

# PIANO PEDAL ACCESSIBILITY AND FEEDBACK

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**Client: Steinway & Sons (via Paul Lehrman & Chris Rogers)**

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## FEEDBACK - THE PROBLEM

- 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



**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

|                               | Hammer Position | Pedal Angle | Pedal Tip | Pedal Rod |
|-------------------------------|-----------------|-------------|-----------|-----------|
| Easy installation and removal | 1               | 2           | 3         | 3         |
| Easy to implement             | 2               | 1           | 3         | 3         |
| Cost                          | 1               | 3           | 1         | 3         |
| Durability                    | 3               | 2           | 1         | 3         |
| Sensitivity                   | 1               | 2           | 3         | 2         |
| Total                         | 8               | 10          | 11        | 14        |

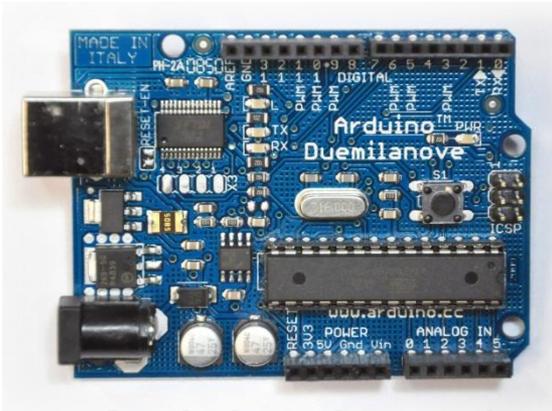
Scale:

3 – most desirable

1 – least desirable

Fields weighted uniformly

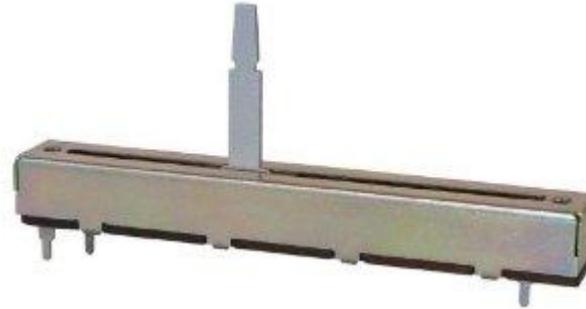
# FEEDBACK - RESOLUTION



Arduino board for maximum I/O flexibility



Push-button for easy calibration



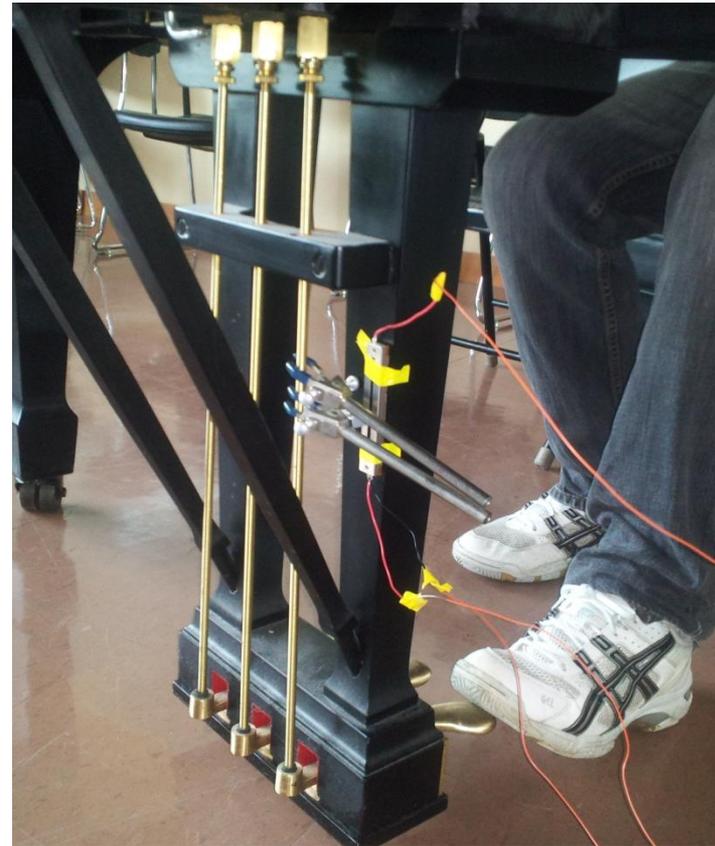
Linear potentiometer attached to pedal rod



