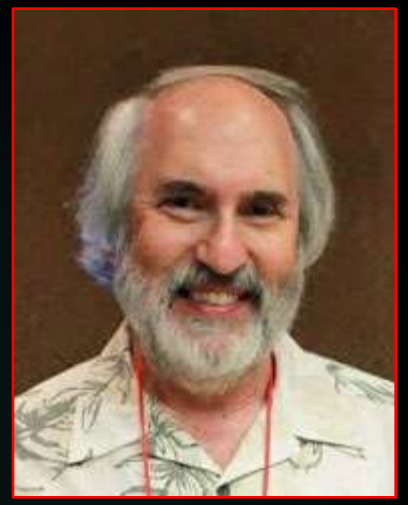
May 7, 2019

CS377Q - Designing for Accessibility

Assistive Technology



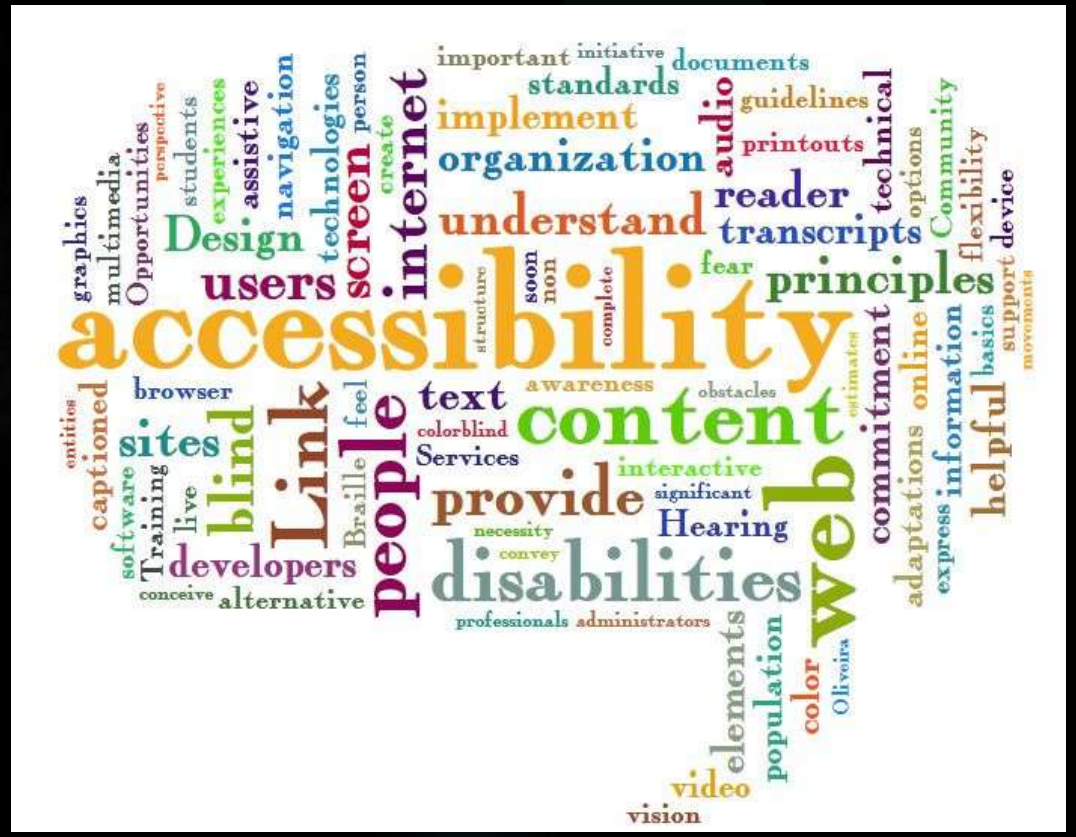
David L. Jaffe, MS

Agenda

- Accessibility vs Assistive Technology
- Disability Definition
- Disability in the US
- Other People with a Disability
- Universal Design
- Assistive Technology Market
- Empathy vs Compassion
- Understanding the Problem
- Judge the Need
- Prototyping
- Example Assistive Technology Devices
- Student Projects in Perspectives in Assistive Technology

Assistive Technology vs Accessibility

- What is the difference?



Assistive Technology vs Accessibility

- **Accessibility** is the criteria, design goal, or product feature that allows people of differing abilities to share / use common resources.

Assistive Technology vs Accessibility

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- Examples of differing abilities are:
  - Sight
  - Hearing
  - Mobility
  - Intellectual / Knowledge / Experience
  - Cognition
  - Language
  - Location

Assistive Technology vs Accessibility

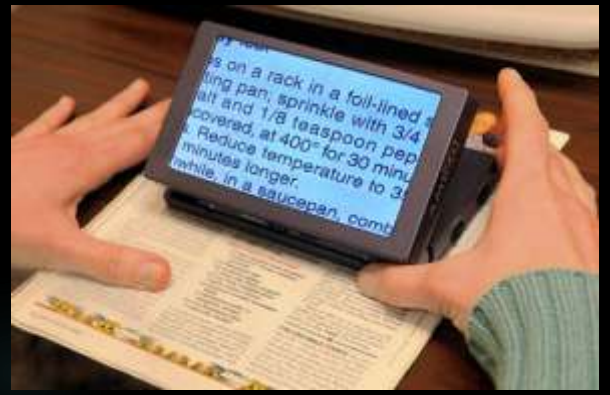
- **Accessibility** is the criteria, design goal, or product feature that allows people of differing abilities to share / use common resources.

- Examples of common resources are:
  - buildings
  - transportation systems
  - consumer products including computers and software
  - institutions such as schools, banks, government facilities, voting places
  - facilities such as parks, playgrounds, trails
  - information systems such as books and internet

Assistive Technology vs Accessibility

- **Accessibility** is the criteria, design goal, or product feature that allows people of differing abilities to share / use common resources.

- In many instances, using an <u>assistive technology device</u> can provide access to an otherwise inaccessible resource.



Assistive Technology vs Accessibility

- Assistive Technology

Device Definition of Assistive Technology

The Technology Related Assistance Act of 1988 (P.L. 101-407) and the Assistive Technology Act of 1998 (P.L. 105-394) provide a standard definition of assistive technology as "any item, piece of equipment, or product, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of individuals with disabilities."

