Demands of Automotive Industry

New Materials (High Strength Steel)

Demands to Forming Technology

Bending and Hydroforming

BMW 5-Series Body In White with High-Strength Steel Components

High-Strength Steel
Steel
Aluminum

BMW E60, Quelle: ATZ/MTZ extra August 2003 D 58922
Alloys for the Body In White of the new 5-Series

Hybrid Body Structure
New Concepts with Profiles
Total Simulation: From Sheet to Crash

Aluminium Add-on Parts new 5 Series

Production Processes

Hybrid Body Structure
New Concepts with Profiles
Total Simulation: From Sheet to Crash

Extrusion Profile  Casting  Hydroforming  Rollforming

BMW E60, Quelle: ATZ/MTZ extra August 2003 D 58922
New Steel Body

Hybrid Body Structure
New Concepts with Profiles
Total Simulation: From Sheet to Crash

Ultra Light Steel Auto Body

Hybrid Body Structure
New Concepts with Profiles
Total Simulation: From Sheet to Crash
Demands of Automotive Industry

Atlas – Space Frame

- Hybrid Body Structure
- New Concepts with Profiles
- Total Simulation: From Sheet to Crash

Crash Simulation based on different Inputs (1)

Material properties from Tensile-Test of Sheet

Assumption: Same properties for Yield Strength, Thickness over the Part

Various properties over the Part depend on Forming - Processes and Hardening - Effects.
Crash Simulation based on different Inputs (2)

Base Mapping

Demands of Automotive Industry

Hybrid Body Structure
New Concepts with Profiles
Total Simulation: From Sheet to Crash

Mapping Data for Crash-Simulation

Increased wall-thickness

without Mapping

with Mapping
Demands to Forming Technology

Mapping Data from different Forming-Technologies

Use of Hardening-Effect
New Bending Concepts
Profile – Hydroforming
Sheet – Hydroforming

New Materials (High Strength Steel)

New Materials: Chance and Challenge

Material Properties
Reduced Formability
**New Materials: Chance and Challenge**

- **Material Properties**
- **Reduced Formability**

**Use of new Materials: Hardening - Effect via Forming Limit**

**Bending and Hydroforming**

- **Classification of Hydroforming**
  - Forming with Fluids
  - Deep drawing with Fluids
  - Hydroforming
  - Hydroforming of hollow profiles
  - Sheet Hydroforming

*Quelle: VDI Richtlinie 3146, Blatt 1, Prospekt VIA Formtec*
Bending and Hydroforming

Hydroforming: Complete Process

- Use of Hardening Effect
- New Bending Concepts
- Profile – Hydroforming
- Sheet – Hydroforming

**Hydroforming - Process**

- Tube-Forming
- Bending
- Die Closing
- Hydroforming
- Part properties

Demands to Forming Technology

Profile Hydroforming

- Use of Hardening Effect
- New Bending Concepts
- Profile – Hydroforming
- Sheet – Hydroforming

**Limitation for Hydroforming**

- Bending
  - Limited Radii
- Hydroforming with axial Feed
  - Limited Length for Expanding Area
- Hydroforming
  - Limited Circumference
- Joining
  - Alternative Joining Methods
Bending – forming limits

Use of Hardening-Effect
New Bending Concepts
Profile – Hydroforming
Sheet – Hydroforming

Tendency: Tubes for Structural Elements increase to a Ratio greater than 90. Ratio: Outer-Diameter to Wall - Thickness

Limitation of small Radii as a result of Buckling.

Bending: Forming - Limit: minimum Radius

Flexible Mandrel to provide Buckling and enlarge Forming-Limit
Bending: Forming - Limits

- Use of Hardening-Effect
- New Bending Concepts
- Profile – Hydroforming
- Sheet – Hydroforming

Measurement-Box for Normal - Forces and Friction - Forces

Limitation of big Radii as a Result of limited Tool-Size

Active Wiper Die

Hydroforming Limits restricted through Bending - Limits

- New Bending Concepts
- Profile – Hydroforming
- Sheet – Hydroforming

Bending-Line places the Cross - Sections
Bending and Hydroforming

Hydroforming Limits restricted through Bending - Limits

New Bending Concepts
Profile – Hydroforming
Sheet – Hydroforming

Positioning in Hydroforming Die – Position 1: no Cracks

Positioning in Hydroforming Die – Position 2: with Cracks
**Bending and Hydroforming**

**ED_BE 25**

**Bending – 3 Rollers Bending**

- New Bending Concepts
- Profile – Hydroforming
- Sheet – Hydroforming

- Positioning X
- Positioning Y
- Collision with Roll 1
- Collision with Roll 2
- Bending Roll
- Bending Radii

**Hydroforming – restricted Design of Radii**

- New Bending Concepts
- Profile – Hydroforming
- Sheet – Hydroforming

- Internal pressure to form out inner radii

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**Tendency:** High – Strength Steel raises the internal Pressure
Bending and Hydroforming

Sheet Hydroforming

New Bending Concepts
Profile – Hydroforming
Sheet – Hydroforming

Required local Pressure over the whole Part

Required Pressure: 400 bar
Required Pressure: 150 bar

Tendency: Big Sheets increases Clamping Force and Cycle Time
Future Methods to focus the Pressure

Classification of Incremental Hydroforming

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### Classification of incremental Hydroforming

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### Pulse Hydroforming – Pressure Distribution

Pressure build up after Unload of a Condenser