SIMULATION OF PEDESTRIAN SAFETY FOR AMG C63 USING ANSA & META

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KEYWORDS – pedestrian safety, pre processing, post processing, automization, regulation

ABSTRACT

Pedestrian safety rules for passenger cars were introduced as regulation for all new series-production vehicles in Europe and Japan in 2003. All cars have to fulfil these regulations from 2005 on, when sold in European markets. Japan requested their regulations fulfilling in 2004. Challenges according to these rules have been the contradiction between stiffness requirements due to every day load cases and the necessary softness of hood and bumper to fulfil safety aspects. Furthermore there are design and aerodynamic aspects, and of course package is demanding too. Due to all this, a pedestrian safety simulation in an early development state seems to be beneficial.

Basically the crash model could be used, however bumper and hood have to be modelled different. More complex models are needed, especially the mechanical behaviour of hood mounts, connecting clips, springs, dampers, seals, locks and hinges should be taken into account. In addition the bonding model of inner and outer sheet is crucial for the results. In case of the bumper with build in spotlight the interaction of plastic parts with foam and metal parts has to be modelled correctly.

Regulations require a certain area where head and leg impacts should be approved. These areas of the car have to be distinguished according to the rules. Especially the head impact zone should be created with a program in order to avoid manual work and errors. Due to the large area of the hood a large number of impact points has to be simulated in a manor of a raster in order not to miss any problematic zone or point. In addition „hard points“ should be marked wherever an aggregate is close to the hood. The task to come from CAD data to a ready to run solver deck is solved by ANSA in a quite fast and efficient way and includes the support of regulations.

A large number of simulations give a tremendous amount of data that has to be post processed. Acceleration plots, HIC values, movies and overviews have to be calculated and created for each impact point so that fast examination and interpretation of results is possible. The advantage of using automated µETA post processing for this issue is shown.

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Simulation of Pedestrian Safety

for **AMG C63**
using
ANSA & µETA

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Agenda

- Overview
- Technical regulations
- Motivation for Pedestrian Safety Simulation
- Pre processing with **ANSA**
- Used Impactors
- Simulation overview
- Post processing with **µETA**
- Summary

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Overview

- Passenger cars have to fulfil Pedestrian safety rules since 2005 in Europe (Japan 2004) ➡ Phase I
- Phase II starting in 2010 will be more tough to fulfill
- These rules are often in contradiction to stiffness requirements
- Design and aerodynamic aspects give more demands
- The pedestrian safety rules require many tests to be fulfilled
- Testing of real parts is
  - time consuming
  - very late in development process and
  - expensive
- Overall demands:
  Low Costs and “Shorten time to market!”

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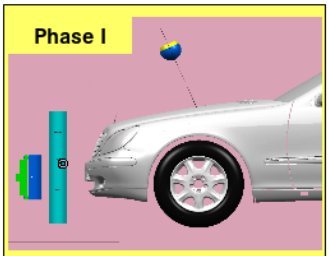
Technical Regulations

Approval of

- **Head impact**
  to bonnet
- **Lower Leg**
  to bumper
- **Upper Leg**
  to bumper and bonnet leading edge (Phase II)

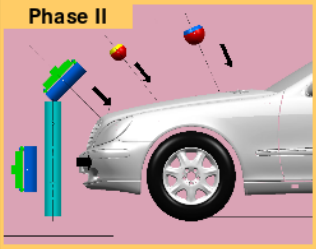
Phase I



Head:
3.5 kg
35 kph
HPC 1000 (2/3-area)
HPC 2000 (1/3-area)
Lower Leg (Upper Leg):
40 kph

10/2005

Phase II



Child/Adult Head:
3.5kg/4.5kg
35 kph
HPC 1000 (2/3-area)
HPC 1700 (1/3-area)
HPC 1000 (1/2-child area)
Lower Leg (Upper Leg):
40 kph
Upper Leg (bonnet):
40 kph

