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innovation to product

11. LS-DYNA Forum, 9.-10. October 2012, Ulm  
**Advantage of LS-DYNA in the convertible top development**  
Matthias Rupp, in2p GmbH




20121012\_publication.pptx Folie 1

•• Target  in2p.  
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**Use of CAD and simulation tools for virtual concept validation  
of convertible tops and saving prototypes.**

20121012\_publication.pptx Folie 2

•• Content 

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- Presentation in2p GmbH
- Motivation
- History of virtual product development
- Process: convertible top development
- Textile simulation

20121012\_publication.pptx Folie 3

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**Presentation in2p GmbH**

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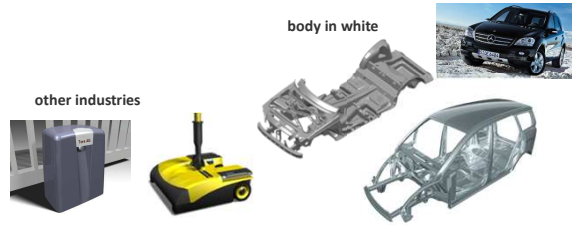
•• Development priorities of in2p GmbH




opening roof systems



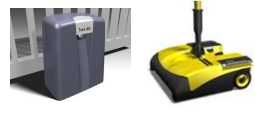
body in white



concepts and workshops





other industries




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 Motivation

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•• Motivation 

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Corny Littmann, former president of FC St. Pauli football club:  
„To find security in the insecurity - that encourages creativity.”  
source: NDR Talkshow

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Be honest: In the complex system of a roof system remains always a pinch of uncertainty in the concept development...

... which allows us to be creative.

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**History of virtual product development**

20121012\_publication.pptx Folie 8

•• History

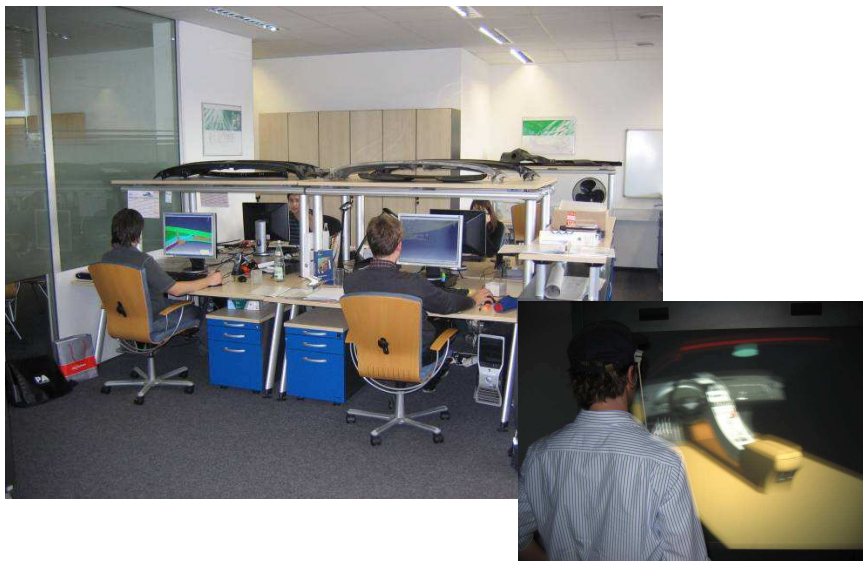


Bundesarchiv, Bild 183-22200-0882  
Foto: Wittig, T&D 19. November 1953

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Folie 9

•• History



20121012\_publication.pptx

Folie 10

•• History

20121012\_publication.pptx

Folie 11

•• History

20121012\_publication.pptx

Folie 12


••



**Process:  
convertible top development**

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•• Development steps to safe virtual prototypes



maturity

time

Styling & Specifications

Package

Kinematics

Forces

3D Model

FEM

Release

Physical Mock Up

functional integration

functional integration

geometrical integration

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•• Package

dimensional concept

R points

20121012\_publication.pptx

Folie 15

Detailed description: This slide shows a technical drawing of a package. On the left, a wireframe model is labeled 'dimensional concept'. On the right, a side-view technical drawing of a car-like package is shown with dimensions: 860, 1445, 840, 414, 903, 811, 420, 454, 212, 908, and 482. Two red boxes highlight specific points labeled 'R - Punkt'. Below the drawing is the text 'R points' and 'Eisenbahnwagen Maßstab: 1:20'. The slide footer contains '20121012\_publication.pptx' and 'Folie 15'.

