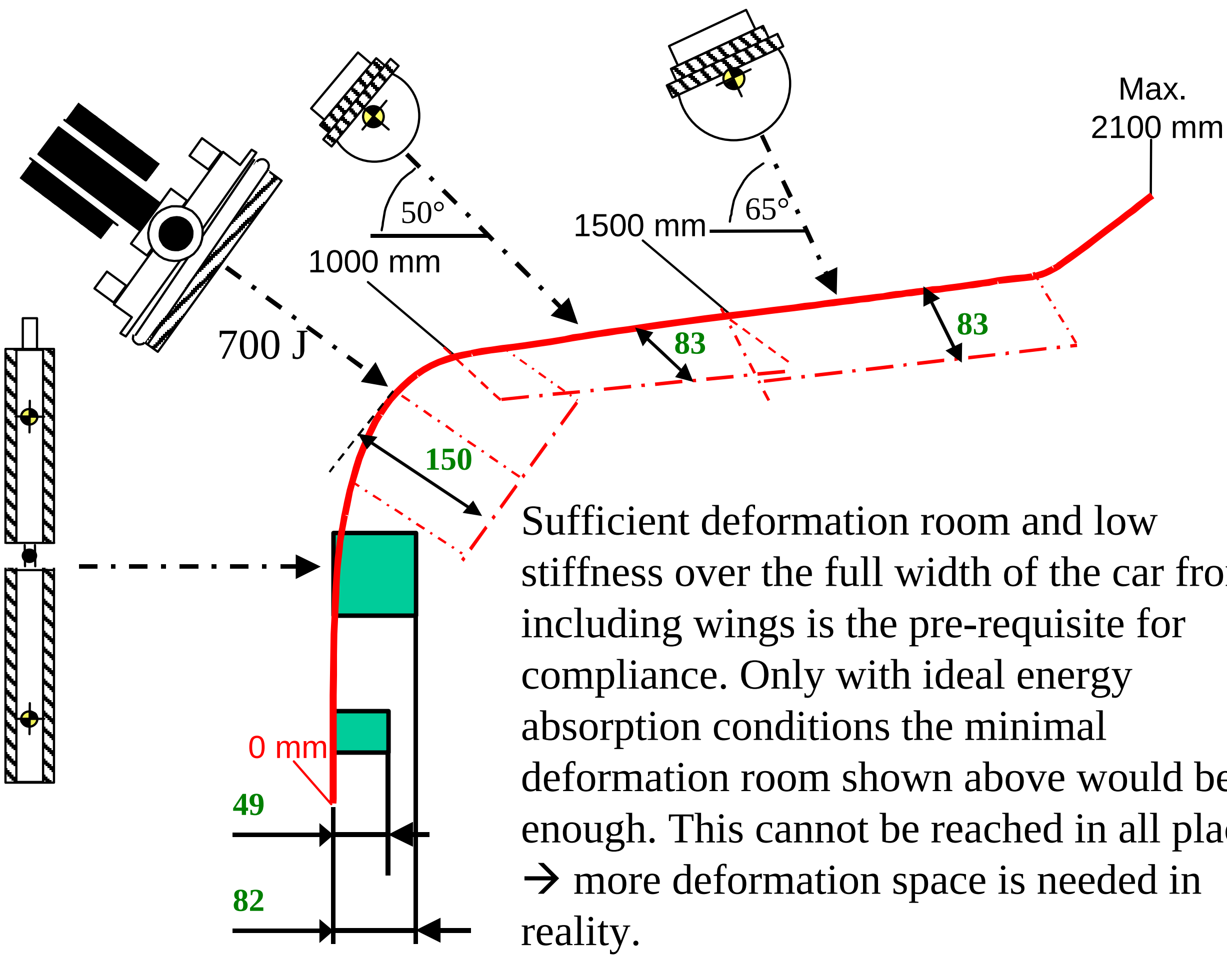
Vehicle Modifications - Examples:

- Maintaining the typical vehicle class
- Re-arranging engine compartment package as far as possible while keeping the functionality
- Changing vehicle shape to provide deformation space or
- Introducing a deployable bonnet (example: sport´s car)
- Design all relevant body parts accordingly
- Modify structure, reduce stiffness and use alternative material when necessary
- Go to the limits of manufacturability