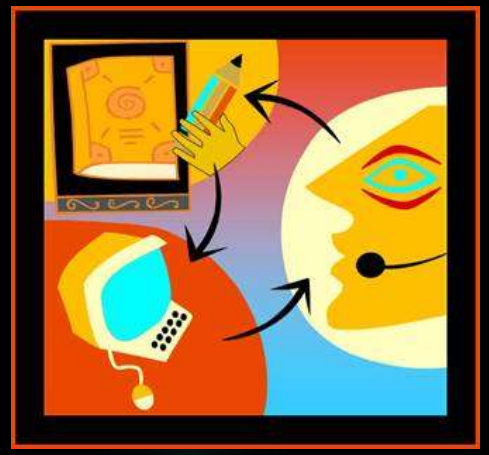
South Carolina Assistive Technology Program - link

My Definition of Assistive Technology

- Assistive Technology (AT) is a generic term that includes:
  - Devices, services, and policies that benefit people with disabilities and
  - The process that makes them available to people with disabilities.
- An AT device is one that has a diagnostic, functional, adaptive, or rehabilitative benefit.
- An AT service provides various resources.
- AT policies, laws, and legislation mandate the provision of devices and services
- Engineers employ an AT process to specify, design, develop, test, and bring to market new devices.

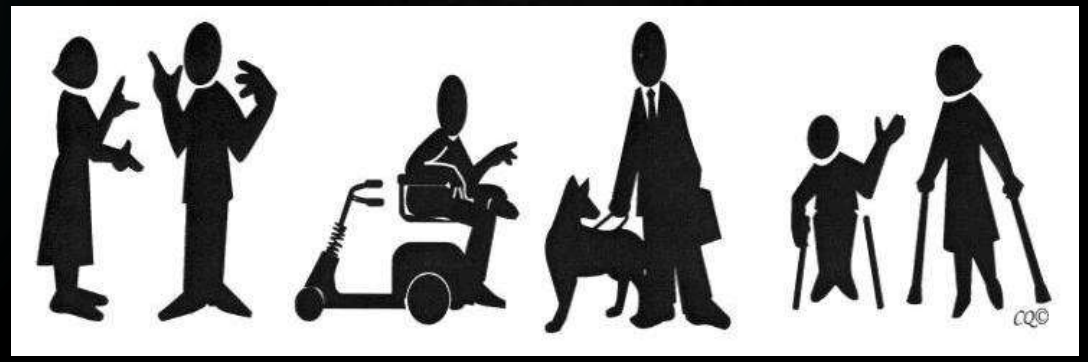
Assistive Technology

AT devices provide greater independence, increased opportunities for participation, and an improved quality of life for people with disabilities by enabling them to perform tasks that they were formerly unable to accomplish (or had great difficulty accomplishing, or required assistance) through enhanced or alternate methods of interacting with the world around them.



Assistive Technology

AT devices provide greater independence, increased opportunities for participation, and an improved quality of life for everyone by enabling us to perform tasks that we were formerly unable to accomplish (or had great difficulty accomplishing, or required assistance) through enhanced or alternate methods of interacting with the world around us.



Assistive Technology

New AT devices incorporating novel designs and emerging technologies have the potential to further improve the lives of people with disabilities.

- Computers, IoT
- Robotics & Mechatronics
- Nanotechnology
- Medical technologies
- Wearable devices

Assistive Technology

New AT devices incorporating novel designs and emerging technologies have the potential to further improve the lives of everyone.

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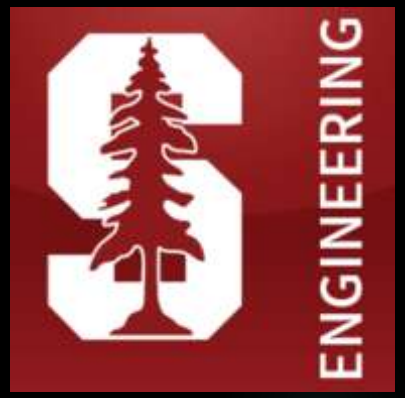
This leads me to conclude that:

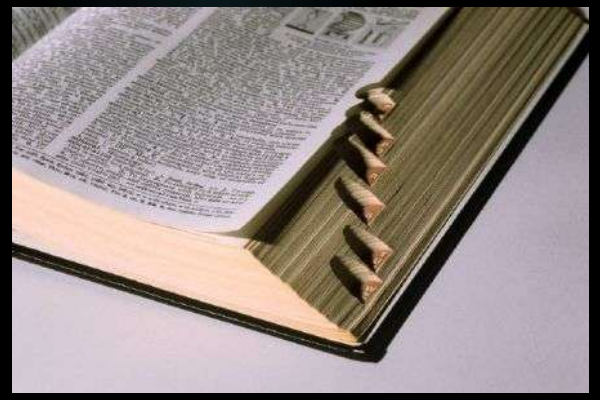
Everything is Assistive Technology!

- Technology
- Transportation
- Institutions
- Organized government
- Networks: TV, Radio, Internet, Highway, Electricity, News, Gas, Food, Commerce, Money, Entertainment, Sports, Computers

The universe seems neither benign nor hostile, merely indifferent to the concerns of such **puny creatures** as we are.
Carl Sagan



Definitions



- Disability

Disability

Opportunity-Based Definition

Disability is defined as a health condition or impairment that prevents an individual from taking full advantage of life's opportunities such as education, vocation, recreation, and activities of daily living

Disability

More Inclusive Definition

Disability includes any situation that prevents an individual from taking full advantage of one's talents and life's opportunities including circumstances such as political system, socio-economic status, etc

Inclusive Definition of Disability

"Disability is a normal variation of the human condition." - Gregor Wolbring

Disability in the US

- Disability rates vary by age, gender, race, ethnicity, state of residence, and economic status

- Disabilities may result in a reduced chance for education and employment

- Disability is associated with differences in income - 27.8% working-age individuals with disability live in poverty

- As the nation ages, the number of people experiencing limitations will certainly increase.

Identify a large group of individuals who spend 12 to 25 years in institutions before they can contribute significantly to society

Identify a large group of individuals who spend 12 to 25 years in institutions before they can contribute significantly to society

Students!

