Progressive Laser Cutting

Brandon Reinhold
Comau LLC
Agenda

1. Comau Introduction
   • History
   • Facts and Figures

2. Comau Laser Solutions
   • Laser Experience & Capabilities
   • Solutions Provided Since 1985
   • Metallurgy Lab Capabilities

3. Progressive Laser Cutting
   • Objective / Test Equipment
   • Test Outline
   • Test Summary

4. Conclusions
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1973
Several companies in the Turin area create Consortio Macchine Utensili

1977
Establishment of Comau Industriale with powertrain and body (welding, assembly and handling) divisions

1978
Comau S.p.A. is established incorporating Comau Industriale activities

1979
Comau Poland is established

1995 - 97
Comau opens plants and offices in Germany, Brazil, Argentina, France and India

1998
Establishment of Comau Service

1999
Comau acquires Renault Automation in France and Pico in USA, Mexico, Germany and UK

2000 - 03
Comau China, Romania and Russia are established

2009
Establishment of Comau Aerospace

2010
Establishment of Comau Adaptive Solutions and eComau

2013
Comau China in expansion: 3 new sites Kunshan, Shanghai, Dalian

2014
Comau Czech and Turkey are established

2015
Comau Thailand is established
Comau São Paulo (BR) is established

2016
The Humanufacturing Innovation Centre in Pisa is opened
Comau opens an office in Palo Alto, California
A History Rooted in Excellence a Future Driven by Innovation

Comau specializes in producing advanced industrial automation solutions that integrate products, technologies and services to help companies of all sizes increase plant efficiency while lowering operating costs and optimizing returns.

Comau’s competency stems from over 40 years of field-proven experience and a strong presence within every major industrial country.
Our Competencies

- Spot, Laser & Arc-welding
- Sealing, Drilling & Riveting
- Machining, Assembly & Test
- Monitoring & Control
- Handling & Logistics

- Maintenance Services
- Consultancy in Manufacturing Process
- Project Management
- Training & Education
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4. Conclusions
• Comau has been involved in laser applications since 1985
• Currently there are hundreds of Comau laser installations in production
• One global team with experienced senior engineers in USA, Europe, Argentina, and China
• Three fully functional laser laboratories in USA, Italy and China for testing and prototyping
Comau Laser Experience & Capabilities

Customers

Applications

- Remote Laser Welding
- Roof Laser Brazing
- Liftgate Laser Brazing
- Roof Laser Welding
- Underbody Laser Welding
- Laser Cutting

Partners
Laser End Effectors Installed Since 2012

Laser Welding

Laser Brazing

Laser Cutting

= 1 End Effector
Comau Laser Experience

Global Program

Application

- Front & Rear Doors Remote Laser Welding
- Tailgate Laser Brazing
- Front-end Laser Cutting

<table>
<thead>
<tr>
<th>Plant</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melfi, Italy</td>
<td>54 s</td>
</tr>
<tr>
<td>Pernambuco, Brazil</td>
<td>68 s</td>
</tr>
<tr>
<td>Quanzhou, China</td>
<td>68 s</td>
</tr>
</tbody>
</table>
Comau Metallurgy Lab Capabilities

Metallurgy Laboratory
• Sectioning
• Mounting
• Grinding/Polishing
• Material Etching
• Microscope Image Analysis
• Hardness Testing
• Tensile/Fatigue/Strength Testing
• 3D Scanning
• XRF Spectrometry

Offerings
• Training
• Welding Inspection (AWS/CWI Personnel)
• Image Analysis and Measurement
• Material Analysis and Identification
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### Test Objective
Develop a laser cutting process that can cut holes and shapes without creating a slug.

### Equipment
<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robot</td>
<td>Fanuc M20iB 25</td>
</tr>
<tr>
<td>Laser</td>
<td>YLS-6000-S2</td>
</tr>
<tr>
<td>Fiber</td>
<td>300 micron</td>
</tr>
<tr>
<td>Cutting Head</td>
<td>LaserMech FiberCut</td>
</tr>
<tr>
<td>Focus</td>
<td>125</td>
</tr>
<tr>
<td>Collimation</td>
<td>100</td>
</tr>
<tr>
<td>Process Gas</td>
<td>Shop Air 200 psi</td>
</tr>
<tr>
<td>Stand Off</td>
<td>.75mm</td>
</tr>
</tbody>
</table>

### Test Location
IPG Photonics Midwest Operations
46695 Magellan Dr., Novi, MI 48377
Test Objective
Develop a laser cutting process that can cut holes and shapes without creating a slug.

<table>
<thead>
<tr>
<th>Pass #</th>
<th>Hole Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.750 mm</td>
</tr>
<tr>
<td>2</td>
<td>3.125 mm</td>
</tr>
<tr>
<td>3</td>
<td>4.500 mm</td>
</tr>
<tr>
<td>4</td>
<td>5.875 mm</td>
</tr>
<tr>
<td>5</td>
<td>7.300 mm</td>
</tr>
</tbody>
</table>

Robot Path Target
- Target: 7.675 mm
- Kerf: 0.375 mm
- Robot Path: 7.30 mm

Target Hole Size
- Min: 7.60 mm
- Max: 7.75 mm
- Target: 7.675 mm
Progressive Laser Hole Cutting
Progressive Laser Hole Cutting
Test Summary

The trial achieved good results with an acceptable cleanliness of the parts after cutting (expelled material left from the cutting process), while also meeting the customer’s cycle time requirements. The actual cut time was roughly 5.0 seconds for all 5 cuts, however we need to add in head time and robot move time. The suggested budgeted process cycle time for this process is 6.0 seconds for a 7.675mm hole and 8.25 seconds for a 10.0mm hole in aluminum material.
Thank you!