- Process

  - Vehicle FE models and pedestrian impactor test results were provided by the vehicle manufacturers
  - Validation of FE vehicle models by impactor test simulation and real test results
  - Modification of the FE models for maximum possible compliance with EEVC WG17
  - Investigation of technical limitations resulting from conflicts:
    - between the different pedestrian test requirements,
    - vehicle functionality and
    - manufacturability
    - other legal requirements

• Theoretical Minimal Deformation Depth for Compliance (MATRA)

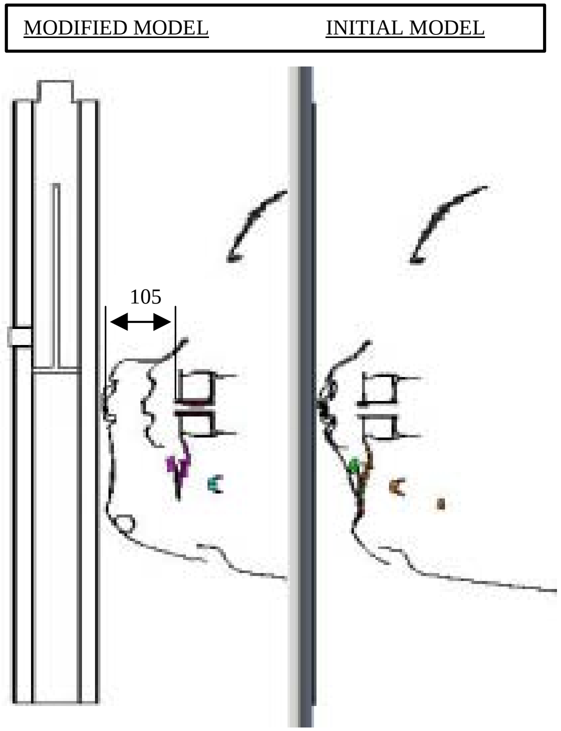


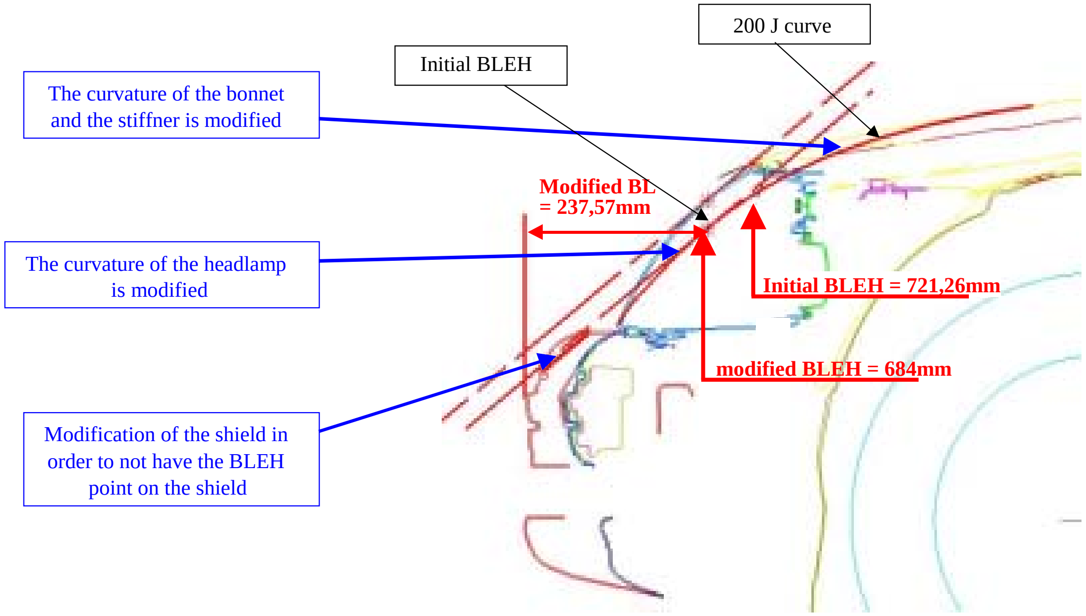
Sufficient deformation room and low stiffness over the full width of the car front including wings is the pre-requisite for compliance. Only with ideal energy absorption conditions the minimal deformation room shown above would be enough. This cannot be reached in all places → more deformation space is needed in reality.