Is this fair?

Downloadable Skills

Can you fly a B-212 Helicopter?

Matrix

A Superhero with a Disability

More Superheros with a Disability

What is Universal Design?

Universal Design

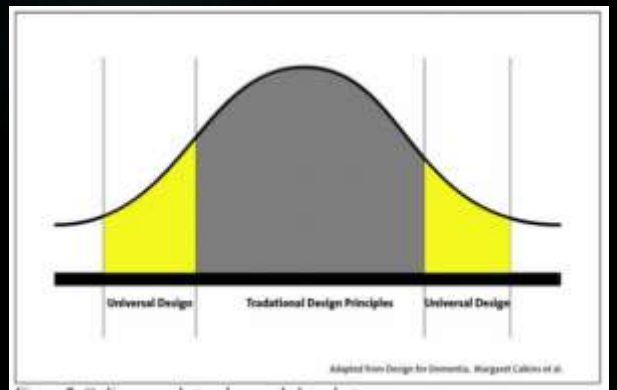


Figure 7: Ordinary market and expanded market

Universal design (often called **inclusive design**) refers to a design strategy meant to produce buildings, products, and environments (shared resources) that are inherently accessible to the greatest number of individuals including older adults, people without disabilities, and people with disabilities.

The term "universal design" was coined by the architect Ronald L. Mace to describe the concept of designing all products and the built environment to be aesthetic and usable to the greatest extent possible by everyone, regardless of their age, ability, or status in life.

Meyer Library

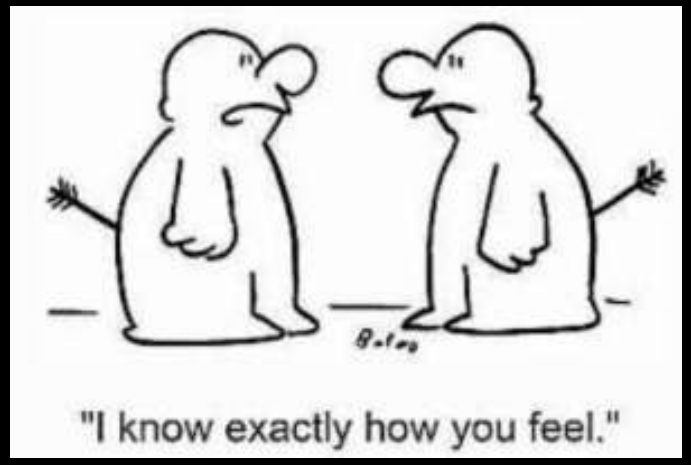
Universal Design Examples

Ed Roberts Campus

Assistive Technology Market

- Many people with a disability - in US (61 million) and world-wide (over 1 billion)
- Largest homogeneous group in the US is wheelchair users (several million)
- **Every consumer has a unique personality, challenges, circumstances, goals, and aesthetic preferences**
- **The lack of a well-defined mass market means that companies serving individuals with disabilities and older adults are small and their products are expensive** (lack of economies of scale)

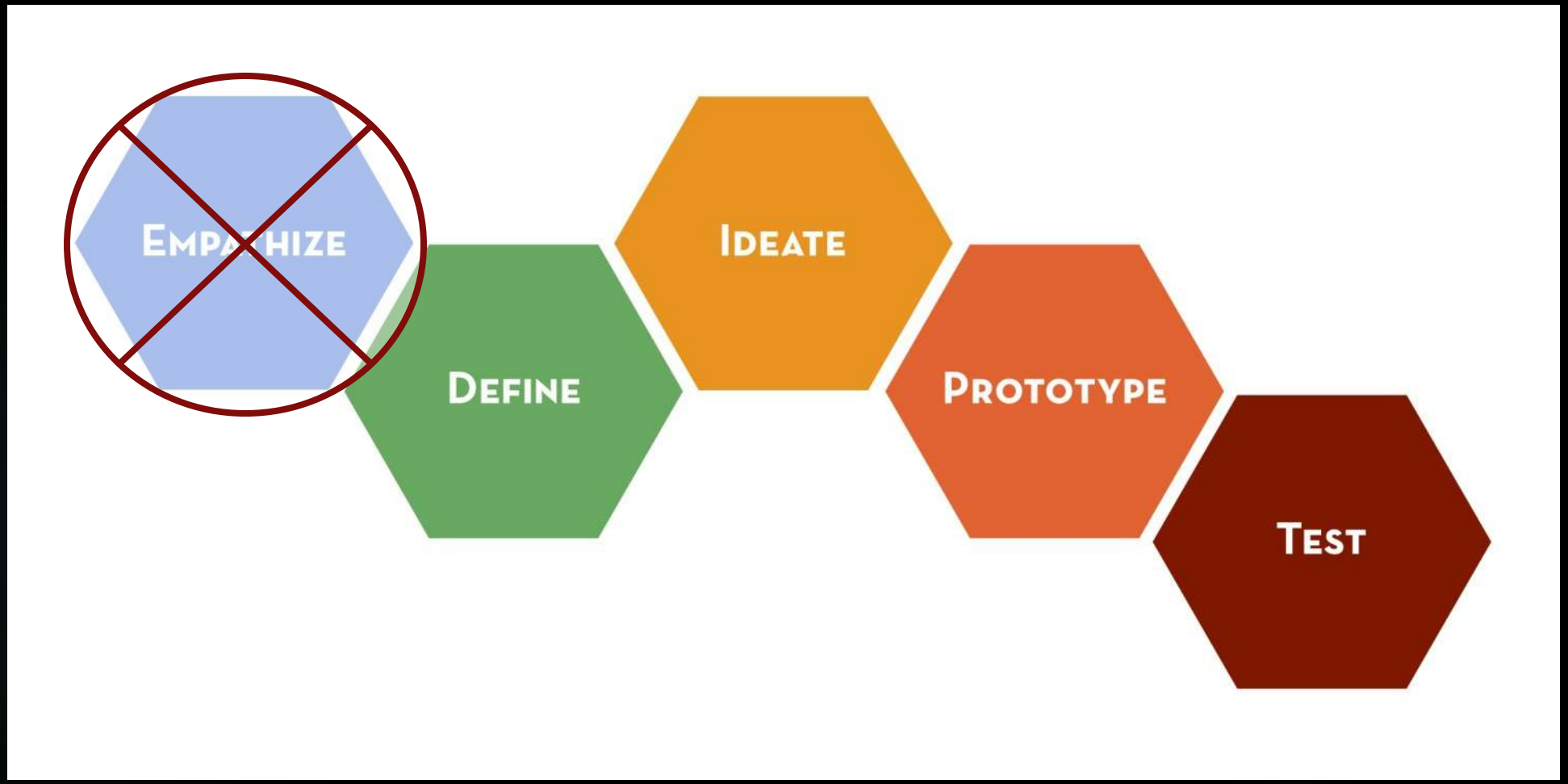
Empathy vs Compassion



- Empathy - the psychological identification with or vicarious experiencing of the feelings, thoughts, or attitudes of another. (no bias for action)

