

# Snap into Motion

Enabling Independent Liner Donning  
Sponsors: Lisa Huffman and the BAE Department



# Amputation

## Precedent:

- 34,000 transtibial amputations performed in the US each year

## Causes:

- Diabetes
- Severe injury
- Poor Circulation
- Infection
- Frostbite
- Cancerous tumor

## Most Common Types:

- Transfemoral- About the knee
- Transtibial- Below the knee

# Prosthetics for Amputees

## Fitting Process:

- Selection of components
- Prosthetic Socket
- Alignment of the prosthetic

## Components:

- Socket
- Liner/Sleeve
- Pin



# Amputee Limitations

## Personal Limitations:

- Hand dexterity
- Flexibility
- Weight
- Vision

## Effects of Limitations:

- Dependency on others
- Misalignment of the pin
- Suspension between the liner and limb

# Problem Statement

Design a donning system that will aid lower limb amputees don their prosthetic liner. The system will ensure that the liner sits flush against the limb, properly aligns the pin into the prosthetic, and enables those with low hand dexterity, vision, or flexibility to don their liner independently.

# Design Goals

The donning system should be:

- Comfortable
- Easy to use
- Work with commercial liners/prosthetic components
- Accommodate majority of patients
- Reduce strain for the patient
- Require little to no hand strength or dexterity.
- Aid inflexible individuals
- Properly align the pin
- Allow independent donning

# Project Learning

## Liner and pin data:

- Pin lengths range with standard pitch and diameter
- Liner matrix is a complex matrix: silicon, gel, etc.
- Liner thickness can vary between 3-9mm
- Commercial liner dimensions vary from Medium to Large ++
- Diameter change of a single liner: approx 62.5%

# Design Specifications

## Liner Compatibility Measurements:

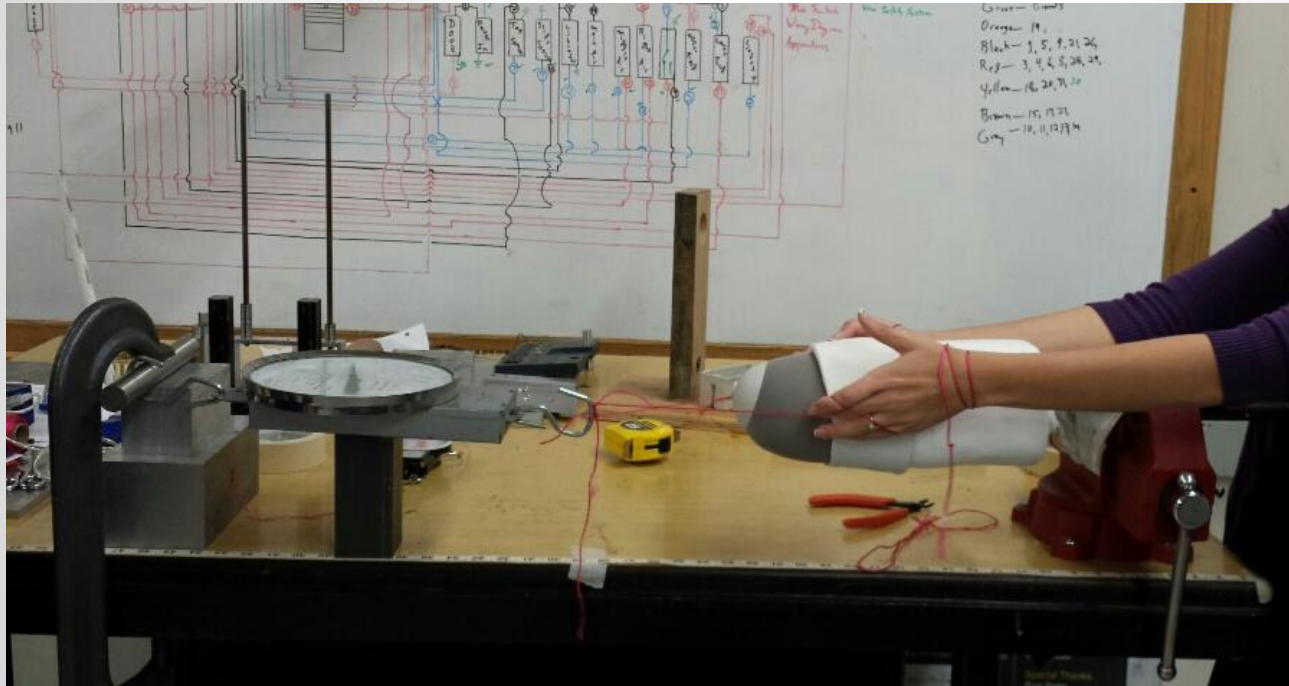
- Distal diameter from 2.5" to 12.0"
- Proximal diameter from 3.1" to 12.0"
- Target length from 12" to 16"

