Application of Inertia Friction Welding to Formula SAE Manufacturing

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Motivation
- Formula Buckeyes is a student managed organization that designs, builds and races a Formula-1 inspired racecar in international collegiate competitions
- Pivot post – An integral component of the pushrod suspension system
- Deflection of the part results in poor vehicle response and possible catastrophic failure
- Previously machined from billet titanium; required roughly 20 hours per part and wasted 90% of the material
- Goal - Reduce the time and money spent on pivot post production to better utilize team resources

Objectives
- Develop parameters to successfully join diameters of 1” to 2” Titanium Grade 5
- Ensure strength of the inertia welded component satisfies design requirements
- Produce a near net shape part, reducing cost of pivot post by decreasing material waste and machining time

Process
- Inertia Friction Welding – Heat generated via friction of a spinning workpiece and a stationary component, with the addition of an axial “upset” force to plastically displace and bond the materials
- Highly repeatable process with minimal variables ideal for production
- Adjustments were made based on established relationships between force, rotational speed and flywheel mass

Weld Data and Visual Findings
- Load: 700psi, Upset: 0.264in
- Load: 500psi, Upset: 0.161in
- Load: 300psi, Upset: 0.127in

Results
- Machining: previous method material (blue), inertia welded near net shape material (red) and final part (gray)

Conclusions
- Inertia welding was successfully used to create a near net shape pivot post
- The parameters to make repeatable welds were found and samples passed mechanical testing successfully
- Machining time reduced by 75%
- In terms of material and production costs, the price per pivot post was reduced by $995
- Project netted a total savings of $3980

Production Analysis

<table>
<thead>
<tr>
<th></th>
<th>Production Cost</th>
<th>Material Cost</th>
<th>Hours</th>
<th>Total Cost</th>
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<tbody>
<tr>
<td>Machining</td>
<td>$1,200</td>
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<td>20</td>
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<tr>
<td>Inertia</td>
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<td>Per Part Savings</td>
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<td>Vehicle Savings</td>
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