Leveraging Rehabilitation Needs into Engineering Design Projects

The Segal Design Institute

June 25, 2009

McCormick School of Engineering and Applied Science

Weinberg College of Arts and Sciences
Engineering Design and Communication

- Two quarter sequence (1 project each quarter)
- One credit engineering design and one credit communication
- Students work in teams of 4 to develop a product to meet a need of an external client.
- It is a required class for all freshmen (350-400 students).
- This requires ~100 project teams per quarter or 200 project teams per year.
- Public Poster Fair and Awards Ceremony at the end for presentation of results
EDC at Work
Poster Fair
Awards Ceremony
EDC focuses on human centered design

Human centered design process

- User observation
- User testing
- Iterative redesign

leads to products

people actually want to use
Real projects: An critical part of EDC

First Quarter: RIC Projects
    Stroke Rehabilitation Projects
    Sports and Recreation Projects

Second Quarter: Diverse Projects
First Quarter Projects: Assistive Technology Projects with the RIC

First quarter projects are all assistive technology related projects most of which are sponsored by RIC through a NIDRR grant.
Writing Aid, Universal Umbrella

**Write Away**

**MISSION STATEMENT**

Design and develop a writing aid that can hold a variety of writing implements for persons with spinal cord injury.

- **Elastic Strap**
  - Easy to put on
  - Draws fingers close to hand

- **One-Way Valve**
  - Stable
  - Easy to grasp
  - Open front

- **Smooth Sliding**
  - Minimal exertion
  - Shoulder and forearm remain relaxed
  - Fluid writing motion

- **Holds pens, pencils, paintbrushes, felt-tipped markers, crayons**

Some device for Right and Left Handed Individuals

Available in: Children’s (Small), Medium, and Large

Removable Cover!

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**The Extended Canopy Umbrella**

**Problem:** Individuals with Rheumatoid Arthritis have difficulty using a standard umbrella comfortably.

**Solution:** Extending the canopy provides additional coverage so the weight of the umbrella may be relocated to the user’s shoulder while still protecting the user from the rain.

**Features of the Design**

- **Canopy Extension:** Extra fabric adds protection over the user’s head even when the umbrella shaft rests on the user’s shoulder.
- **Grip:** A 5-inch extension allows the user to grip the umbrella with two hands for additional support. A larger diameter makes the handle easier to grasp.

- **Easy Press Button:** Enlarged, extended button allows easier operation.
Bag Opening Assist, Adaptive Dog Leash

**SLICE N’ SNACK**

**Problem:** Stroke survivors often have difficulty opening sealed plastic bags.

**Solution: Slice N’ Snack**
Use one hand to operate a sliding blade to cut off the top of the bag.

**Benefits**
- Contents of bag easy to remove
- Blade not accessible during operation
- Slider can be used with affected hand

**How to use:**
- Place it!
- Clamp it!
- Slide it!

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**Retract-A-Leash**

**Problem** - People with use of one hand cannot manipulate current leash attachments.

**Solution** - Leash is permanently attached to the collar and carried by the dog! No hand dexterity required.

**Features**
- **Simplicity** – In one step, the leash is grasped with one hand and pulled out from the collar
- **Storage** – Leash is stored on dog’s collar and retracts after use
- **Safety** – Leash won’t sag, if dog escapes, no leash drags behind

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Wheelchair Straps, Ski Pole

**Problem**
Current straps used by wheelchair athletes cause abrasion to the skin and inhibit their motion.

**Mission Statement**
To safely, comfortably and conveniently secure athletes to their wheelchairs, thus maximizing their performance.

**Solution**
An adjustable belt that attaches easily and quickly to the wheelchair and allows the athlete greater control over their movements in the chair.

**Features**
- Spring Clips
  - Strong
  - Secure
  - Easy on
  - Easy off
- Lap Pad
  - Comfortable
  - Durable
  - Washable
  - Thin
- Velcro
  - Adjustable
  - Universal
  - Easy to Use

**Strap in 4 Easy Steps:**
1. Sit
2. Clip
3. Tighten
4. Strap

**Ski Button**

**PROBLEM**
- The device currently used for skiers with disabilities does not accommodate people who also have weak or small hands.
- Slanted cord (right) is inaccessible to these people.