Executive Car

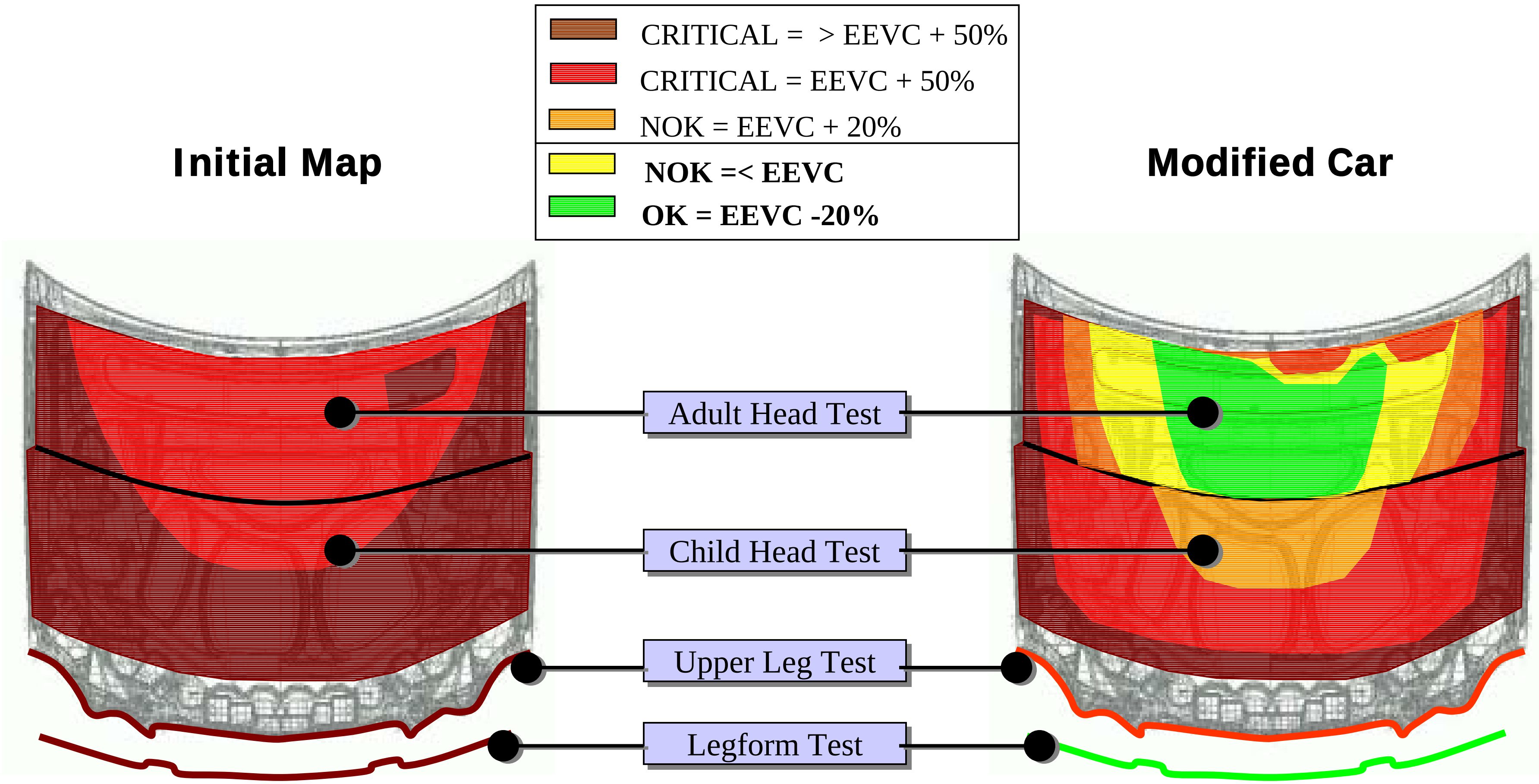
Executive Car

Design approaches for legform and upper leg





Executive Car - Results



Executive Car – Results and main conflicts

		EEVC Criteria WG17 –20%	Technical feasibility	Certification / Specifications (*)
Head impact ● ● ● ●		Hinges' and latches' stiffness Wing area / Bonnet's borders		
Upper leg impact ● ● ●	200J		Latch and striker to be redesigned	Durability Cooling system Packaging New car's front end
	400J	Front end stiffness		Cooling system
Lower leg impact ● ●				Low speed impacts