- Compassion - a feeling of deep sympathy and sorrow for another who is stricken by misfortune, accompanied by a strong desire to alleviate the suffering. (active action component)

Design Thinking



The Design Process
Understand the Problem

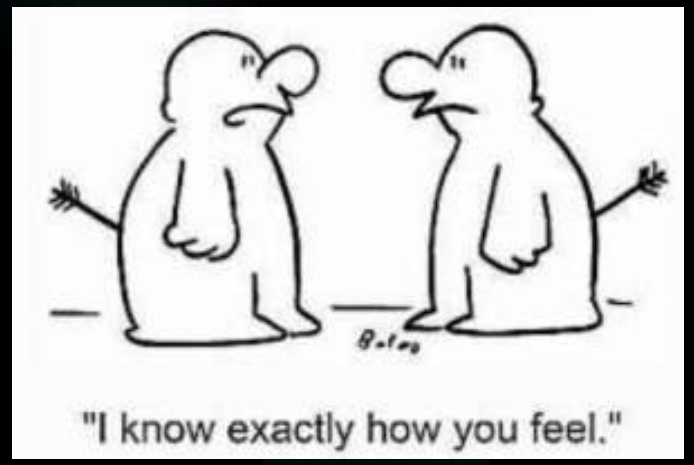
- Clarify goals and objectives
  - Incorporate users' perspectives and standards of care

- Gather information
  - WWW, library, journals (research)
  - Product catalogs (existing products)
  - Stakeholders
  - Experts & health care professionals

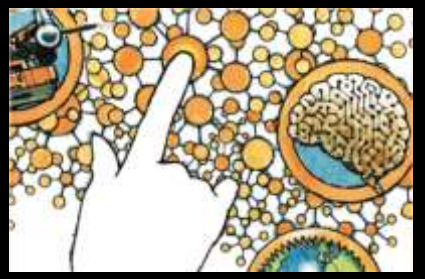
AbleData
Tools & Technologies to Enhance Life

The Design Process
Understand the Problem

- Often called "Empathy"
- Find out as much as you can thru observation & interview
- User's specific background and situation
- Review information on the disability condition (simulation?)
- Solicit the perspectives of people with disabilities and older adults, family members, friends, health care professionals, colleagues, researchers, engineers, product suppliers
- Query professionals and experts via online listservs



The Design Process
Understand the Problem



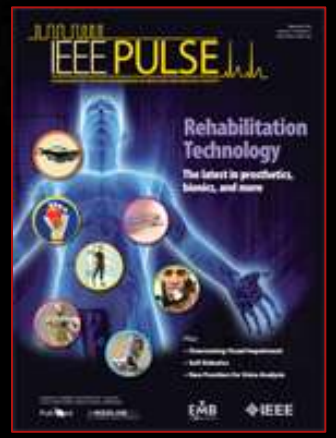
- *"While a user may have a good handle on The Problem, he/she may not fully appreciate the benefits and limitations of technology."*

- *"Since each person has his/her own circumstances, desires, and sense of aesthetics, a solution for one user may not be applicable for the entire user population."*

The Design Process
Understand the Problem

Research current solutions

- Published research
- Articles in popular media
- Previous student projects
- Product catalogs



The Design Process
Understand the Problem

"A deeper dive"

- What products currently address the problem?
- What products are most commonly used?
- What is considered the standard of care?
- You may not want to reinvent what already exists or has already been tried

"Sometimes the only problem is the lack of awareness of a suitable existing solution."

AbleData
Your Source for Assistive Technology Information

The Design Process
Understand the Problem

- Determine why current "solutions" don't work
  - Important to find limitations of current products:
    - High cost, weight, size, reliability, etc
    - Ineffectiveness
    - Non-compliance, non-use, mis-prescription
    - Poor aesthetics, functionality, durability, fit
    - Does not take advantage of current technology
- Why a new solution may not work

  "The old shoe is more comfortable."

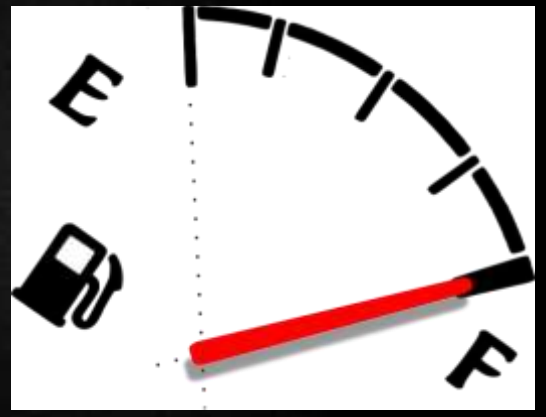
  Barbara (age 92)