2010

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Motivation for Simulation

- High cost efficiency
  - about 200 target points to “test” on head impact
  - another 10 to 20 positions for LowerLeg impact
- Early stage development
- Small design changes could have strong effects
- Continuous simulation during the whole development process
- ⇨ Pedestrian safety **simulation** seems to be beneficial

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Pre processing with ANSA

- CAD data translation
- Geometry treatment like repairing, midsurface creation
- Meshing
- Connections: bolts, springs, spotwelds, adhesives, folded joints
- Boundary conditions
- Control cards for solvers
- Raster creation for EC-Regulations and EuroNCAP
- Head and Leg positioning
- Output of solver deck with include structure

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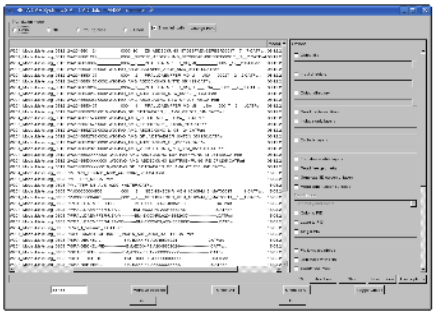
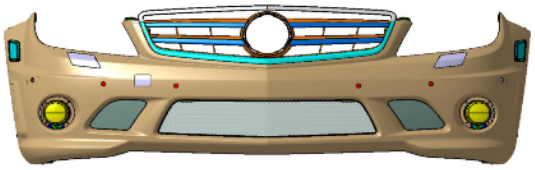
Translation from CAD-Data

- series production crash model is basis
- additional and replacing parts have to be fetched from CAD by ansa_catia direct interface





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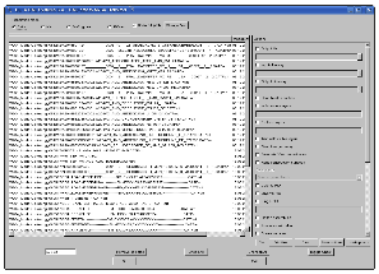
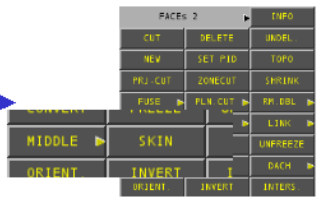
Geometry treatment & Meshing





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Replace Parts & Assembly

- A sub structure of the Crash Model is used
- Unnecessary parts are removed
  - *wheels*
  - *cut behind A-Pillar*
- add Boundary Conditions
- replace Fenders & Bumper
- replace Bonnet

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Critical “Inner and Outer Parts”

- extension with components near the lower side of the bonnet
- add wiper system
- “Engine” replacement

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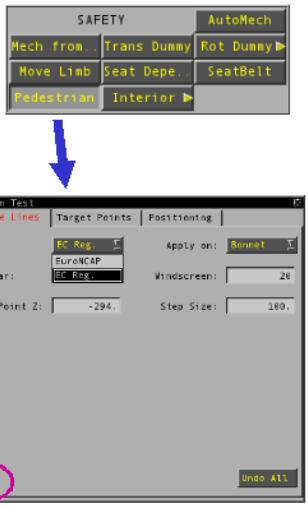
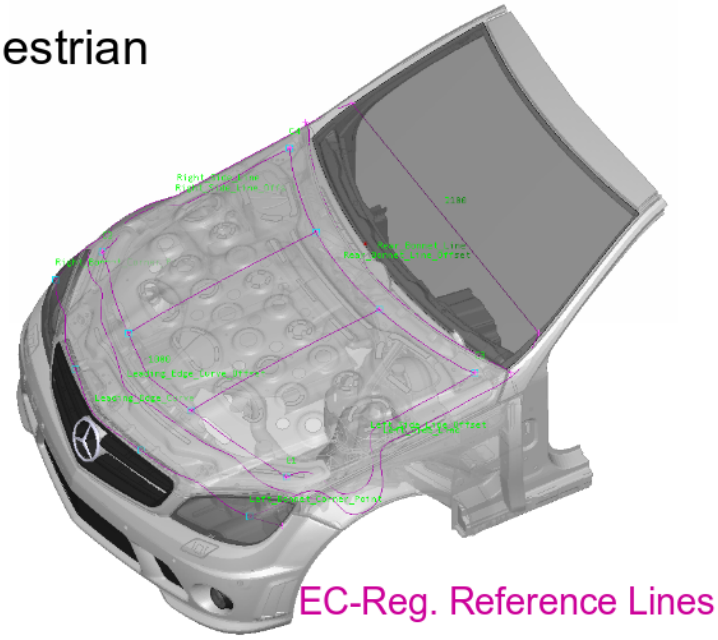
Raster & Target point creation (1)