(*) Vehicle's and customer's functions expertise

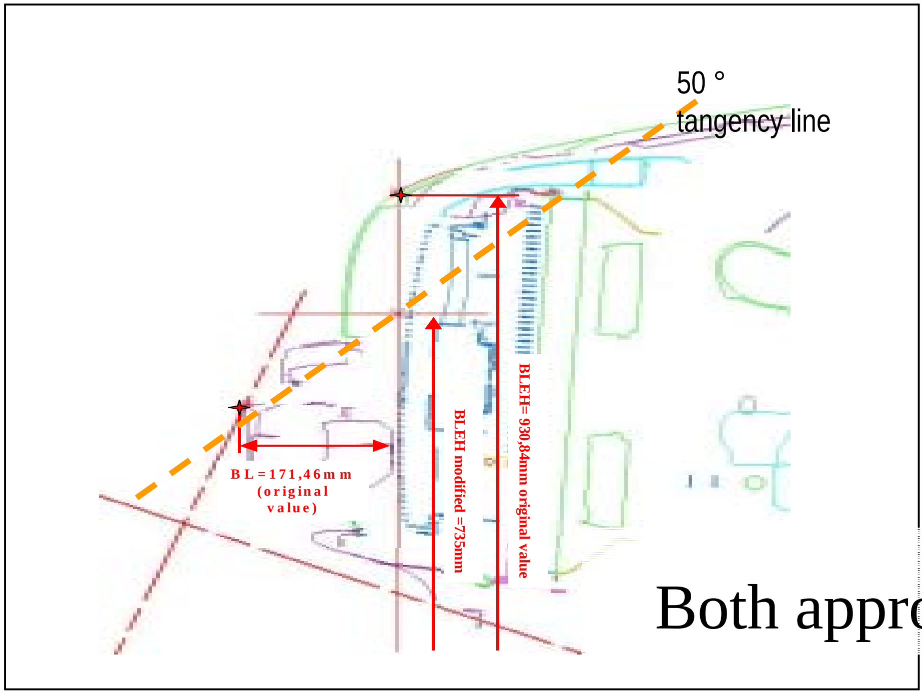
● Remains a possible solvable problem
● Remains an unsolvable problem

SUV car

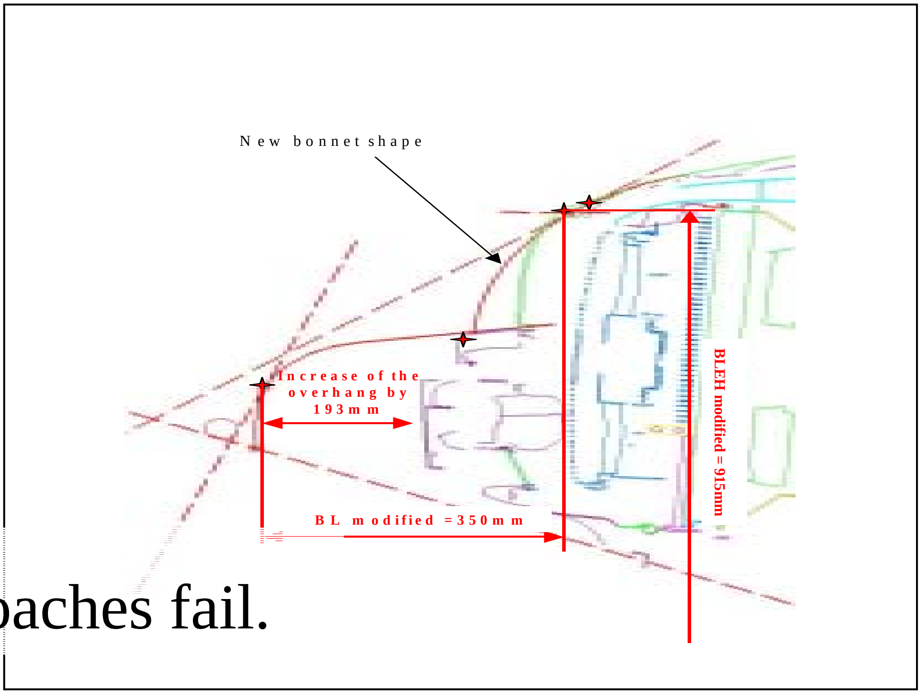
Sport utility Vehicle

Two options for an upper leg development:

A: Providing deformation room



B: Lowering energy by vehicle shape



Both approaches fail.