•• Design of a kinematic

skeleton method

stroke kinematics

Template linkage

Template four-bar

20121012\_publication.pptx

Folie 16

Detailed description: This slide illustrates kinematic design methods. On the left, a 3D model of a car chassis is shown with a blue linkage structure, labeled 'skeleton method'. On the right, a 2D kinematic diagram is shown, labeled 'stroke kinematics'. It features a 'Template linkage' (red dashed lines) and a 'Template four-bar' (blue solid lines). A coordinate system with X, Y, and Z axes is shown. The slide footer contains '20121012\_publication.pptx' and 'Folie 16'.



•• Skeleton method

Template stratification

20121012\_publication.pptx Folie 17

•• Forces calculation with SimDesigner Enterprise

Functional integration with CATIA V5

Results:

- Forces
- Moments
- Accelerations
- required driving forces and moments

under influence of :

- Component masses
- Gravitation
- Friction

Presentation of results by Adams PostProcessor

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•• 3D modeling with CATIA V5

surface modeling

solid modeling

- parametric - associative design
- interface optimized working
- integration of templates

20121012\_publication.pptx Folie 19

•• Finite Elemente Method - Calculation

FEM CATIA V5 GPS GSA

tensions & deformations

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•• Simulation of textile behavior

20121012\_publication.pptx Folie 21

•• Development steps to safe virtual prototypes

20121012\_publication.pptx Folie 22

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**Textile simulation**

Supported by:






Federal Ministry  
of Economics  
and Technology

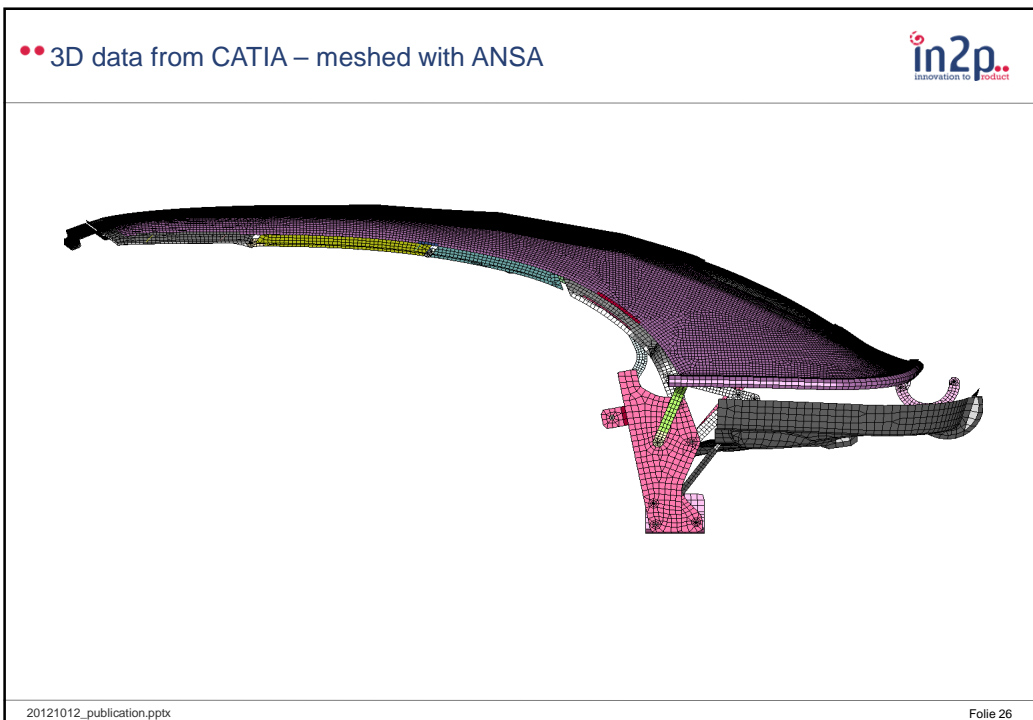
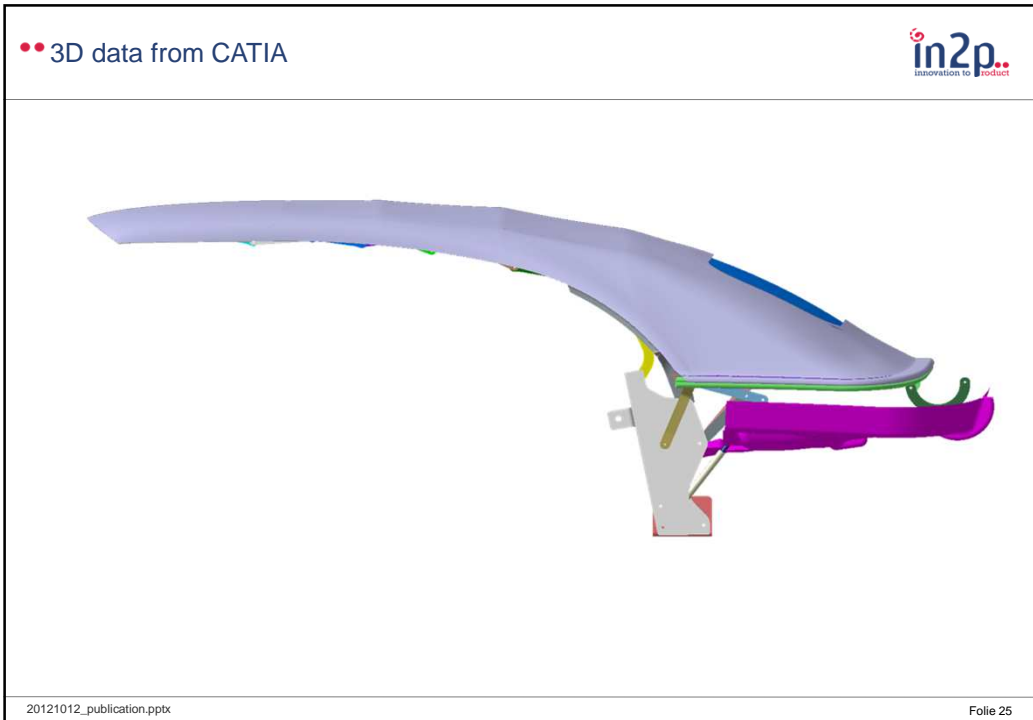
on the basis of a decision  
by the German Bundestag

