

# PRINCIPLES AND PRACTICE OF ASSISTIVE TECHNOLOGY

## CLIENT: D

NAMES AND IMAGES EDITED FOR PRIVACY

MIT 6.S196

Fall 2011

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# INITIAL FINDINGS AND DIRECTION

# CLIENT: D



- C-5 Spinal Cord Tumor (3 years ago) → incomplete tetraplegia
  - No control of legs or trunk
  - Hypertonicity in arms and hands
  - Therapy has led to use of right arm and right thumb and index finger
  - Complete loss of sensation (temperature, pressure, texture, etc) below chest

- Custom Power Wheelchair for mobility
- PCA's during the day who prepare meals, help around the house, run errands with him; has his kids on the weekends
- Typical day includes: eating, watching TV, using his computer, using phone

# TOP FUNCTIONAL DESIRES

1. Hug his children
2. Eat better
  - Improve fork skills
  - Be able to use a knife
  - Eat soup
3. Grip and turn a steering wheel (eventually be able to drive)
4. Grip and use small objects (t.v. remote, e.g.)
5. Hold a poker and kindle the fire
6. Throw a ball to his kids
7. Hold and turn a jump rope for his daughters

# HOW DOES HE EAT NOW?

- Context – his home, with a PCA or family member
- Set up
  - Chair rotates back
    - Pressure relief
    - Would slouch otherwise
  - Plate on lap with pad
  - Food has specific locations on plate
- Utensil Grip
  - No tactile sensation – placing it in fist ensures grip
  - Can rotate utensil by putting it his mouth and moving his hand
- Takes breaks because of wrist fatigue
- PCA or family member does “finish job” for food he can’t get



# WHERE CAN WE ENABLE SOUP EATING?



Improve spoon design

- add tolerance for rotation
- eliminate dripping along the bottom

Decrease horizontal travel distance

- Move soup closer to D in x



Change utensil grip

- Adaptation  $\rightarrow$  wrist flexion  $\rightarrow$  fatigue  $\rightarrow$  spills
- New grip means less fatigue, more motor control

# CONCEPT A: NON-Spill SPOON

- This solution has the largest audience of possible users
- Preventing spill from rotation
  - Spoon rotates freely from handle, can compensate for handle movement
  - An inside-facing lip along the top of the spoon
  - Somehow ensure the soup level is never at the brim
  - Adding weight can dampen tremors/shaking
- Solving dripping along the bottom:
  - Wick water off surface
    - Hydrophobic material
    - Better design
  - Wipe off the bottom
  - Get soup into spoon without submerging the spoon at all (bottom never interacts with soup)

# CONCEPT B: 'SPIDEY' SPORK

- The problem is the grip, so enable a better grip for D!
- Existing AT utensils use this design:
- Utensil attached to wrist, comes through fist
  - Grip ensured (as before)
  - Interchangeable heads for different utensils
  - Preliminary testing looks promising!



Image credit: instructables.com

# METRICS FOR SUCCESS

- **Spills/spoonful**
  - **1 spill/10 spoonfuls maximum**
  - Not counting soup that falls back into the bowl, which is acceptable (as it is for other human users)
- **Spoonfuls before wrist fatigue**
  - **4 spoonfuls minimum**
  - He can't sense fatigue, but knows he no longer has adequate control over the spoon because wrist does not respond the same way
- **D's Satisfaction**
  - D should find this method/system easier than the current one
  - This is subjective for him but could depend on: ease and certainty of grip, time it takes to set up, compatibility with other foods he wants to eat

# FINAL RESULTS

# SPOON – IMPROVING GRIP

- 1<sup>st</sup> iteration: notch with 180 degree rotation
  - Spork means one utensil for entire meal
- 2<sup>nd</sup> iteration; Exploration of clay grips on sporks
  - Separate fork and spoon hand configurations, use same grip
  - Derek responded very well to these sporks, but they don't enable soup eating
- Grip exploration used for final product