LED to facilitate dependence on natural haptic feedback of pedal



# 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

# PEDAL EXTENDER - PROBLEM STATEMENT

- 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

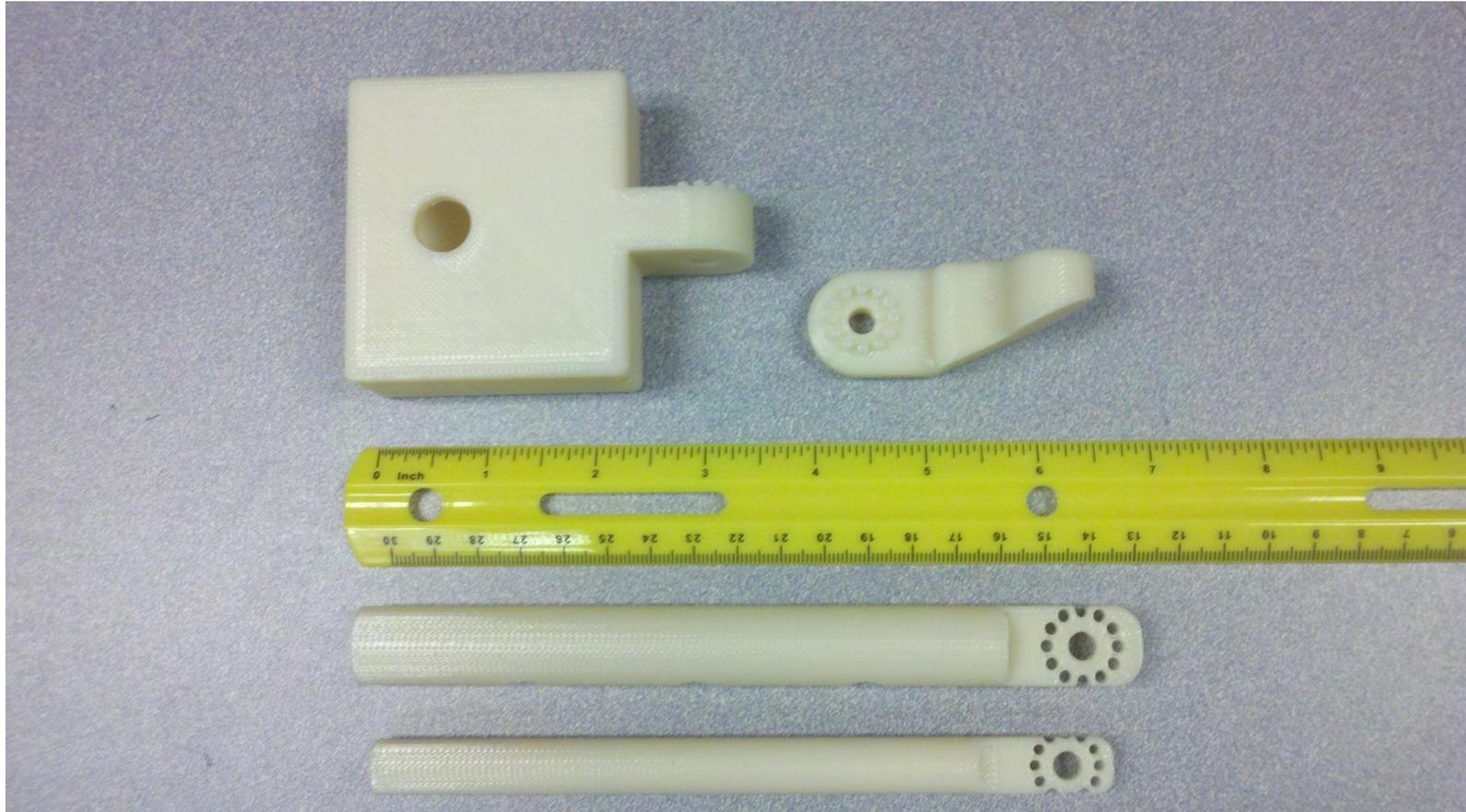


# PEDAL EXTENDER - DECISION MATRIX

| Possible Designs<br>Criteria (Weight) | Threaded Shafts | Bars with Adjustability | Non Adjustable Bars |
|---------------------------------------|-----------------|-------------------------|---------------------|
| Range of Motion (5)                   | 3               | 2                       | 2                   |
| Adjustability (4)                     | 3               | 2                       | 1                   |
| Lightweight Assembly (3)              | 1               | 2                       | 2                   |
| Cost (2)                              | 1               | 2                       | 3                   |
| Easy Installation (1)                 | 2               | 2                       | 2                   |
| Total Points                          | 34              | 30                      | 28                  |