Deck>Safety>Pedestrian

- Reference Lines





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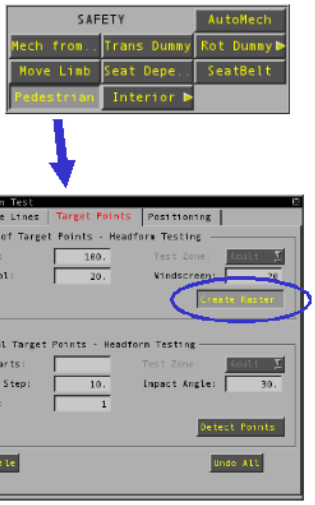
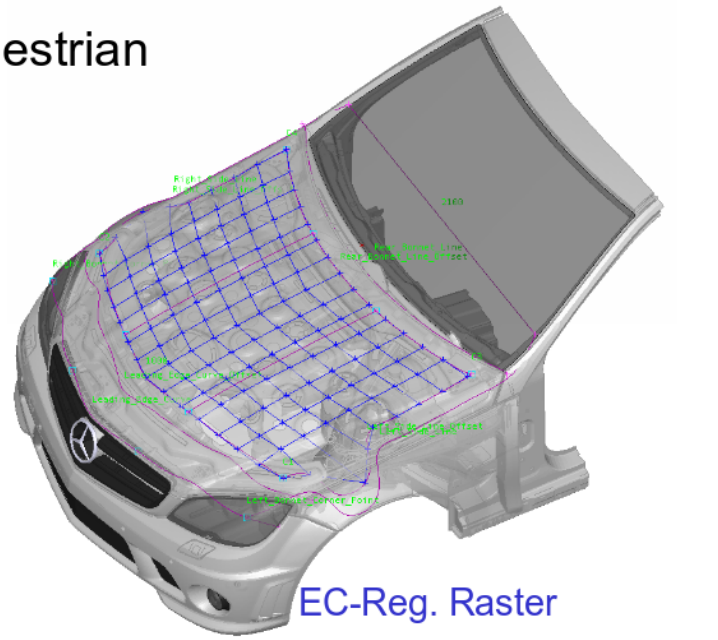
Raster & Target point creation (2)

