Introduction
• We designed and fabricated new microforceps to be used with the Galen surgical robot.
• This included creating and prototyping multiple designs prior to our final design.
• While it is fairly easy to adapt already existing tools for use with the Galen, these may not make the best use out of the surgical platform.

Outcomes and Results
• The plastic prototype of the new tool is easy to actuate and use.
• The new instrument integrates with the Galen and is able to be controlled while attached to the robot.
• Apparent workspace is increased, as the shorter shaft below the robot means small angle changes at the tool tip require less movement of the robot arm.

The Problem
• When modifying already existing forceps for use with the Galen, the user ends up holding the tool below the robot attachment point.
• This leads to the surgeon running into workspace limits.
• It also results less fine control, as small changes in angle at the tool tip would necessitate large movements of the robot arm.

The Solution
• Design new microvascular forceps that allows them to be held by the surgeon above the robot attachment point.
• We took apart existing forceps and cannibalized the jaws and inner sliding rod mechanism.
• We studied existing forceps and evaluated designs for applicability in our situation.
• We created, prototyped, and tested five different gripper and actuator designs before settling on a final, improved design.
• The latest design is now being fabricated out of a stainless steel and bronze composite metal.

Future Work
• The stainless steel and bronze composite metal prototype will arrive and be assembled in a week.
• Olivia will be conducting a user study using this instrument to quantify the benefits of using the Galen robot in microvascular anastomosis.

Lessons Learned
• Establish requirements of final product very clearly right from the beginning.
• It is okay and sometimes even preferred for the initial design and final product to be very different.
• Order parts and book training well ahead of time.
• Engineering and medical mentors may not agree with each other.

Support by and Acknowledgements
• Core NSF CISST/ERC; Galen Robotics
• Thank you to Dr. Russell Taylor for being an incredible mentor!

<table>
<thead>
<tr>
<th>Feature</th>
<th>S.No</th>
<th>Feature</th>
<th>Characteristics of good microsurgical instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylindrical/Semi-cylindrical shape</td>
<td>1.</td>
<td>5-10 mm diameter of handle</td>
<td>4.</td>
</tr>
<tr>
<td>Milled for friction</td>
<td>2.</td>
<td>40-100 gm opening/closing force</td>
<td>5.</td>
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<tr>
<td>The length of the handle from where it is gripped to the top end must be around 10 cm</td>
<td>3.</td>
<td>3:1 - 6:1 mechanical advantage</td>
<td>6.</td>
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<tr>
<td>Grip span no more than 3 inch when fully open</td>
<td>7.</td>
<td>Grip span no less than 1 inch when fully closed</td>
<td>8.</td>
</tr>
<tr>
<td>Grip span does not rest inside of palm</td>
<td>9.</td>
<td>Handle does not rest inside of palm</td>
<td>10.</td>
</tr>
</tbody>
</table>

Table 1. Requirements for a microsurgical forceps

Table 2. Characteristics of good microsurgical instruments