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

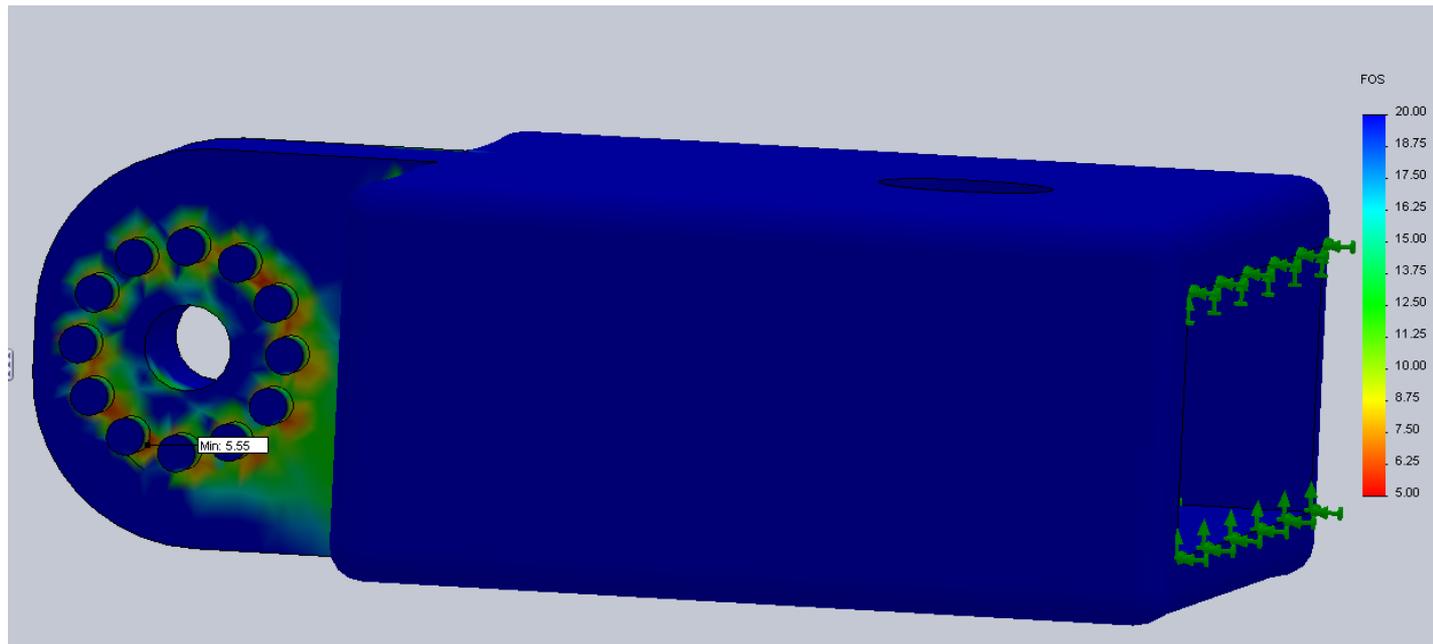


Aluminum 6061 T6 Solidworks Assembly

# PEDAL EXTENDER - DESIGN SPECIFICATIONS

| Criteria             | Consumer Need                              | Solution Specification                       | Met Criteria? |
|----------------------|--|--|---------------|
| Angle Adjustability  | 0, 45, and 90 degree settings              | 0,30,60,90 degree settings                   | Exceeds       |
| Radial Adjustability | Up to 1ft of adjustability                 | .50 ft to 1ft of adjustability               | Meets         |
| Weight               | Under .50 lb                               | .48 lb                                       | Meets         |
| Safety               | Can sustain the weight of the player       | FoS > 5 with 1000N load and 1000N*m torque   | Exceeds       |
| Ease of Use          | Easy assembly and installation. Removable. | Two handed installation, needs a screwdriver | Meets         |
| Cost to Produce      | Under \$50                                 | Hundreds of dollars                          | Does not meet |

# PEDAL EXTENDER - SAFETY ANALYSIS



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)

## PEDAL EXTENDER – GOING FORWARD

- 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

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# QUESTIONS?

