2. Isolate

Vibration Reduction Add-on for Jackhammers
Bad Vibrations

- 2 Million workers in the US exposed to hand-arm vibration [1]
- No enforced regulations in the U.S. [2]
- Jackhammers used for 4-5 Hours per day

Hand Arm Vibration Syndrome [3]
## Existing Solutions

<table>
<thead>
<tr>
<th></th>
<th>Taking a Break</th>
<th>Anti-vibration Gloves</th>
<th>Electric Jackhammers with anti-vibration</th>
<th>Isolate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Effectiveness</strong></td>
<td>✔</td>
<td>×</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Adaptability</strong></td>
<td>✔</td>
<td>✔</td>
<td>×</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Minimal Work Disruption</strong></td>
<td>×</td>
<td>✔</td>
<td>×</td>
<td>✔</td>
</tr>
</tbody>
</table>
Isolate

- Active vibration reduction system
- Price: $400
<table>
<thead>
<tr>
<th>CUSTOMER NEED</th>
<th>PRODUCT ATTRIBUTE</th>
<th>ENGINEERING SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allow safe use for longer periods</td>
<td>Vibration reduction</td>
<td>Reduce vibration exposure to below $5 \frac{m}{s^2}$</td>
</tr>
<tr>
<td>Keep current jackhammers</td>
<td>Adjustable attachment mechanism</td>
<td>End-to-end handle distance between 12 to 24 inches</td>
</tr>
<tr>
<td>Can be easily stored</td>
<td>Height</td>
<td>Less than 6 inches</td>
</tr>
<tr>
<td>Can be easily transported</td>
<td>Weight</td>
<td>Less than 6 pounds</td>
</tr>
<tr>
<td>Comfortable to use</td>
<td>New handle displacement from old handle</td>
<td>Less than 4&quot;</td>
</tr>
</tbody>
</table>
Mockup – Passive damping

• Tested out passive spring damping solution
• Saw damping of higher frequencies rather than the problem frequencies (10 – 50 Hz)
Mockup – Passive damping
Mockup – Vibration Cancellation

- Active vibration cancellation mockup
- Uses upper-stage motor to cancel out vibration amplitude
Mockup – Active Damping

Active System Frequency Response

- Active Isolate Spring System
- Jackhammer

Legend: 
- Blue: Active Isolate Spring System
- Red: Jackhammer

Relative Amplitude vs. Frequency (Hz)
Risks

- Voice-coil active damping/magnetic suspension
- Compact system
- Adaptable design
- User need
- Functionality on a jackhammer
References

