Catheter Tube Assembly Process

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The Problem

Design a device to streamline the assembly process of the tube, TBV valve, and three-way valve.

Previous Concerns:
- Operators at multiple stations required for assembly
- Repetitive motion injuries experienced by operators
- Incomplete assembly leads to product waste and loss of money

Preliminary Testing

Buckle Point

Incomplete Assembly

Complete Assembly

Conclusions:
- The tube cannot overhang more than 12mm
- Primer must be applied to the inside of the tube

Development of Prototype

Test 1: 2 Hand Tie-downs and 2 E-stops
Test 2: Out of 30 samples, 25 were successful
Test 3: Cost of prototype
Test 4: Used stopwatch to determine average cycle time and setup time

Concept Validation

<table>
<thead>
<tr>
<th>Test</th>
<th>Metric</th>
<th>Target Value</th>
<th>Actual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Safety Precautions</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Success Rate</td>
<td>98%</td>
<td>83%</td>
</tr>
<tr>
<td>3</td>
<td>Price</td>
<td>$5,000 - $10,000</td>
<td>$1,500</td>
</tr>
<tr>
<td>4</td>
<td>Cycle Time</td>
<td>50 seconds</td>
<td>23 seconds</td>
</tr>
<tr>
<td></td>
<td>Setup Time</td>
<td>5 - 10 minutes</td>
<td>3 minutes</td>
</tr>
</tbody>
</table>

Final Concept

- Insertion actuators mount on top of locking actuators
- Multiple three-position valves sit on the manifold
- Optical sensors detect the tube end locations
- Programmable Logic Controller (PLC) operates the entire system

Operating Steps

- Insert Tube
- Insert Valves
- Clamp Tube
- Machine Resets
- Clamp Opens And Operator Removes Assembled Parts
- Apply Adhesive
- Insertion Actuator Presses Valves On Tube
- Positioning Actuator Moves Until Tube Is Found
- Apply Primer

The Benefits

- Productivity: Fewer operators are needed to assemble the product
- Ergonomics: Repetitive motion injuries are significantly reduced through the use of automation
- Variability: Able to handle tubes of length between 93 and 103 millimeters
- Elimination of Waste: Higher success rate leads to virtually no failed parts that need to be thrown away