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•• Textile simulation at in2p – tests



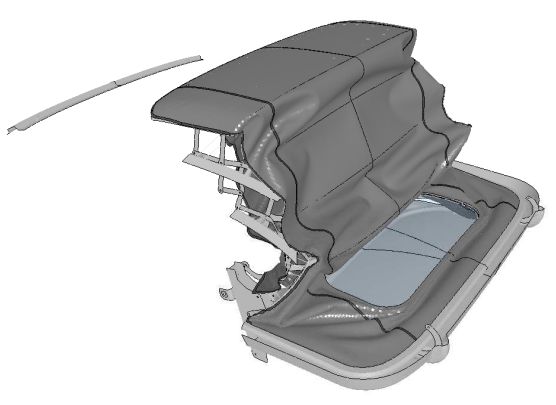
20121012\_publication.pptx Folie 24



•• simulation of convertible softtop with LS-DYNA




Simulation VS CLAVIS  
Time = 2.0926

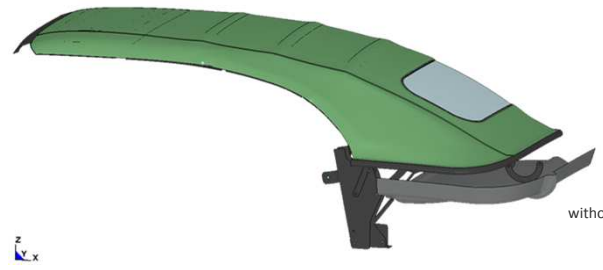


20121012\_publication.pptx Folie 27

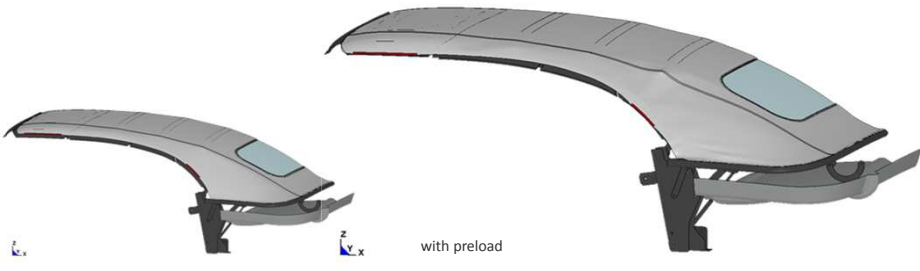
•• Consideration of textile preload



without preload




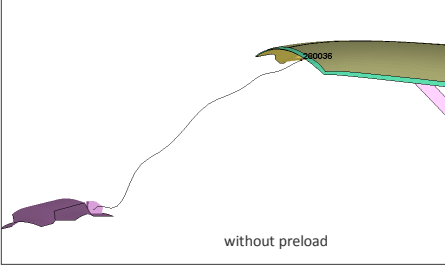
with preload



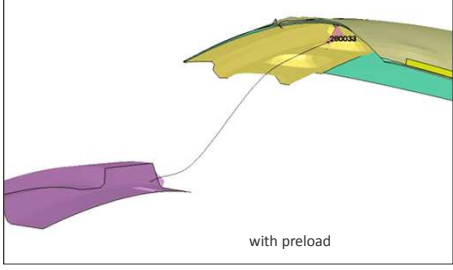
20121012\_publication.pptx Folie 28

•• Tracecurve of fixing pin






without preload

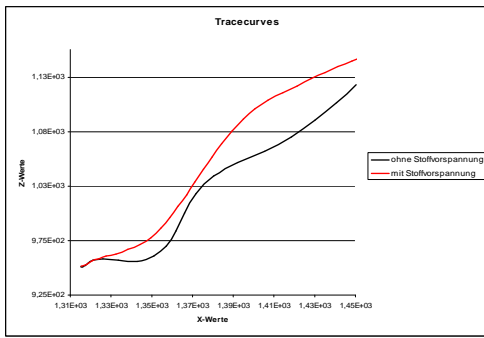


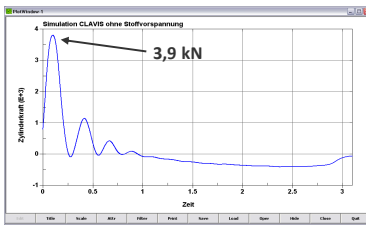
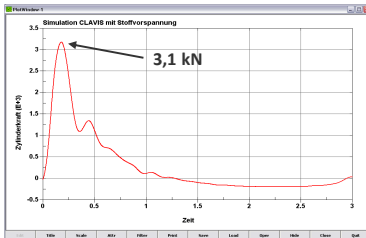
with preload