## Pin Compatibility Measurements:

- Diameter: 10 mm
- Length: 1" - 2.25"
- Pitch: 1.5 metric



# Testing

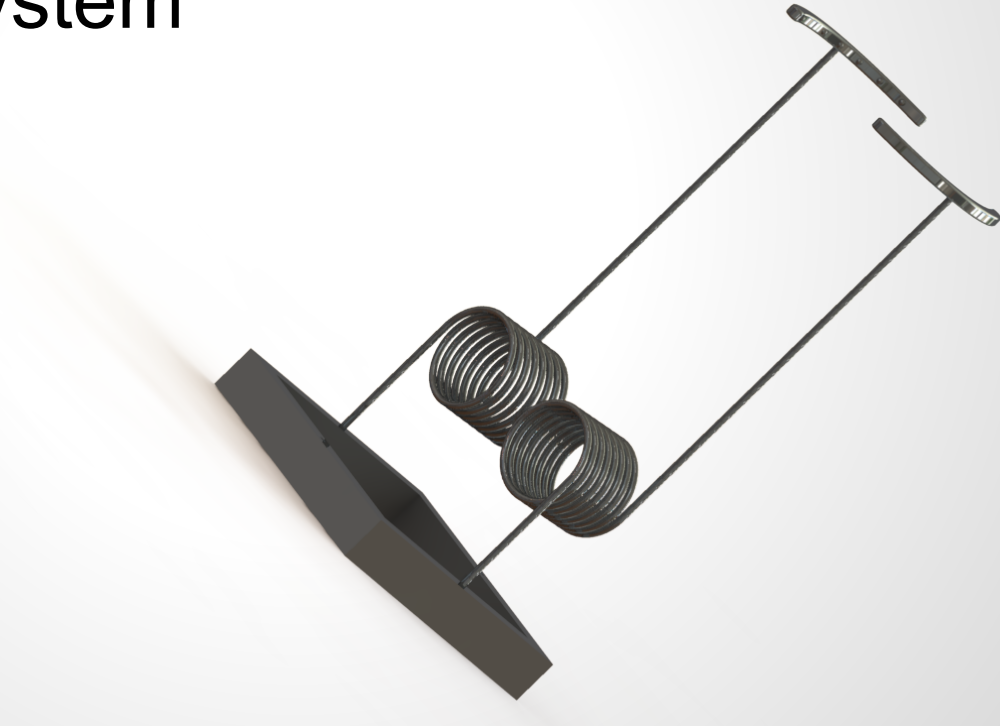
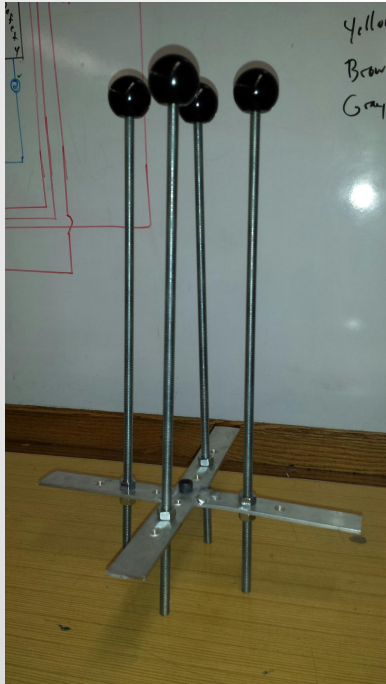


# Test Results

Distance up limb mold starting from umbrella	Average Pulling Force
2 in.	4 lbs
4 in.	5 lbs
6 in.	6 lbs
8 in.	8.5 lbs

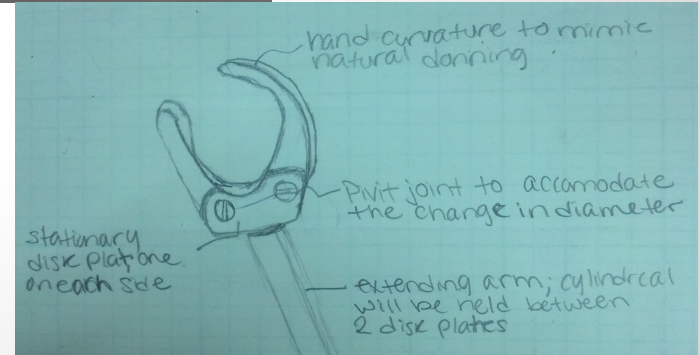
# Interior Donning Approach

## Flexible Arm System



# Garter Design Alternatives

- Multiple finials
- Crescent Shape
- Donning Hand



# Drive Design Alternatives

Alternative 1: Parallel Track Donning System

Alternative 2: Linear Actuator System

Alternative 3: Glider Track System



# Alternative 2: Linear Actuating System

## Pros:

- Simultaneous or alternating actuation
- Compact design
- Position/feedback control with potentiometer capabilities

