KUKA Systems Corporation, North America
Design for Laser Welding

Energy  Production  Logistics  Automotive

Aerospace  Assembly & Test  Technology
LASER – Continuous Development


Roof-seam laser-welding
Volvo

Roof-brazing
Seat

Laser-brazing bodyside
Daimler

Bodyside
BMW Cabrio

Doors VW Golf
worldwide

Applications

TOTAL INSTALLED BASE: 269 Systems
Thin Gage Joint Sections – Gap & Location Tolerance

Part & Tooling Tolerance
Laser, MIG/MAG, Plasma, TIG, Hybrid Processes

Process Head position Y & Z Axis
Part Relationship to one another
Part Position
Joint Gap

Butt

Over Lap & Edge Fillet
With & without cold wire feed

Edge Fillet with Formed Step
With cold wire feed

Edge Welding
With & without cold wire feed

Coach Joint
With & without cold wire feed

½ Coach Joint
With & without cold wire feed

Fillet

Part Relationship to one another
Part Position
Joint Gap

Thin Gage Joint Sections

Over Lap & Edge Fillet
With & without cold wire feed

Edge Fillet with Formed Step
With cold wire feed

Edge Welding
With & without cold wire feed

Coach Joint
With & without cold wire feed

½ Coach Joint
With & without cold wire feed

Fillet
## System Configuration for Various Parts and Processes

<table>
<thead>
<tr>
<th>Joining Technology</th>
<th>Sheet/Sheet</th>
<th>Sheet to Extrusion/Hydroform</th>
<th>Extrusion/Hydroform</th>
<th>Sheet to Hot/Cold Rolled</th>
<th>Sheet to Hot/Cold Rolled</th>
<th>Hot/Cold Rolled to Forgings</th>
<th>Yoke Joints Forgings</th>
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<td>1 MIG</td>
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<td>Unibody = MC</td>
<td>Extrusion = EX</td>
<td>Hydroform = IHU</td>
<td>Forgings = GK</td>
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<td>19 SF with GK</td>
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<tr>
<td>20 SF with EX or IHU</td>
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<tr>
<td>Preference</td>
<td>++ better</td>
<td>+ good</td>
<td>0 fair</td>
<td>- not good</td>
<td>-- bad</td>
<td>** sometimes</td>
<td>* * * * often</td>
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<tr>
<td>Process Speed</td>
<td>very slow</td>
<td>very fast</td>
<td>very fast</td>
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<td>Gap &amp; Location tolerance</td>
<td>close</td>
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<td>very forgiving</td>
<td>very forgiving</td>
<td>very forgiving</td>
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<td>very forgiving</td>
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</table>

Use the Process for the required joint
Technical Requirements of Function Package

**Functional Requirements**

- gap-free clamping in the joining zone
- constant focus position

**System Requirements**

- pressure wheel, pressure finger
- pressure wheel and backup wheel
  - lateral correction stylus
  - seam tracking sensor
  - force balancing system
  - force application system
  - hot/cold wire feeder
  - hybrid welding technology

KUKA system heads for various weld types and joint forms

Weld Types and Joint Forms
Laser Stitch Welding Vs Resistance Spot Welding

- One side access
  Each weld exhibits higher mechanical properties

- Higher structural performance resulting in reduction in weld content, reinforcement count, or gage thickness

- Smaller flanges (weight reduction - increasing of accessibility)

- Constant welding quality (no electrode degradation)

- Higher flexibility in product design
Advantages – Product for Laser

Case Study

Bodyside
0.8 mm

Inner Reinforcement
1.2 mm

Close Out
2 mm

Flange Unsuitable for 5 Star Safety

“A” Pillar

www.nhtsa.dot.gov
people saving people
Advantages – Product for Laser

Flange Exceeded HIC Value
(Head Impact Criteria)
Advantages – Product for Laser

No Modification

- Standard Production Trim

5 Star Alternative Solution

- Extended Trim With Foam and Metal Strip

Laser Modification

- Reduced Interior Trim
Advantages – Product for Laser

- **Traditional Resistance Spot Weld**
  - Inner Reinforcement: 1.2 mm
  - Bodyside: 0.8 mm
  - Close Out: 2 mm

- **Laser Modifications**
  - Inner Reinforcement: 1.5 mm
  - Darts (Stamped)
  - Bodyside: 0.8 mm
  - Close Out: 1.2 mm
Advantages – Product for Laser

- Build Sequence
  - Resistance Spot Weld
  - Traditional
Advantages – Product for Laser

*Single – Sided Roller*

*Hollow Section Closeout*

- Laser Modifications
  Build Sequence
Advantages – Product for Laser

Preliminary Test

Feasibility Studies
Advantages – Product for Laser

- Standard Fixturing to Reduce Process Variables
- Introduced New Stampings, Pins & Locators into Existing Production Assembly Tools
- Assembled 40 New Bodysides on Weekend Shutdown
Advantages – Product for Laser

- Same P.L.P.’s (Primary Location Points) as in Resistance Spot Weld

New Fixture
Advantages – Product for Laser

Backup Plan - Fusion Welding

Weld Teardown
Advantages – Product for Laser

<table>
<thead>
<tr>
<th>Challenges / Requirements</th>
<th>Solutions</th>
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</thead>
<tbody>
<tr>
<td>▪ Eliminate Flange – Produce Hollow Section</td>
<td>✓ Laser with Single Sided Roller</td>
</tr>
<tr>
<td>▪ Maintain Stiffness/Roll-over Crush Specifications &amp; Other Safety Requirements</td>
<td>✓ Redesign &amp; Redistribute Parts Gauges</td>
</tr>
<tr>
<td>▪ Maintain or Improve “A” Pillar Dimensional Control with Standard Fixture Build</td>
<td>✓ Proved Standard PLP Designs are Adequate for Process - Deflection 0.1mm</td>
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<tr>
<td>▪ Close 2 to 3mm Standard Gap Tolerance</td>
<td>✓ Apply 4 to 6mm Gap to Prove that the Process is Robust</td>
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<tr>
<td>▪ Process Assembly in One Station Without Heat Distortion</td>
<td>✓ Overlay Thin to Thick With Stamped-in Structural Characters (Darts) for Stiffness</td>
</tr>
<tr>
<td>▪ Provide Valid Business Case</td>
<td>✓ Produced 10 – 25mm Stitches in 12 Seconds With No Distortion and No Stagger Welding Requirements – Deflection 0.1mm</td>
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</table>
Advantages – Product for Laser

Case Summary & Achievements

- Achieved 5 Star Rating by Eliminating Critical Flange
- Improved Driving Visibility (Binocular Vision) by Reducing Overall Cross Section
- Eliminated 2.1 lbs. of Weight by Eliminating Flanges
- Reduced Overall Vehicle Cost with a 2 Year Pay Back vs. $2.00 per Vehicle Trim Charge
- Improved Passenger Comfort Headroom – Egress by bringing in Trim Panels Closer to the New Cross Section
Bodyside Design

Section above Front Door  
Section thru A-Pillar
Beam & Roller Relative Position
Robot Simulation
A TRADITION OF EXCELLENCE

Thank You!