PIANO PEDAL ACCESSIBILITY AND FEEDBACK

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Client: Steinway & Sons (via Paul Lehrman & Chris Rogers)
Mentor: Gary Leisk
The una corda (soft pedal) on modern day grand pianos is difficult for novice players to learn to use.

Novice piano players need clear feedback system for soft pedal.
**Feedback - Design Considerations**

- Must not interfere with the actual playing of the piano
- Should not cause the pianist to depend on it
- Should allow for easy installation and removal
- Should be relatively cheap to manufacture
- Can allow calibration to account for drift and different models
FEEDBACK - OPTIONS

- Sensing
  - Hammer position inside piano
  - Pedal angle direct measurement
  - Pedal tip to ground
  - Linear displacement of pedal rod

- Output
  - Vibration in seat or wristband
  - Ambient light on keyboard
  - LEDs (3 or array)
### Feedback - Downselection

<table>
<thead>
<tr>
<th></th>
<th>Hammer Position</th>
<th>Pedal Angle</th>
<th>Pedal Tip</th>
<th>Pedal Rod</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy installation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>and removal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy to implement</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Cost</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Durability</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>14</td>
</tr>
</tbody>
</table>

**Scale:**

3 – most desirable
1 – least desirable

Fields weighted uniformly
Feedback - Resolution

Arduino board for maximum I/O flexibility

Linear potentiometer attached to pedal rod

Push-button for easy calibration

LED to facilitate dependence on natural haptic feedback of pedal
FEEDBACK - CIRCUIT DIAGRAM
FEEDBACK IN ACTION
FEEDBACK – GOING FORWARD

- Custom part to attach linear sensor to pedal rod
- More sensitive linear sensor
- Cheaper, less versatile PCB/microcontroller
- Housing for the apparatus, mount for LEDs
The generic grand piano design has limited accessibility to children and shorter players who cannot reach the pedals.

Shorter players need a safe and easy-to-use device that allows them to use the grand piano pedals properly while playing.
Due to the versatility of the threaded shaft model, and the spatial limitations of the rigid x and y axis bar models, the threaded shaft model was deemed to be worth the investment.
PEDAL EXTENDER - FINAL DESIGN PICTURES

ABS prototype
PEDAL EXTENDER - FINAL DESIGN PICTURES

Aluminum 6061 T6 Solidworks Assembly
# Pedal Extender - Design Specifications

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Consumer Need</th>
<th>Solution Specification</th>
<th>Met Criteria?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle Adjustability</td>
<td>0, 45, and 90 degree settings</td>
<td>0,30,60,90 degree settings</td>
<td>Exceeds</td>
</tr>
<tr>
<td>Radial Adjustability</td>
<td>Up to 1ft of adjustability</td>
<td>.50 ft to 1ft of adjustability</td>
<td>Meets</td>
</tr>
<tr>
<td>Weight</td>
<td>Under .50 lb</td>
<td>.48 lb</td>
<td>Meets</td>
</tr>
<tr>
<td>Safety</td>
<td>Can sustain the weight of the player</td>
<td>FoS &gt; 5 with 1000N load and 1000N*m torque</td>
<td>Exceeds</td>
</tr>
<tr>
<td>Ease of Use</td>
<td>Easy assembly and installation. Removable.</td>
<td>Two handed installation, needs a screwdriver</td>
<td>Meets</td>
</tr>
<tr>
<td>Cost to Produce</td>
<td>Under $50</td>
<td>Hundreds of dollars</td>
<td>Does not meet</td>
</tr>
</tbody>
</table>
Both conservative hand calculations and FEA analysis show a factor of safety above 5 with a worst case scenario of an adult standing on the pedal of 600 N (200 Nm)
The next prototype will consist of an aluminum skeleton with simplified geometry to provide strength and reduce machining or casting costs. The aluminum skeleton will be surrounded by plastic snap-fit pieces to simulate more complex geometry like the extended pedal shape.

The aluminum/plastic model will incorporate threading so a cap screw can securely hold the piano pedal in the housing, and the interior shaft can screw into the exterior shaft through a ½ in UNF nut welded onto the opening of the exterior shaft.
ACKNOWLEDGEMENTS

- Gary Leisk, Chris Rogers and Paul Lehrman for guidance throughout this project
- Jason Rife for discussions on feedback systems
- Steinway & Sons for funding this project
QUESTIONS?