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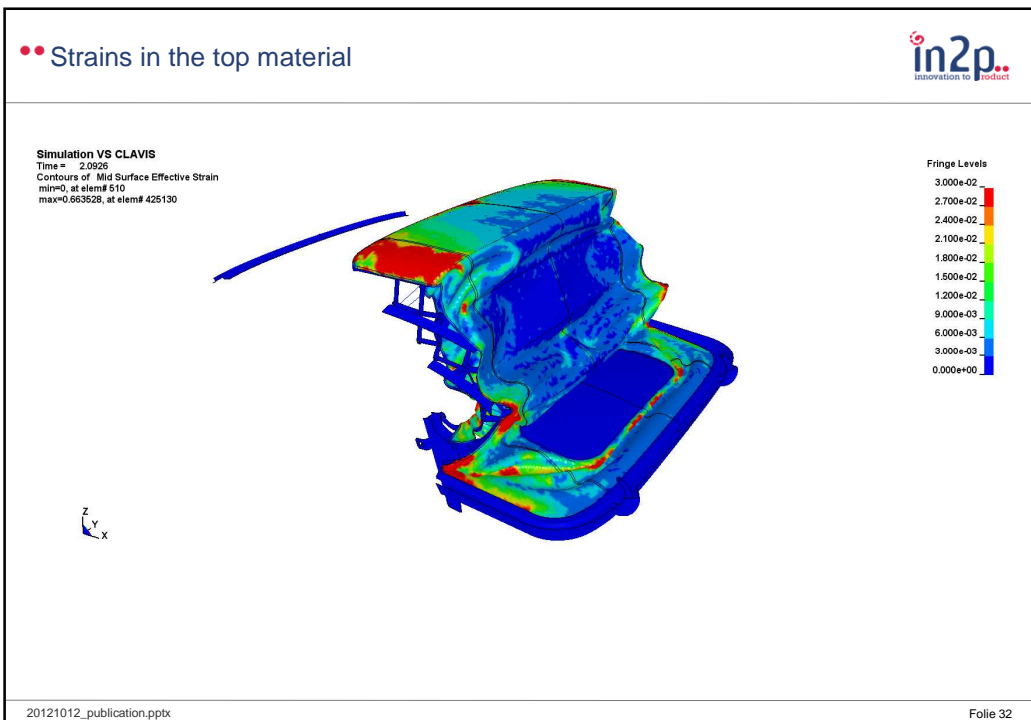
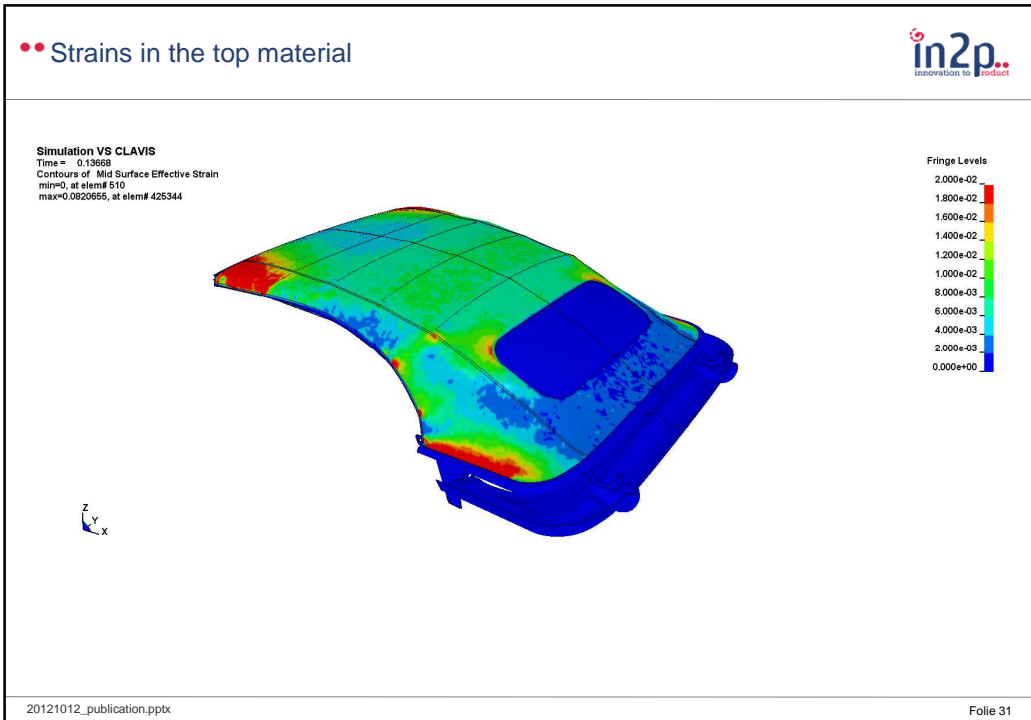
•• Tracecurve of fixing pin in conjunction with cylinder force





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•• Strains in the top material

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**Simulation VS CLAVIS**  
Time = 3.7704  
Contours of Mid Surface Effective Strain  
min=0, at elem# 610  
max=1.07368, at elem# 418195

Fringe Levels  
3.000e-02  
2.700e-02  
2.400e-02  
2.100e-02  
1.800e-02  
1.600e-02  
1.200e-02  
9.000e-03  
6.000e-03  
3.000e-03  
0.000e+00

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•• Forces in the top material