Sport Utility Vehicle

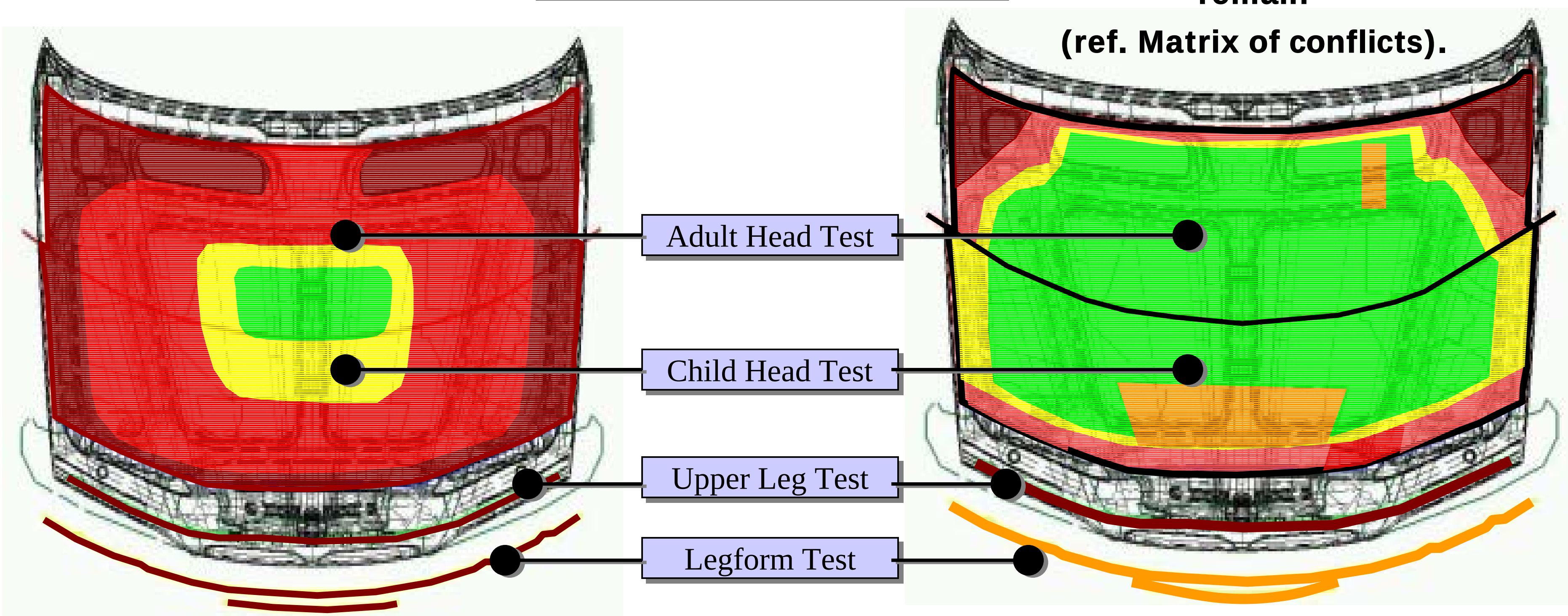
(dark brown)	CRITICAL = > EEVC + 50%
(red)	CRITICAL = EEVC + 50%
(orange)	NOK = EEVC + 20%
(yellow)	**NOK =< EEVC**
(green)	**OK = EEVC -20%**

Initial Map

Modified Car

Modified to the maximum HIC reduction but unresolvable functional problems remain

(ref. Matrix of conflicts).



Sport Utility Vehicle – Results and main conflicts

	EEVC Criteria WG17 –20%	Technical feasibility	Certification / Specifications (*)
Head impact ● ● ●	Hinges' stiffness Wing area / Bonnet's borders	Packaging and architectural problems remain	Air intake surface, reliability and fluttering problem
Upper leg impact ●	No solution		
Lower leg impact ● ●			Damages on bumper skin