**SOLUTION**
- Simple push-button operation
- Usable by anyone
- Finger-free operation
- Easy for sit-down and stand up skiers alike
- Light and comfortable

- Ski can be triggered with just the thumb.
- Position of internal slider: Attaches to string which triggers ski.
- String is in tension wrapped around an internal bolt, which acts as an axle.

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### EDC Design Process

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RIC Project Structure

One client (usually an OT)
Multiple users (the therapist’s clients)

EDC Section (2 faculty)

Team 1  Team 2  Team 3  Team 4

EDC Section (2 faculty)

Team 1  Team 2  Team 3  Team 4
RIC Projects

• Benefits
  – Social benefit to users
  – Student exposure to rehab.
  – Shop experience
  – Fulfilling projects
  – Available users
  – Knowledgeable clients
  – Projects have theme
  – Competition/cooperation
  – Continuing source of projects
  – RIC infrastructure
  – Projects can be followed up

• Challenges
  – Overload on client
  – Overload on users
  – Sensitivity issues
  – Professional issues
  – Need more than one prototype
Sample Projects
Project Selection Activity

• Skim the project descriptions in the handout
• Order the projects from most desirable to least desirable
• Identify what made the projects appealing, or not
Ideal Project Criteria

• Device fits on a tabletop
• Design requires minimal engineering analysis
• Target users have been identified & are available
• Client is open to range of solutions
• Client is available
# Student-Client-User Interactions

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Client Interview – Week 3

• Students prepare interview guide in advance

• Clients share info on:
  – user group
  – user needs
  – existing solutions and their drawbacks

• Client and students sign “Understanding” form

• Schedule user observation session, if possible
User Observations – Week 4

• Prepare user observation guide in advance

• Observe & interview users

• Take photos, sometimes video
  − Consent needed
  − Crop or blur photos for reports, presentations, etc.
Building Mockups – Weeks 6 & 7

Build mockups to:

• Learn something
• Understand the problem
• Generate energy/momentum
• Communicate ideas
• Test quickly and cheaply (alternatives)
• Answer questions you didn’t ask
User Testing – Week 7

• Prepare testing plan in advance
• Test 3-4 mockups of different potential solutions
• Test the designs, not the users
• Identify which *design aspects* work well

Batting stabilizers for wheelchair softball
User Testing the Golf Aid
Mockup Exercise

Tobeggan
One-handed egg cracker

What needs to be tested?
How would you make a mockup?
How would you evaluate it?
Qualities of a Good Mockup

• Lowest *useful* fidelity
• Communicates the concept
• Allows adjustment to test variations
• Can be built quickly and inexpensively
• Makes use of found objects
• Helps answer questions
Peer reviews of final design direction in which each team must:

• Quickly communicate design
• Share results of FMEA
• Encourage feedback without becoming defensive
• Take thorough notes
• Decide on action items from the review
Final Presentation – Week 11

• Clients and users are invited to attend

• First quarter – Poster Fair
  – All teams participate for the 3 hour event
  – 3 and 5 minute versions of presentation

• Second quarter – PPT presentation
  – Teams present within their class
  – 30 minutes, including Q&A

• Serves as formal handoff
  – Project report
  – Prototype
Discussion
Mockups for opening a jar with one hand

Success: Easy to understand & use
Problems: Not durable or easy to clean

EDC SQ 2008: Doug Peterson, Jon Stockton, Len Okoth, Ted Stein
Revisions to jar-opener design

Revised for:
• Durability
• Ease of cleaning
• Ease of lifting
• Aesthetics

Jarcano

Jarcano v. 2

EDC SQ 2008: Doug Peterson, Jon Stockton, Len Okoth, Ted Stein; Summer 2008: James Cooper, Jonathin Shih
Mockups for donning a shoe with an AFO

Success: Held the weak foot positioned on the strong knee
Problem: Too big and awkward to use

EDC WQ 2007: Carissa Black Derek Liu, Henry Petrash, Greg Warga
Revisions to shoe-donning design

Revised to:
• Refine elements that worked
• Eliminate unnecessary elements

The Knee Nook

EDC WQ 2007: Carissa Black Derek Liu, Henry Petrash, Greg Warga