The Next Generation Bumper Technology and
The P-Tech Process

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Pullman Industries Inc.
Company Overview
- Vision and Quality policy
- Locations
- Customers
- Products General

P-Tech
- Process
- Applications

Next Generation Bumpers
- Objective
- Bumper Technology
  - Packaging
  - Mass
  - Crash Performance
  - Benchmarking
  - Damageability
  - Costs
  - Investment

Q/A
Vision and Quality Policy

Pullman

Our vision is to be the worldwide supplier of choice for the development and production of roll-formed systems and related components for the automotive industry.

We are committed to continuous improvement, zero defects and internal / external customer satisfaction

EVERY TIME, ON TIME, WITH EVERYTHING WE DO
Locations and Strategic Alliances

North America
- Pullman
  - Butler, IN
  - South Haven, MI (2)
  - Spring Lake, MI
- Troy Corporate Center
  - Troy, MI
- Linde+Pullman JV
  - Querétaro, Mexico
  - Puebla, Mexico

Europe
- Linde+Wiemann Alliance
  - Dillenburg, Germany
  - Ingelstadt, Germany
  - Elstra, Germany
  - Südbrookmerland, Germany
  - La Garriga, Spain
  - Lysá nad Labem, Czech Republic

Asia-Pacific
- Asteer Co, Ltd.
  - Okayama, Japan
- Pullman
  - Hiroshima, Japan
**Products**

**Impact Systems**
- Bumpers
- Rocker Reinforcements
- A/B – Pillar Reinforcements
- Side Impact Beams

**Structural Systems**
- Load Floors
- Windshield Headers
- Roof Bows
- Door Tracks
- Door Sashes/Frames

**Trim Systems**
- Seal Retainers
- Glass Channels
P-tech® is a new technology applied to roll formed products, expanding the applicability of Ultra High Strength Steel (UHSS).

- Bypasses typical manufacturing issues of forming UHSS
- Reduces piece to piece variability
- Lower cost
- Reduces weight
- Lower tooling investment
- Shares tools across family of products
- Design flexibility
Pullman Industries tubular steel hot-forming process introduced on 2005 Ford Mustang

1. Tubular blank is roll formed using 450 Mpa Boron steel

2. Tubular blank is heated to 1700°F for maximum formability

3. Hot blank is formed then quenched inside press

Result

Tensile: ~1500 Mpa
True Plastic Strain: 25-40%
P-Tech Process
P-Tech® Safety Cage
Porsche Boxter

Safety Cage
Thickness: Varied
Length: Varied
Weight: 14 kg (assembly)
P-Tech® Roof Bow

General
- Roll-forming can provide multiple parts with unique sweeps and lengths when a common section is maintained
- Very thin walls achievable
  - Lower mass by up to 30%
- One piece closed sections
  - Increased structural stiffness
  - Lower cost

Center Roof Bow
- Thickness: 0.5 mm
- Length: 1000 mm
- Weight: 0.8 kg
P-Tech® Front Header

General
- Can provide UHSS in compound multi dimensional sweeps
- Very thin walls achievable
  - Lower mass by up to 30%
- One piece closed sections
  - Increased structural stiffness
  - Lower cost
P-Tech® A Pillar

General
Highly swept UHSS bumpers
Detailed and variable cross sections tune product for maximum efficiency
30% weight savings over traditional UHSS B sections approach weights of aluminum beams

**Bumpers**
- Thickness: 1.28 mm
- Length: 1100/1405 mm
- Weight: 4.5/5.9 kg

**P-Tech® Bumper**
Ford Mustang

[Image of a car undercarriage showing a P-Tech® bumper]
Next Generation Bumper

Cost
- One Piece Design
- Reduced Material Usage
- Reduction/Elimination of EA

Package
- Shorter Overhang
- Improved Cooling
- Compound Sweep

Investment
- Commonization Plan

Damageability
- Lower Replacement Cost

Crash
- Low Speed
- High Speed

Mass
- Closed Section
- Integrated Crush Can
- High Sweep
- UHSS
Objective

Develop the Next Generation Bumper energy management system that takes advantage of the latest metal forming technology to deliver the following attribute improvements:

• **Reduce variable cost and weight** of the bumper system and surrounding components.

• **Produce bumpers of varying sweeps, thicknesses and strength off common/partially common tools.**

• **More efficient high speed and low speed crash performance enabling reduction of overhangs and/or improved crash performance.**

• **Provide Geometry that enhances engine cooling module air flow.**

• **Reduced damage in low speed impact, easy to repair, lower replacement cost.**
Next Generation Bumper

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**Mass**
- Closed Section
- Integrated Crush Can
- High Sweep
- UHSS
Mass

- Light-weight Ultra High Strength Boron steel
- Closed section with improved geometry and integrated crush cans
- 2-10 lbs weight savings per vehicle compared to roll formed martensite beams (Styling and vehicle weight dependent)
High yield and tensile strength together with relatively high ductility enables high energy absorption resulting in low weight.
Next Generation Bumper

**ADVANTAGES**

**Cost**
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- Compound Sweep

**Investment**
- Commonization Plan

**Damageability**
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**www.autosteel.org**
Next Generation Bumper

**Package**

- The new manufacturing process enables new geometry that enables optimal packaging for enhanced engine cooling airflow.
- The improved geometry, material, higher sweep, and more efficient crash pulse in both high speed and low speed crash impacts enables Shorter Overhangs and Styling Flexibility.