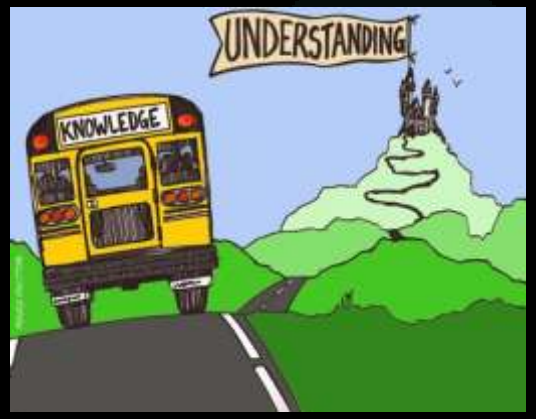
The Design Process

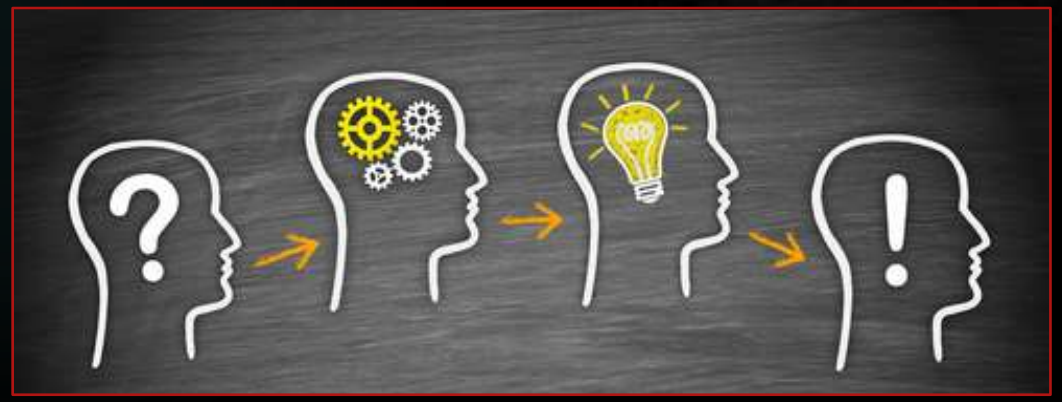
Judge the Need

"Judge what is needed from a full understanding of the problem."

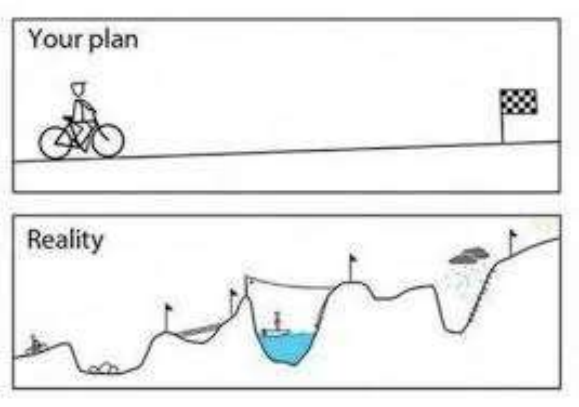
Then you can move onto brainstorming.





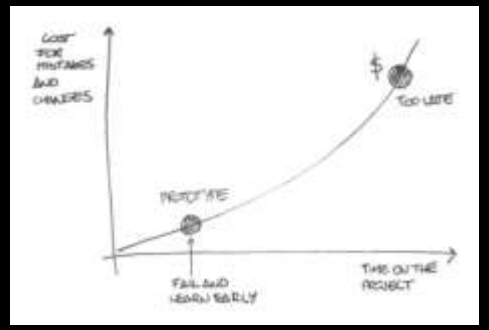


The Design Process
General Prototyping



1. Start early, fail early
2. Quickly fabricate low resolution prototypes using low cost materials
3. Test with users, measure, get feedback, analyze, reconsider, re-design, re-fabricate, refine
4. The current prototype should (ideally) inform your next design iteration

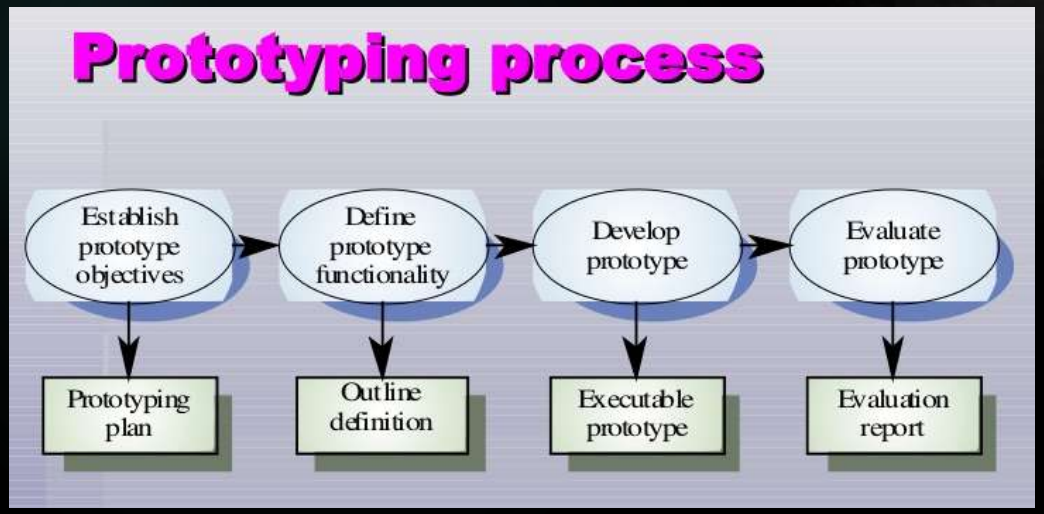
> Failure is an option here. If things are not failing, you are not innovating enough.
>
> — *Elon Musk* —