Deck>Safety>Pedestrian

- Raster creation





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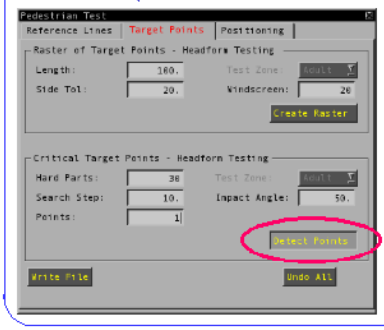
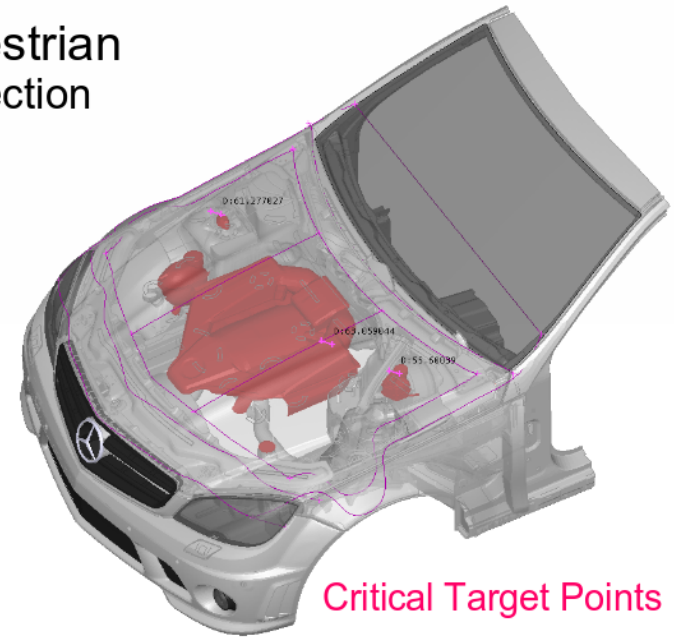
Raster & Target point creation (3)

Deck>Safety>Pedestrian

- Critical Zones detection





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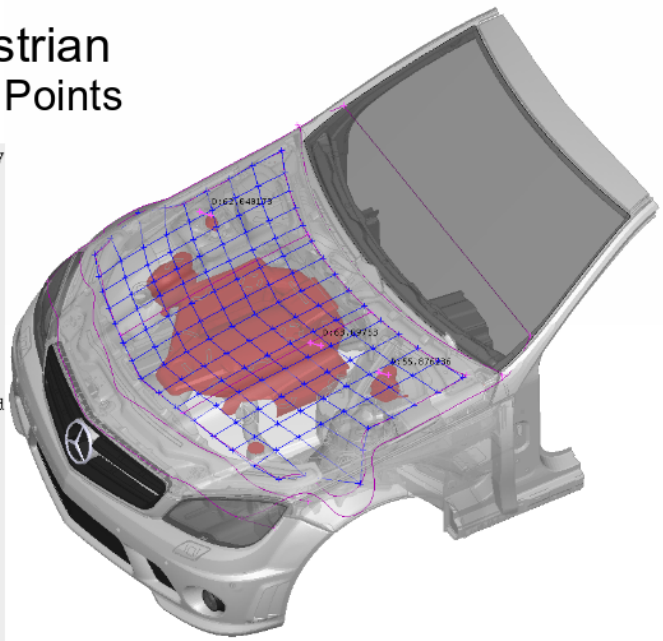
Raster & Target point creation (4)

Deck>Safety>Pedestrian

- Write File = Output Points

```
!########################Target Points created by
P1,-519.652771,-0.005974,524.406982
P2,-500.927063,-98.211700,525.190369
P3,-481.856476,-196.417435,523.781799
P4,-462.318085,-294.325714,530.430725
P5,-433.525391,-389.746399,516.151245
P6,-405.867676,-485.167084,509.087280
P7,-367.570068,-577.491882,486.475372
P8,-322.687561,-685.866577,488.635834
P9,-519.652771,-0.005974,524.406982
P10,-500.927063,-98.211700,525.190369
P11,-481.856476,-196.417435,523.781799
...
...
...
!##################Critical Target Points detected
P1,74.656128,-235.082230,622.402344
P2,218.423737,-495.510620,618.712952
P3,80.395111,601.512451,584.596375
```



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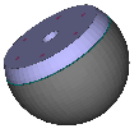
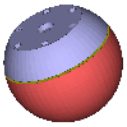
Used Impactors

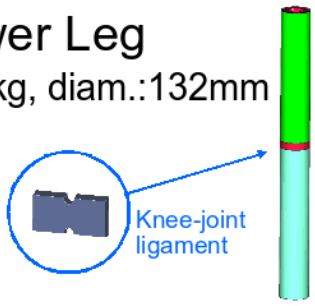
- Child/Small Adult Head
  3.5kg, diam.:165mm