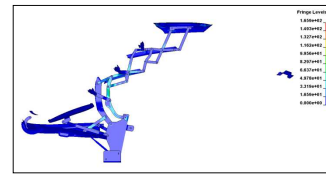
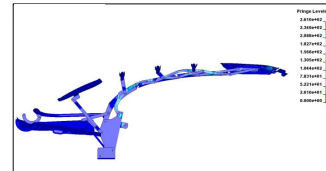
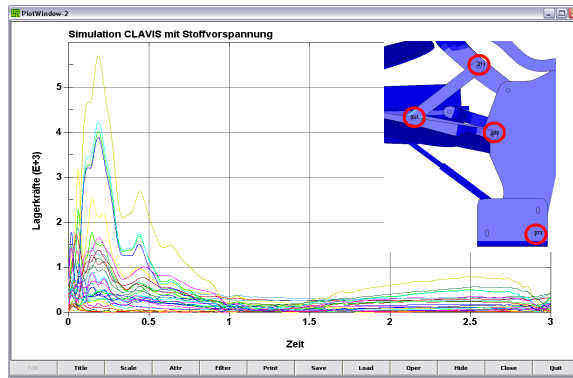
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Simulation CLAVIS mit Stoffvorspannung

Section IDI  
A\_vorne  
B\_mittig  
C\_hinten

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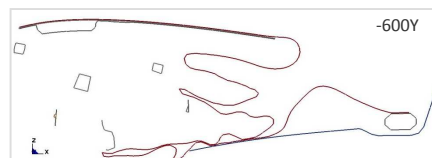
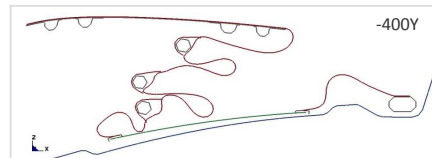
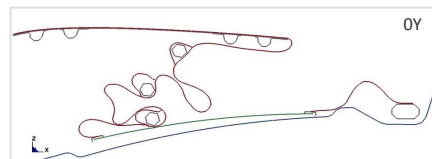
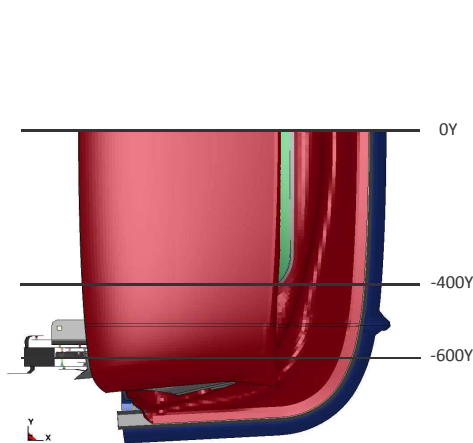
•• Tensions in convertible roof frame and bearing forces



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Folie 35

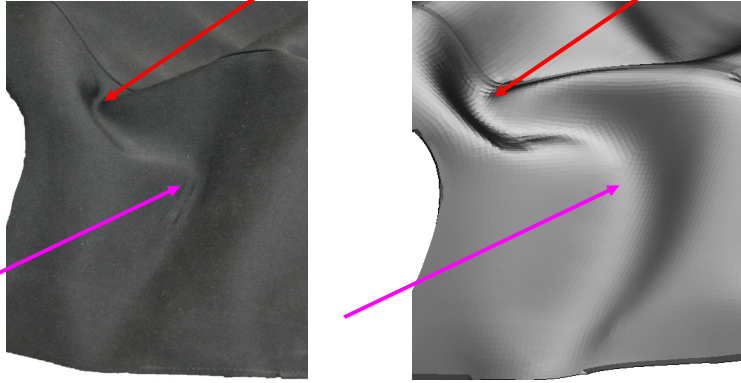
•• Sections of the convertible top in storage position



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Folie 36

•• Comparison theory – practice



The image shows two side-by-side views of a curved surface. The left view is a photograph of a physical prototype, and the right view is a grayscale simulation result. Both views show a similar curved shape with a crease. A red arrow points to the top crease in both, and a pink arrow points to a lower crease in both. The simulation result shows a smoother, more uniform curvature compared to the physical prototype.

photo prototype

result simulation

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Folie 37

•• Summary - benefits for the developer

The following points can be tested or derived by help of textile simulation:

- fabric lengths
- tension / strain
- fabric connections
- frame elasticities
- intake curves
- closing forces
- seam curves
- dimensioning ropes
- influence of the rear window
- narrow points in the storage
- straps
- pads

→ The developers is given a safe statement to functionality of their roof concepts - even before the first functional prototype is built.

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Folie 38

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Thank you for your attention.



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