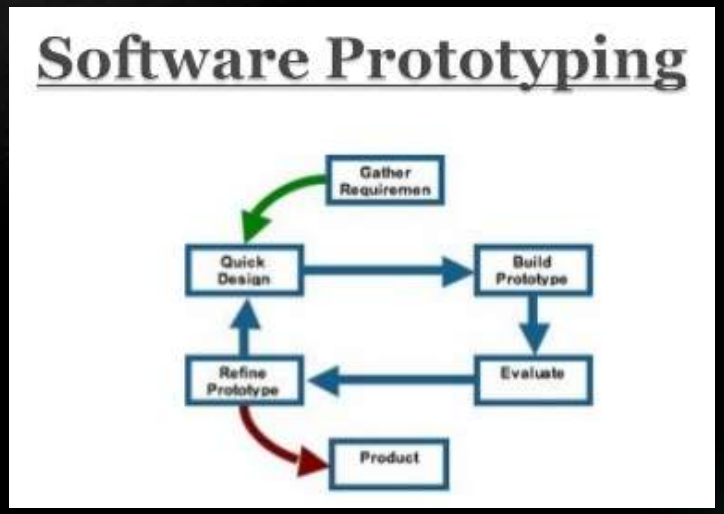


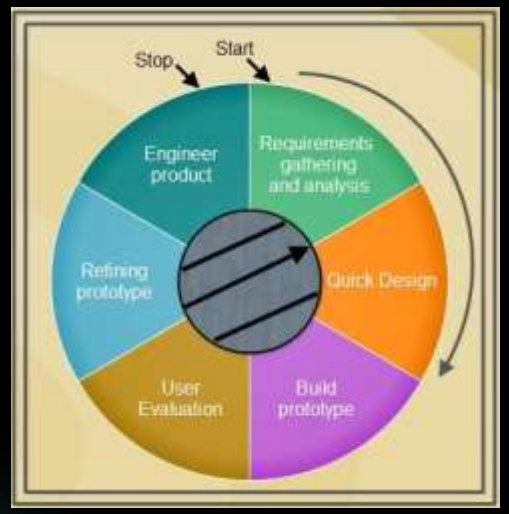
> Fail early, fail often, in order to succeed sooner.
>
> — *Tom Kelley* —

The Design Process
Software Prototyping Thoughts

1. It may be difficult to impossible to modify proprietary software
2. Understand development environment (APIs, apps)
3. Simulate software (screen display) with paper (or PowerPoint)







Example Assistive Technology Devices

- A project I worked on at the VA RR&D Center
- Commercial devices and research projects
- Technologies that have made an impact

Head Control Interface

- Features
  - 2 degrees of freedom
  - real-time operation
  - non-contact interface
  - front or rear sensing
  - mouse or joystick substitute
- Applications
  - control of mobility (electric wheelchair) contrast with voice control alternative
  - control of cursor position with hands on keyboard
  - demonstrated robot control

Head Control Interface Video

YouTube link

Example Assistive Technology Devices

Bionic Hand	Bionics
Luke Arm	Terminator Arm Fingers
Prosthetic Arm Design	iBot Wheelchair
Bionic Eye	Cochlear Implants
Joint Implants	Advanced Prosthetics
Personal Robot	Exoskeleton
Brain Computer Interface	Mind-controlled Limbs
3-D Printing	Project Daniel
Cyborg Beast	Robot Bed / Wheelchair
Google Glass	Designs for People with Dementia
Bionic Pets	Steampunk Wheelchair
Essential Tremor	Head Control Wheelchair
Ralph Fingerspelling Hand	Whill Wheelchair

Brain Computer Interface

- Noninvasive - picks up surface EEGs
- Determines 6 mental states - concentration / meditation
- Detects blinks
- Controls computer games
- Open API for other applications

NeuroSky's MindSet

$200

Mind-controlled Limbs

Humans can now move robotic limbs using only their thoughts and, in some cases, even get sensory feedback from their robotic hands. 60 Minutes

3-D Printing

"Officially launched in January 2012, Robohand creates affordable mechanical prosthetics through the use of 3D printers. Not only that, but it has made its designs open source, so that anyone with access to such printers can print out fingers, hands, and now arms as well."

Project Daniel

"A company called Not Impossible Labs has come up with one of the best uses for 3D printer technology we've ever heard of: printing low-cost prosthetic arms for people, mainly children, who have lost limbs in the war-torn country of Sudan."

Cyborg Beast

"Jeremy Simon from 3D universe was able to create a 3D-printed hand that he calls the Cyborg Beast. It's a completely mechanical device made from ABS plastic with a series of flexible cords that allow it to act like a real hand. It turned out so well that the patient says he prefers it for day-to-day use."

Infinity Gauntlet Orthotic

The Infinity Gauntlet is a powerful Dwarven glove owned by Thanos, who used it to channel the powers of the six Infinity Stones: Mind, Power, Reality, Soul, Space, and Time. When used in combination their already impressive powers make Thanos able to do anything he wants.

Buy it on Amazon

Robot Bed / Wheelchair

"A bed that transforms directly into a wheelchair. The mattress is split in half, with one side remaining firmly in place when the other half is separated to form the body of the chair. A patient simply needs to move over a few inches to one side, and with a few adjustments they'll be sitting upright in an powered wheelchair. A single caregiver assists during the transformation process, significantly reducing the burden on staff."

Panasonic

Xbox Adaptive Controller

Designed primarily to meet the needs of gamers with limited mobility, the Xbox Adaptive Controller is a unified hub for devices that helps make gaming more accessible.

Connect external devices such as switches, buttons, mounts, and joysticks to create a custom controllers experience that is uniquely yours. Button, thumb-stick and trigger inputs are controlled with assistive devices (sold separately) connected through 3.5mm jacks and USB ports.

Google Glass

Tammie Lou Van Sant of Santa Cruz is a quadriplegic. She has wanted to take pictures for years and now is able to do it independently using Google Glass - with a nod, swipe, or verbal command.

"I am a New Yorker, a law student, a quadriplegic. With Google Glass I could finally capture my life on my own. I would show the world how to thrive with physical limitations in the most interesting city on the planet. With Glass, paralysis doesn't have to be paralyzing." Alex Blaszczuk

Designs for People with Dementia

"A re-thinking of a table setting specifically tailored to help those with cognitive impairment eat without assistance." Sha Yao

Winner of Stanford Center on Longevity First Design Challenge

Bionic Pets

"Sometimes individual animals need our help. Left disabled without fins, flippers, beaks, or tails because of disease, accidents, or even human cruelty, these unfortunate creatures need what amounts to a miracle if they are to survive. Luckily for them, sometimes miracles do happen. Amazing prosthetics made possible by the latest engineering and technology are able to provide just what they need, and scientists are finding that innovations created in the process are benefiting both animals and humans."

PBS Nature

Steampunk Wheelchair

"Help us construct a retro-futuristic Steampunk Wheelchair for a 14 year old boy with Muscular Dystrophy. We want to modify a wheelchair to take it from 'functional' to 'awesome' to will help him gain confidence in his interactions by changing the focus of the conversation and expressing his uniqueness and individuality through his mobility device."

