Design proposal

Jingoog Kim, Sarah Abdellahi, Dinesh Auti
Interaction Design studio
Spring 2017

Our design concepts are based on the interview response from Jeff Powell and some of the issues listed in the survey paper by Biddiss and Chau (2007).

Need-finding session with Jeff Powell

Need-finding included a QA session with Jeff Powell from "Helping Hands". In this session, Jeff shared a part of his experience with prosthetic receivers with the class, we watched a short video of one of the annual gatherings with the users and asked our need finding questions. Our takeout from the need finding session with Jeff was the main concerns to be handled in the field include:

- Need for social and emotional support: One of the concerns "Helping Hands" is assigning lots of resources to is providing social and emotional support to the prosthetic receivers. These kids participate in several counselling sessions to help them with self-confidence problems, bullying issues, and social interaction difficulties.
- Need for improved general use prosthetic: Another problem mentioned by Jeff was the difficulty of performing general tasks such as holding a spoon, pen or bicycle handles with current prosthetics.
- No User Feedback: A problem designers of prosthetic hands are currently facing is lots of users never come back after receiving their prosthetic to provide designers after-use data and feedback.

Takeout from Survey paper

According to Biddiss and Chau, some of the factors reported by prosthetic limb users motivating them not to wear the prosthetics permanently or occasionally include:

- Feeling more functional without the prosthetic
- Finding prosthetic too difficult or tiring to use
- Inconvenience of wearing or using the device
- Dissatisfaction with the device technology

Design goals

To respond to the discovered needs and challenges during the need finding phase, we decided on the following goals for our design concepts:

1. ***Enhancing social interaction:*** One of our goals is to respond to social and emotional problems kids with prosthetics are dealing with. The aim is to help them feel empowered because of their prosthetics. For this reason, we are aiming to support the

kids in activities they might struggle or need more support with. These activities include facilitating learning, supporting play, replacing physical hand gestures with interactive displays, and enhancing parent-child bonding and friendship.

2. ***Facilitate sustained grip:*** As appeared both in our need-finding interview and literature review, one of the problems with current prosthetic limbs is holding an object for a long time. Since finger motions are currently controlled by the upper part of user's hand, it is difficult for them to keep prosthetic fingers in holding the position for long. As a result, prosthetic users are not able to perform some of the daily tasks with general use prosthetics. We are aiming to address the holding issue in order to facilitate a part of these general actions for users

3. ***Facilitate dexterity:*** Another problem we faced in our need-finding and preceding study phase was users' struggle with grasping as they do not have sufficient control of prosthetic fingers and pressure. This appears especially when users try to grasp small or sensitive objects without damaging them. Another design goal we are looking into is facilitating grasping to support the users in a wider range of daily activities.

4. ***Facilitate frequently used actions based on user's specific needs:*** In response to the feeling difficulty using the prosthetic, we are aiming to automate some of the general actions to facilitate using the prosthetic in daily life.

5. ***Enhancing feedback mechanism:*** Traditional feedback mechanisms to improve the design are based on observations and interviews. This, in turn, requires the designer to work closely with the user and has to depend upon his observations and the user's interpretation of the problem. One of the problems mentioned by Jeff during our need finding interview was some of the prosthetic users never contact them back to provide any feedback about the device they received. To tackle this problem and to reduce the overall feedback time, a sensor based data driven approach is suggested.

Design Concepts

Concept 1: *INTERACTIVE ACCESSORIES FOR PROSTHETIC*

This concept responds to our first design goal. It helps the child to enjoy using the prosthetic and have a better feeling when participating in group activities and socialising.
We are providing below functionalities with this design:

- Allow use of the LED screen on the prosthetic as a replacement for the hand gesture.
- Use a brush fingertip and the LED screen to teach the child how to paint. Friends or family members joining the child in the painting activity could use the LED screen as well.
- The device performs as a “Sound Fingertip” to motivate the child, to use the prosthetic more often. The child could use this functionality and benefit from the device as a musical instrument or a musical toy to interact with others.
- This design concept performs using modular accessories to perform the above tasks. These accessories could be moved from one prosthetic to the other in order to reduce the prosthetic cost.

	User Action	System Action
Sound	Pointing / Touching	Playing pre-assigned sound
	Tapping / Tilting / Shaking	Playing pre-assigned sound
Lighting	Banding wrist (Single / Double)	Displaying pre-assigned shape
	Tilting / Shaking	Displaying / removing shape
	Neighboring (Shape - Empty)	Copy shape to another display
	Neighboring (Shape - Shape)	Playing pre-assigned effect

Concept 2: INTERACTIVE VOICE COMMAND SYSTEM FOR PROSTHETIC

This concept looks to respond to design goals 2,3 and 4. To do so, this design concept benefits from voice interaction and prerecorded actions.
For doing so, our device allows the users to:

- Allow the user to grasp, hold, and release items by use of vocal commands, without a need to keep the prosthetic fingers in place using upper arm muscles. A previously suggested solution to facilitate holding items for a long time was the use of a button on the device, but safety concerns existed because of the difficulty of pressing a button in critical situations. In this design concept, we solve the safety issue by allowing voice command as a natural quicker interaction to replace the button idea.
- Allow users to decide on a limited list of preferred actions among general tasks. These actions could be performed automatically by user command without need to control the device using muscles. Holding a pen to write, holding cutlery or holding a musical instrument are examples of actions to be suggested to the user for customization of the prosthetic when the device is received.

User Action	System Action
Say “Grasp”	Grasping
Say “Release”	Opening hand
Say a customized word	Pre-assigned gesture

Concept 3: INTERACTIVE DATA COLLECTION SYSTEM FOR PROSTHETIC DESIGNERS

This concept looks at exploring new and improved methods of feedback from the end-user. Rather than using traditional methods such as interviews and observation, it uses a data-driven approach by capturing real-time usage patterns.

- The device would allow the child to press a button whenever he/she feels socially uncomfortable because of the prosthetic. This way frequency of social and emotional struggles because of the prosthetic could be captured to be used by the child’s counsellor and family. This data would allow the counsellor and the family to know about kids emotional struggles over time, so they can provide better support.
- The button and the usage feedback could help the parent to know how often and in what contexts and situations the child is having difficulty with the prosthetic.
- Collected data can allow designers to know which designs facilitate better social interaction e.g. A child who uses a different prosthetic hand during social events or playing with friends and a different hand when at home, can give a good insight into what changes the designer has to make. Or if fewer cases of social problems are recorded

by the device when the child is using one of the prosthetics compared to the other, designers would know the socially preferred design for the kid's situation.

- The proximity sensor can help us analyse the number of times the arm was put on/removed and usage duration. This will give us insights into the "wear pattern" of the user to evaluate each design
- The temperature sensor data combined with usage pattern will give us an idea of how often the user takes off the hand due to increased internal temperature. Such data would allow the designers to evaluate each prosthetic design and make improvements if required.

User Action	System Action
Put on	Count the wearing number and time
Take off	Count the wearing number and time
While it's on the user	Check internal temperature
Press	Record time-stamp

Reference

Biddiss, E., & Chau, T. (2007). Upper-limb prosthetics: critical factors in device abandonment. *American journal of physical medicine & rehabilitation*, *86*(12), 977-987.