(*) Vehicle's and customer's functions expertise

● Remains a possible solvable problem
● Remains an unsolvable problem

Super Mini Car

Super Mini Car - Results

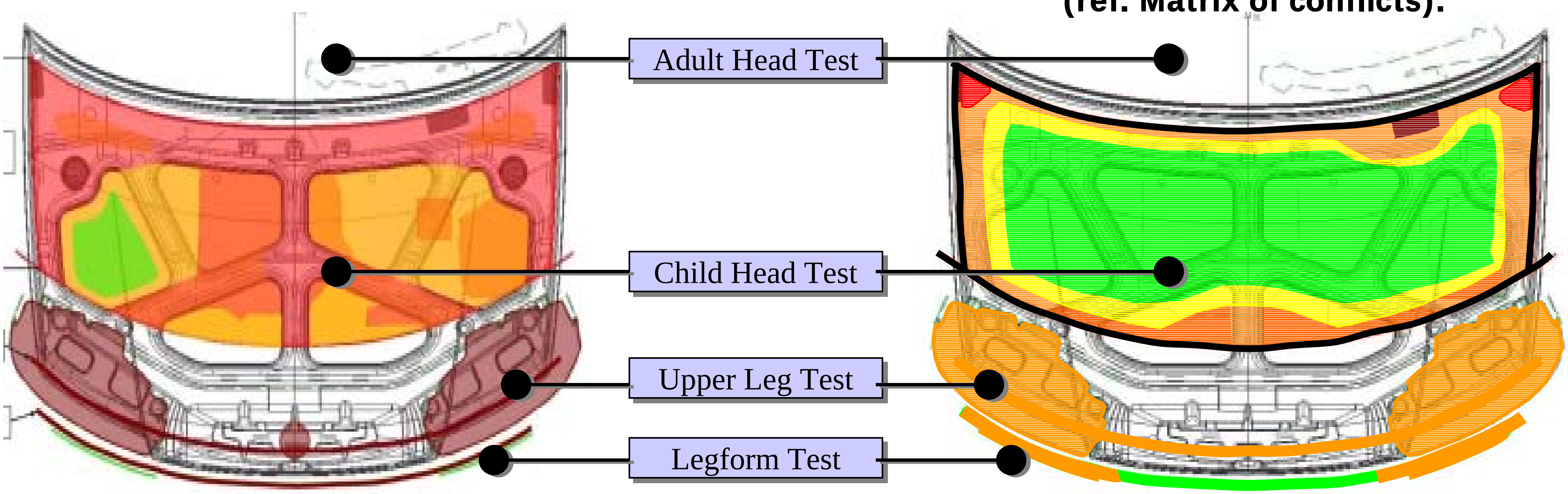
Initial Map

- CRITICAL = > EEVC + 50%
- CRITICAL = EEVC + 50%
- NOK = EEVC + 20%
- **NOK =< EEVC**
- **OK = EEVC -20%**

Modified Car

Modified to the maximum HIC reduction but unresolvable functional problems remain

(ref. Matrix of conflicts).



Super Mini Car - Results

	EEVC Criteria WG17 –20%	Technical feasibility	Certification / Specifications (*)
Head impact ● ● ● ●	Hinges' and latches' stiffness Wing area / Bonnet's borders		Reliability
Upper leg impact ● ● ●			Reliability Latch accessibility Architectural problem
Lower leg impact ● ● ●			Damages on bumper skin Architectural problem

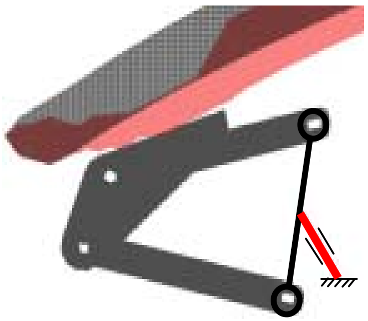
(*) Vehicle's and customer's functions expertise

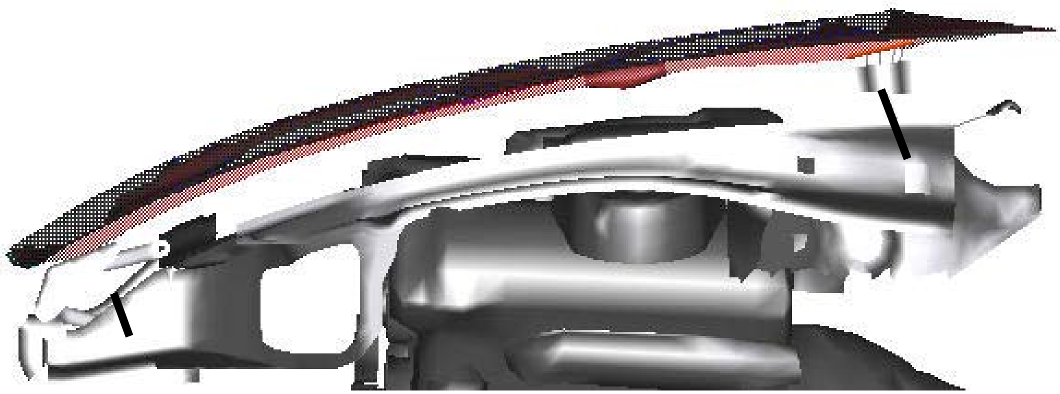
● Remains a possible solvable problem
● Remains an unsolvable problem