Essential Tremor

"A motion sensor and a tiny computer in Liftware's rechargeable base work together to analyze movement frequencies and distinguish unintentional tremor from intentional movements like bringing the spoon to your mouth. Based on that feedback, the utensil attachment compensates for the involuntary motion; if the tremor sends the base stabilizer to the left, the spoon head will adjust to the right."

iBot Wheelchair

- The Balance Function elevates the user to move around at eye level and to reach high places independently. In this function, the front wheels rotate up and over the back wheels, while the user remains seated at an elevated position.
- The Stair Function enables the user to safely climb up and down stairs, with or without assistance, giving them access to previously inaccessible places.
- The 4-Wheel Function enables the user to climb curbs as high as five inches and to travel over a variety of uneven terrain, such as sand, gravel, grass, thick carpet and other surfaces.

- Johnson & Johnson Independence Technology
- Toyota

weblink

Alexis Wheelchair

Whill Wheelchair

Student Projects from 2019

STUDENT
PROJECT
GALLERY

Perspectives in Assistive Technology

ENGR110/210

- Ten week course
- Teams of three
- Lectures, tours, faire, movie night
- Working with the community
- Two presentations and reports
- End-of-term demonstrations

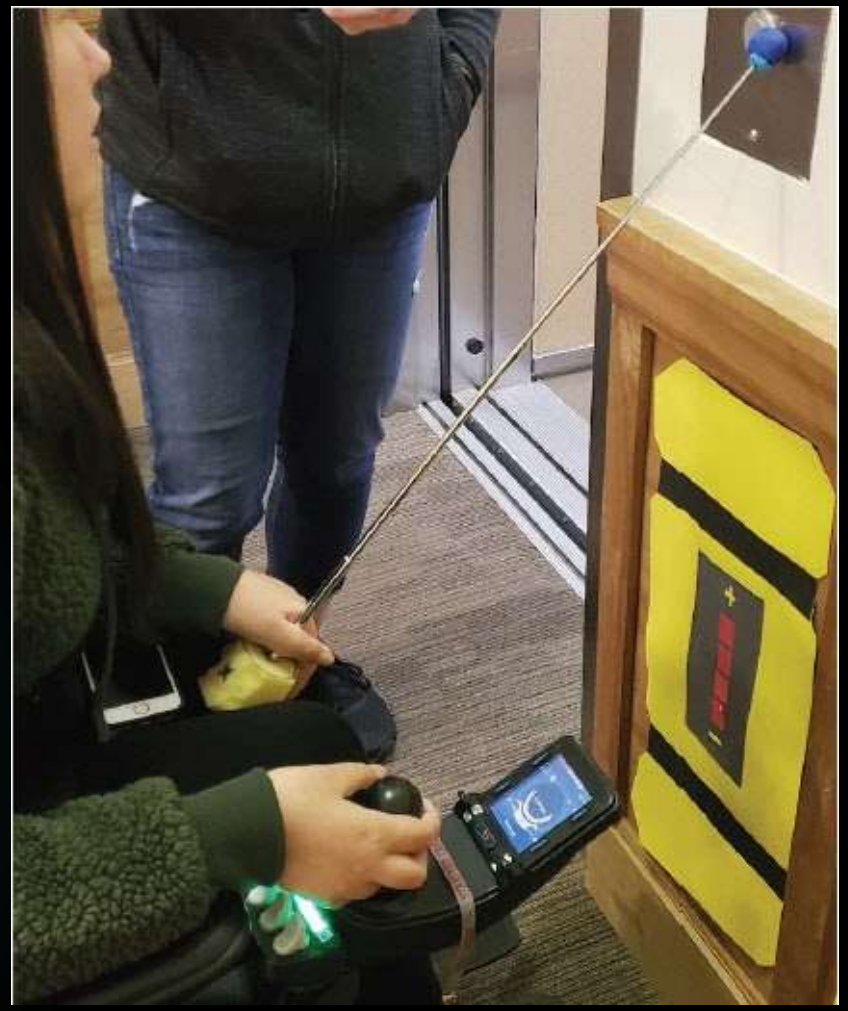
Secure Shopping Project for Abby

Explore ways to provide Abby, a power wheelchair user, a way to hold items she wishes to purchase while grocery shopping.

Pain-free Buckles for Abby's Service Dog

Explore solutions that will make it easier and less painful for Abby to operate buckles on her service dog's harness.

Elevator Button Pusher for Angie



Explore device designs that would enable Angie to ride elevators independently

Lap Tray for Danny

Explore designs that would provide Danny with a lap tray that he can easily deploy and stow given his reduced arm range of motion and limited hand dexterity.

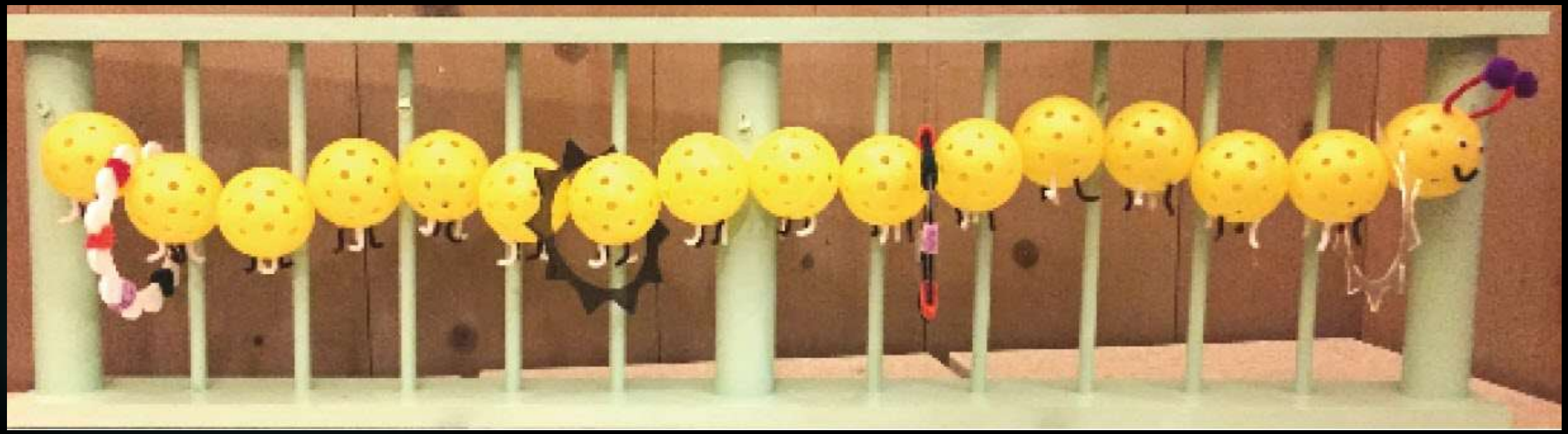
Water Bottle & iPhone Holder for Danny

Explore designs that would provide Danny with a device that would hold his water bottle and iPhone while using his manual wheelchair.