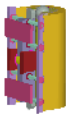
- Adult Head
  4.5kg, diam.:165mm



- Lower Leg
  13.4kg, diam.:132mm



- Upper Leg
  8.5-10.5kg variable,
  length: 350mm



FEM-Models developed by:

DAIMLER LASSO Peng GmbH PORSCHE

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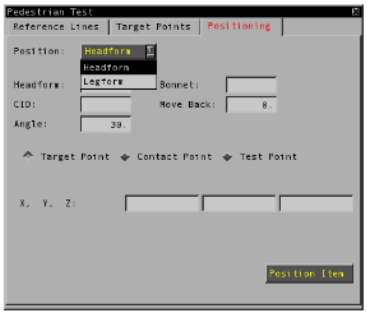
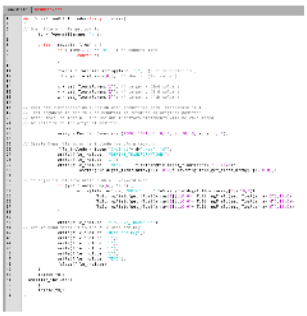
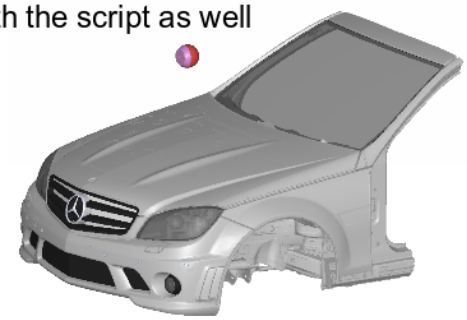
Positioning – ANSA Scripting

Deck>Safety>Pedestrian

- `PositionPedestrian()`
  - Each target point needs a solver run
  - Include files are written by the script
  - The solver could be started with the script as well







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Simulation effort

- LS-Dyna running on Linux Cluster (16cores)
- Jobs submitted by script
- Computation time Head (average): 2h
- Computation time Lower Leg (average): 3.5h
- Disk space: 1.5GB
  - 100 Head jobs + 10 LowerLeg jobs accumulated to:
    - **1 week** on two clusters
    - **170GB** disk space of results

➔ **automated Post processing needed!**

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Post processing with µETA

- Show animated 3d results interactively
- Create cut planes to see deformation of inner parts
- Extract curves from 3d and 2d result files
- Filtering results with SAE filters
- Calculation of HIC values
- Image and video creation for documentation
- Create reports in HTML or pptx formats

all handled with session files and scripts

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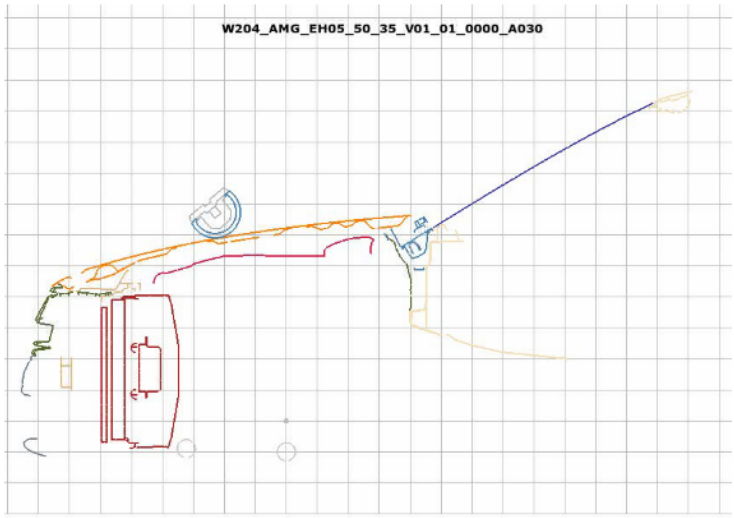
Animation of results