First prototype



Grip models

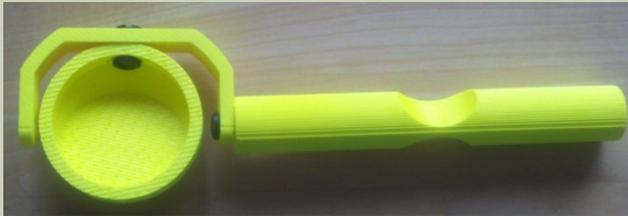


Final sporks

# STEADY SPOON (PT. 1)

- We found two existing devices to emulate

- Gyro bowl



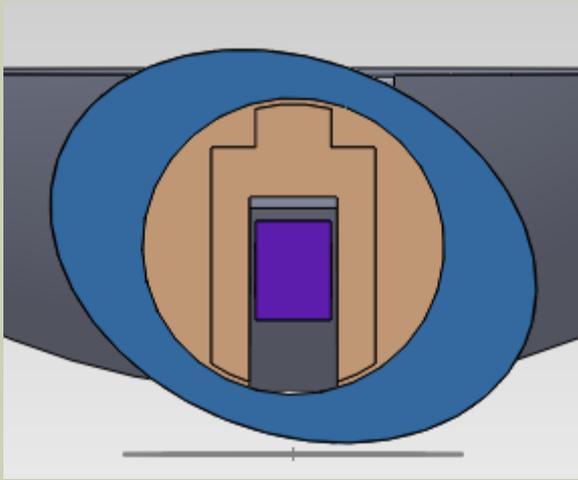
- Steady Spoon

- Improved eating success
- Abandonment: it can't be comfortably gripped because of hypertonicity

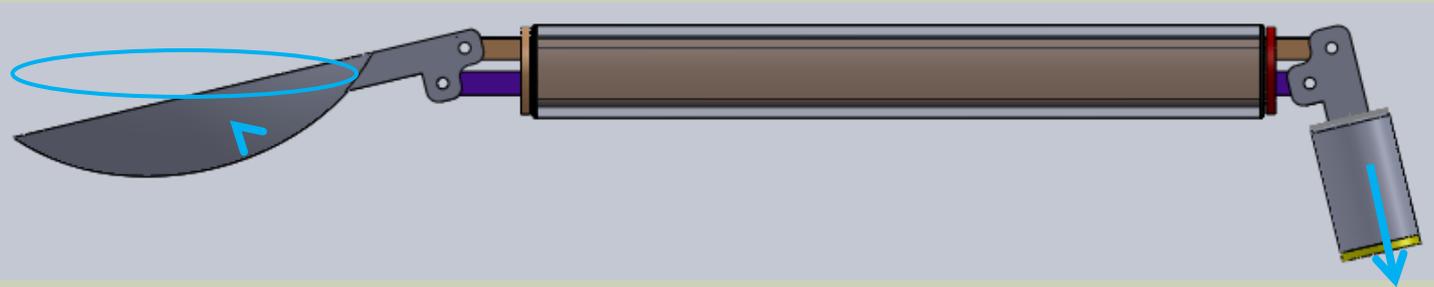
- Note: At this point we abandoned the idea of having soup wick away from spoon



# STEADY SPOON (PT. 2)



- Prototype 1: proof of concept, new geometry
- Prototype 2:
  - Made envelope smaller
  - Produced with Objet 3D printer
- Prototype 2.5:
  - Added grip
  - Used less counterweight by:
    - Increasing length to counterweight
    - Change angle of spoon



# SUCCESS METRICS

	<b>Spills/total spoonfuls</b>	<b>Spill Percentage</b>	<b>Confidence/Satisfaction</b>
<b>Goal</b>	<b>1/10</b>	<b>10%</b>	<b>Utter and total</b>
<b>Regular Spoon (baseline)</b>	<b>7/9</b>	<b>78%</b>	<b>None</b>
<b>Spoon (trial 2)</b>	<b>3/5</b>	<b>60%</b>	<b>None</b>
<b>Spork (with grip)</b>	<b>3/7</b>	<b>43%</b>	<b>“confident” spork will not fall!</b>
<b>OTS Steady Spoon</b>	<b>2/7*</b>	<b>29%</b>	<b>None (abandoned)</b>
<b>Our Steady Spoon</b>	<b>3/9*</b>	<b>33%</b>	<b>TBD</b>

**\*All but one of the spills were little drips**

**Fatigue was not measured or recorded; included in ‘confidence’**

# LESSONS LEARNED

- Contextual Inquiry is an ongoing process
  - We learned more about D as the semester progressed, and had to adapt to changes
- Consult more experts and people who worked with him
  - Recommendations of technologies he's used and abandoned
  - Faster/more complete Contextual Inquiry (less holes)
- Improve data collection
  - Getting all pertinent chair measurements
  - Getting more spill data
    - Figure out how to get more data in one session
    - Better worksheets to leave with him
    - Able to see how he improves over time