**The new geometry allows the beam to follow the sweep of the fascia, reducing or eliminating foam isolators**
**Next Generation Bumper**

**Package**

- Accommodates package space @ Y-0 of 40 to 400 mm (mounting bracket may be needed)
- Capable of delivering section depths from 40 to 100 mm and beyond
- **Compound sweep** capability
- Non-constant closed cross-section
- Replacement applications require **minimal upset** to existing system surroundings
- Ability to accommodate “square-to-grid” AND angled rail mounting

![Diagram of package](image)

1800mm min sweep radius—improbable with traditional M190-M220 material

Sweep can be made parallel to corner impacts for improved performance and damageability

**Square-to-grid rail mounting**

**Angled rail mounting**
Next Generation Bumper

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The breakthrough forming technology enables improved geometry including the addition of integral crush cans and of crash “triggers”

A more efficient square wave (65% vs. 40% efficient) achievable in high and low speed impacts

Crash Performance

P-Tech Next Generation Bumper vs M190 roll formed B-Section +EA. 5mph barrier impact
Next Generation Bumper

Crash Performance

P-Tech: 39% Improvement of energy absorption
P-Tech: 38% Improvement of Bumper System Mass

Quasi Static compression – 40% offset barrier. Rigid fixture. P-Tech Next Generation Bumper System vs Hot Stamped (martensite) + EA
Crash Performance

P-Tech: 50% Improvement of energy absorption
P-Tech: 38% Improvement of Bumper System Mass

Quasi Static compression – full flat barrier. Rigid fixture. P-Tech Next Generation Bumper System vs Hot Stamped (martensite) + EA
Next Generation Bumper

Crash Performance

5mph Flat Barrier Impact

- P-Tech: 22% Improvement of Intrusion
- P-Tech: 21% Improvement of Bumper System Mass

P-Tech Next Generation Bumper + EA vs M190 roll formed B-Section +EA.
Next Generation Bumper

Crash Performance

5 mph Rigid Pole Impact

P-Tech: 43% Improvement of Bumper System Mass

P-Tech Next Generation Bumper vs RA140 open section roll formed bumper system

www.autosteel.org
Next Generation Bumper

Crash Performance

6.5mph Curve Barrier Impact

P-Tech “green” GVW=1.982 ton: Bumper System Mass normalized 1.0
Car A “blue” GVW=1.943 ton: Bumper System Weight factor of 2.2
Car B “red” GVW=1.982 ton: Bumper System Weight factor of 1.3
Car C “pink” GVW=1.896 ton: Bumper System Weight factor of 1.5

P-Tech Next Generation Bumper vs bumper systems of three different but similar vehicles
Next Generation Bumper

**Advantages**

- **Cost**
  - One Piece Design
  - Reduced Material Usage
  - Reduction/Elimination of EA

- **Package**
  - Shorter Overhang
  - Improved Cooling

- **Investment**
  - Commonization Plan

- **Crash**
  - Low Speed
  - High Speed

- **Damageability**
  - Lower Replacement Cost

- **Mass**
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  - High Sweep
  - UHSS
## Next Generation Bumper

### Damageability

- More Efficient Energy Management
- Less Damage to Surrounding Components
- Lower Bumper Replacement Costs

### Load Case

<table>
<thead>
<tr>
<th>Load Case</th>
<th>Next Generation Bumper* (as tested)</th>
<th>Typical B-section with EPP foam 3750 lbs test weight</th>
<th>Improvement %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrier (mm)</td>
<td>56</td>
<td>84</td>
<td>33</td>
</tr>
<tr>
<td>OTBD Pendulum</td>
<td>59</td>
<td>90</td>
<td>34</td>
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<tr>
<td>Cntr Pendulum</td>
<td>62</td>
<td>86</td>
<td>28</td>
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<tr>
<td>Corner</td>
<td>46</td>
<td>55-75</td>
<td>11</td>
</tr>
<tr>
<td>RR Pole (FEA)</td>
<td>93</td>
<td>113</td>
<td>17</td>
</tr>
<tr>
<td><strong>System Weight (lbs)</strong> (Brkts,Isolators,Beam)</td>
<td><strong>13.8</strong></td>
<td><strong>17.9</strong></td>
<td><strong>22</strong></td>
</tr>
</tbody>
</table>

*SAE cart and 25 mm EPP foam used @ Defiance Test Labs.

Ford Mustang Prototype testing
Next Generation Bumper

**ADVANTAGES**

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- **Damageability**
  - Lower Replacement Cost

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  - High Speed

- **Mass**
  - Closed Section Integrated Crush Can
  - High Sweep UHSS
Cost

- **One Piece Design**
- Manufactured from **low cost boron steel**
- More efficient energy absorption enables shorter overhangs, meaning **less material required for fascias**.
- Capable of managing 5 mph loads **without the addition of a bumper isolator**. (A “firm feel” plastic piece may be required)
- Beam geometry provides for improved airflow. This may enable **downsizing of TASE components**.
- Cost of the new beam will be $12-18 per side vs. $15-21
- Typical costs of a firm feel device will be $0-6 vs. $6-9 for a bumper energy absorber.
- **Typical savings per vehicle will be $6.00-20.00.**
Next Generation Bumper

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- **Investment**
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- **Crash**
  - Low Speed
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- **Damageability**
  - Lower Replacement Cost

- **Mass**
  - Closed Section
  - Integrated Crush Can
  - High Sweep
  - UHSS
**Investment**

- Significant reduction in tooling cost by using common roll tooling with multiple form fixtures
- Process robust enough to handle +/- 15% gage changes (minor tooling modifications may be required)
- Both significant change (0-45) in sweep and shape can be accommodated during fixture form operation
- Beams can be cut to any practical length

**Carryover**

**Modified**
Next Generation Bumper

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Advantages