Head impact

- Videos

  with cut plane



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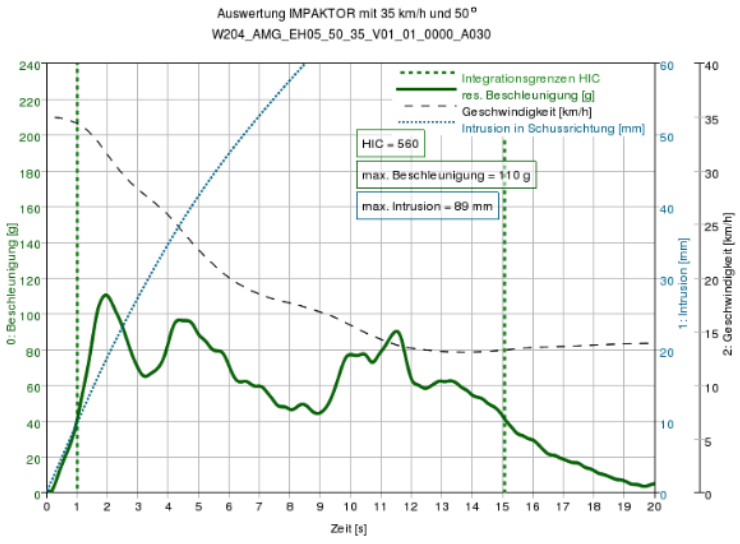
2d-plot with HIC calculation

Head impact

- `xyplot curve function hic ...`
  - acceleration(t)
  - limits of HIC int. boundaries
  - intrusion(t)
  - velocity(t)
  - max. values as annotations
  - `xyplot output file` writes a list of HIC values



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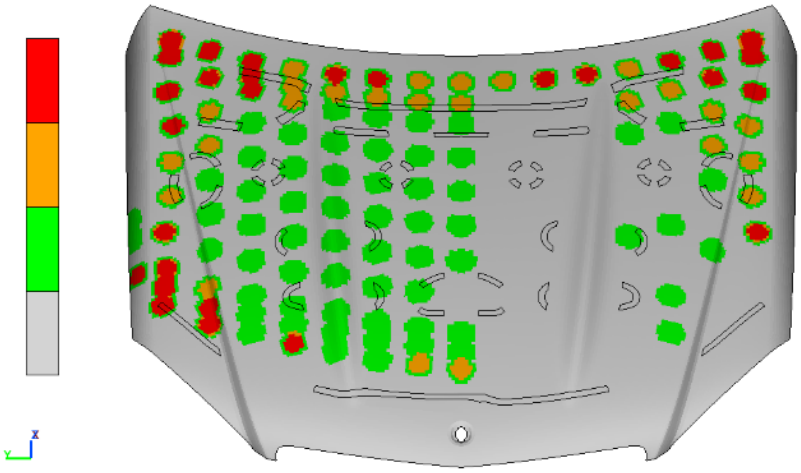
Visualized HIC checking

Head impact

- function mapping ...
  every
  HIC value
  is mapped to
  its position
  on the bonnet



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Summary

- Pedestrian Safety in brief
- EC-Regulations overview
- Simulation is needed to be effective
- Pre processing for pedestrian safety with **ANSA**
  - The whole process from **CAD data** to a “ready to run” **Input Deck** including
  - preparation of target points according to regulation requirements
- Overview of impactors
- **µETA** in post processing
  - Session file and scripting available
  - Complete interpretation and presentation capabilities for Pedestrian Safety including HIC value calculation
- Example was the AMG C63

REFERENCES

(1) ANSA version 13.0.1 User's Guide, BETA CAE Systems S.A., May 2009

(2) µETA PostProcessor version 6.3.2. User's Guide, BETA CAE Systems S.A., June 2009

(3) Official Journal EU 2004-90-EC pedestrian protection, April 2004