Pick Up Stick for Danny

Explore designs that would provide Danny with a device that would facilitate picking up dropped items from the floor.

Magical Bridge Playground Project



Explore designs to create new play and educational experiences along the playground fence that incorporate multiple senses, actions, and outcomes for all playground users and visitors, especially those with visual impairments and diminished fine motor skills.

Hide-Away Lap Tray for Nick

Explore designs that would provide Danny with a device that would prevent items from falling from his lap when operating his manual wheelchair.

Lap Extender for Tony

Explore designs for a wheelchair accessory that will not interfere with propulsion while Tony is carrying or using items such as a food tray or laptop computer.

Individual Student Project

ENGR110/210

- One student working to refine a prototype fabricated in a shop course
- One quarter - 10 weeks
- One unit credit
- Weekly coaching sessions
- Final Presentation & Report

Handy - Kevin Supakkul

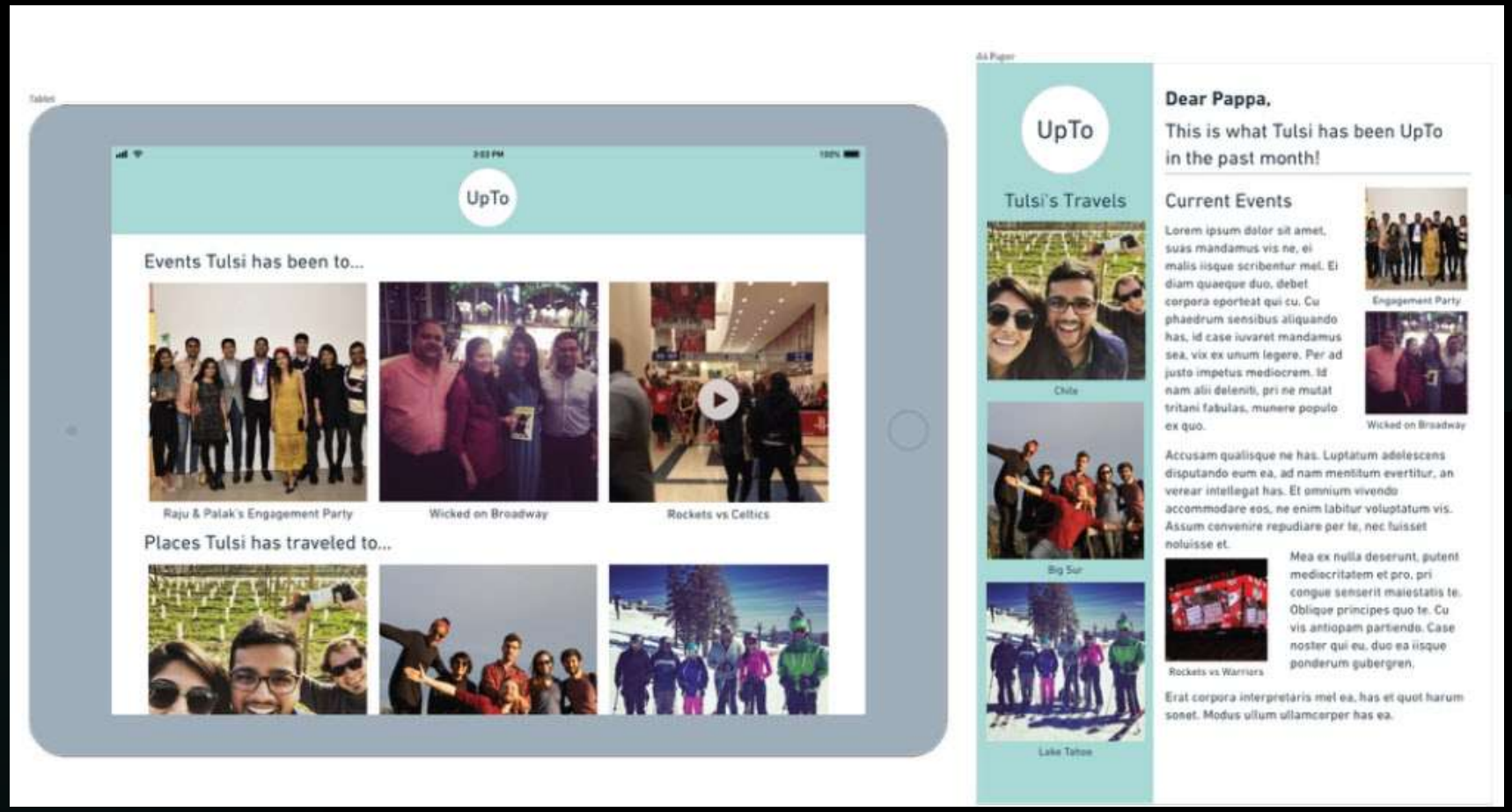
A refined grasper mounted to a wrist / hand brace for individual with carpal tunnel or other hand impairments.

Individual Student Project

ENGR110/210

- Two students working on a project that doesn't require mechanical fabrication
- One quarter - 10 weeks
- One unit credit
- Weekly coaching sessions
- Final Presentation & Report

Design for Intergenerational Impact



Explore new solutions that would enable younger and older adults to create and maintain personal connections.

Design Entrepreneurship and Innovation

ME310

- Three quarter graduate-level course
- Two teams of four: one from Stanford, one international
- Corporate sponsors
- End-of-term joint presentations and demonstrations

VW

Explore ways to allow a wheelchair user to independently board and ride an autonomous robo-taxi.

Contact

David L. Jaffe

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Perspectives in Assistive Technology (Winter Quarter)

http://engr110.stanford.edu

Questions?

Adjourn