## Cons:

- Multiple actuator timing
- Unstable Arm
- Cost



# Alternative 3: Glider Track System

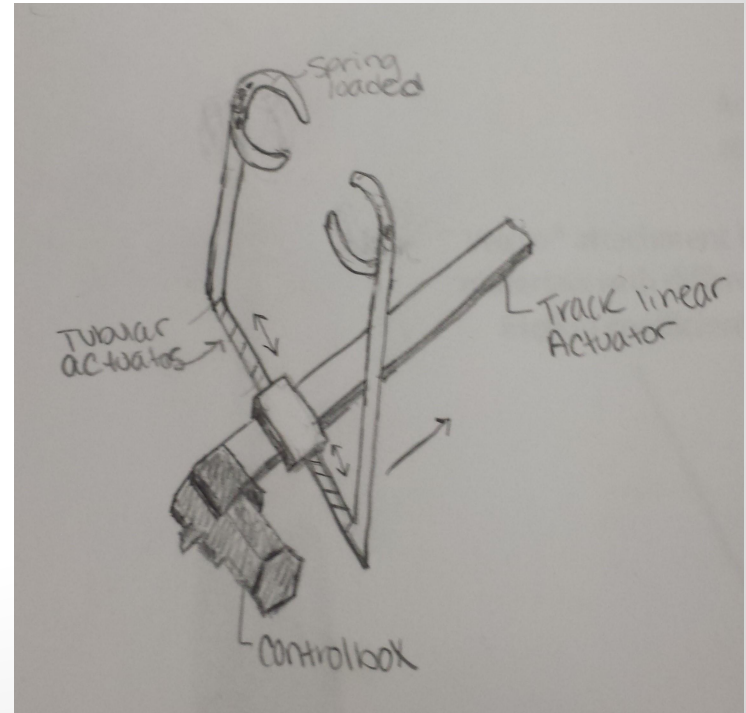
## Exterior Design Approach

### Pros:

- Single Track System
- Horizontal or Elevated
- Force/Speed
- Ground Support

### Cons:

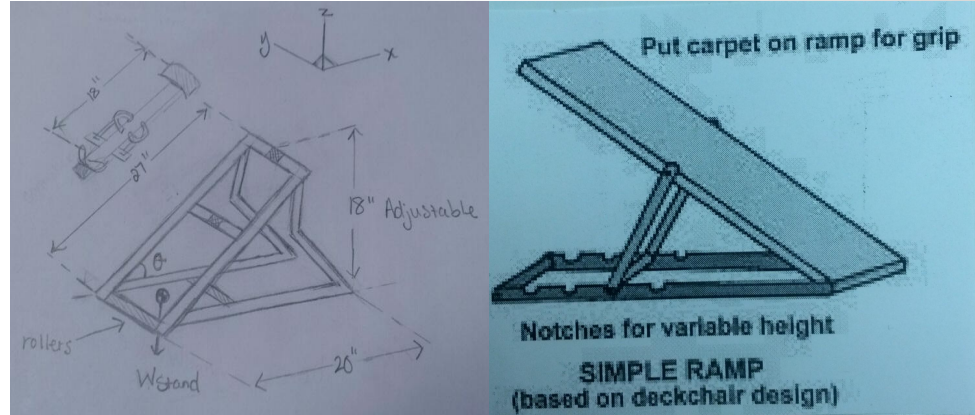
- Possible Arm Deflection





# Device Accessibility: Adjustable Donning Stand

- Collapsible
- Adjustable
- Accommodates Dynamic Loading
- Allows for Comfortable Donning Process



# Recommended Design



# Project Cost Estimations

- Glider Track: \$139
- Control Box: \$86
- Hand Remote: \$30
- Linear Actuators: \$100 - \$140
- Miscellaneous Costs:\$200
  - Garter
  - Connectors
  - Stand
- Total Cost Estimate:\$735

# Project Projections

- 3D Modeling/Dimensioning
- Utilize Robotics Department
- Order Parts and Devices
- Create Prototype