Sport's car

Sport´s Car

Deployable Bonnet System



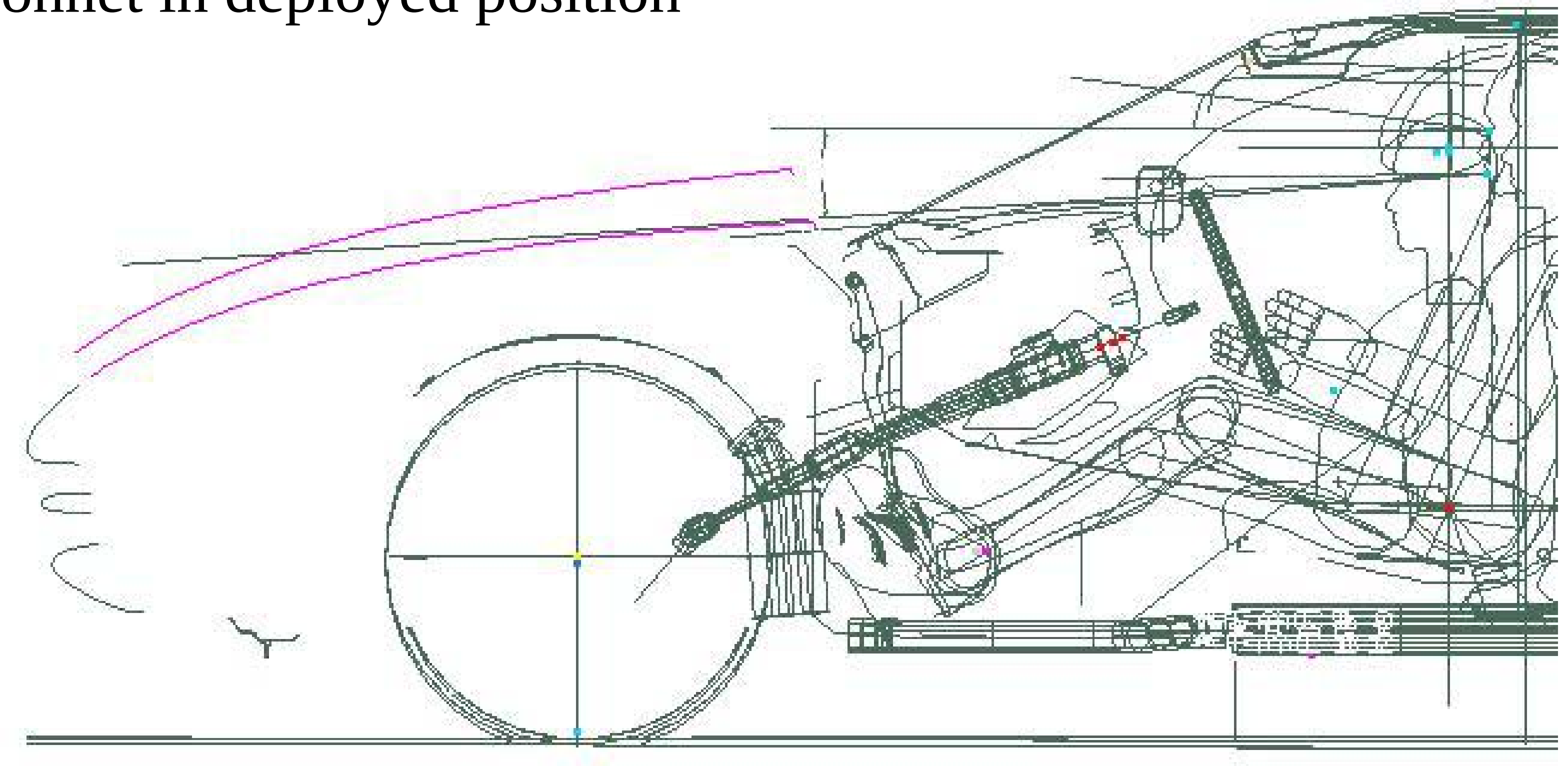


Characteristics of the pop up bonnet:

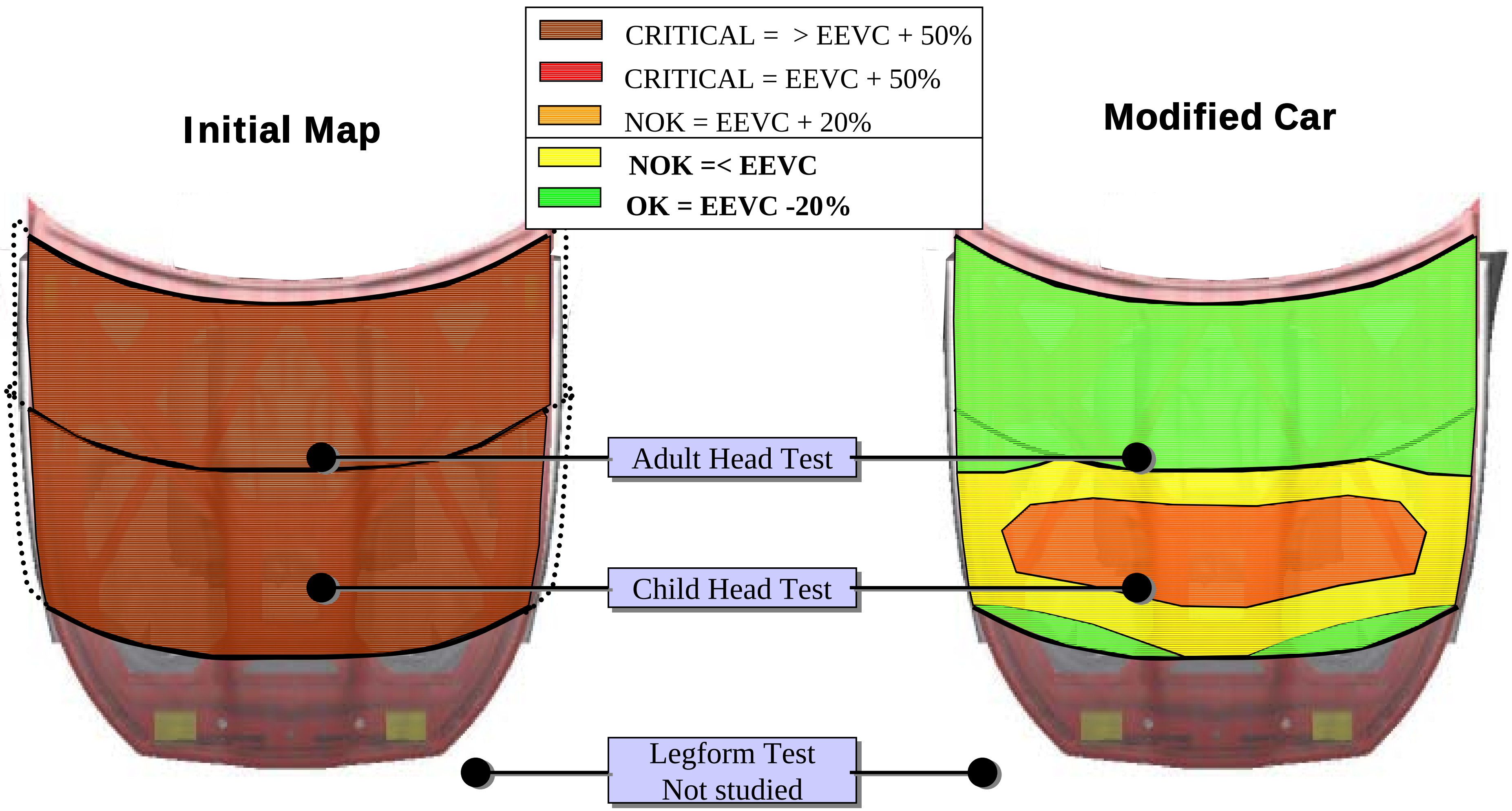
- Two front actuators (50mm, angle : 58deg/horizontal)
- Two rear actuators (100mm, angle : 67deg/horizontal)

Sport´s Car

Bonnet in deployed position



Sport´s Car


CRITICAL = > EEVC + 50%
CRITICAL = EEVC + 50%
NOK = EEVC + 20%
NOK =< EEVC
OK = EEVC -20%
Initial Map
Modified Car
Adult Head Test
Child Head Test
Legform Test
Not studied

Sport´s Car – Results and main conflicts

	EEVC Criteria WG17 –20%	Technical feasibility	Certification / Specifications (*)
Head impact ●●	The inertia of the bonnet prevent from reaching the criteria	Impact detection, calibration	Crash behaviour to be validated
Upper leg impact	The energy level is below 200J, then the test is skipped		
Lower leg impact	Not studied		

● Remains a possibly solvable problem
● Remains an unsolvable problem

(*): Vehicle's and customer's functions expertise