# Pusher Syndrome Assist Device:
## *Progress Report*

*Client: Audra Sturmoski, PT, MSPT, NCS*

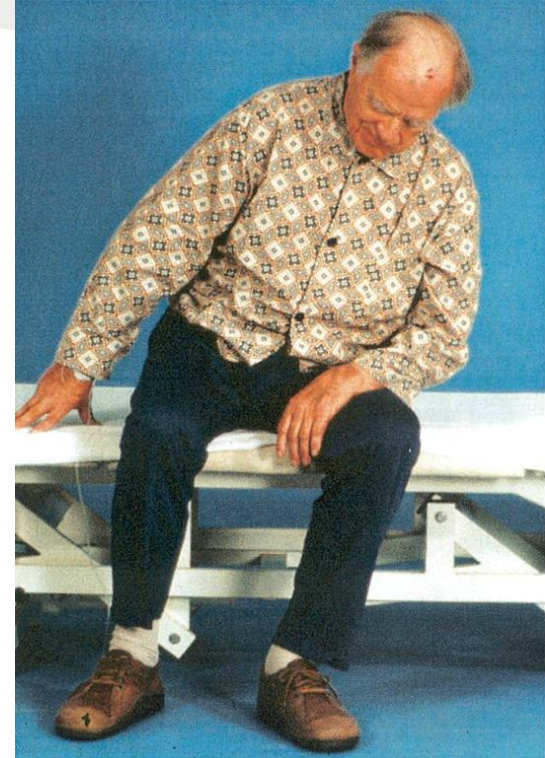*Group #13*
*Jake Hoyne*
*Pat Naureckas*
*David Glaubke*

# Background

- Stroke related condition

  o Patients "push" to their weak side

  o Internal sense of balance is distorted

- Falling risk

# Project Scope and Need

- Wearable device

  - Feedback in the absence of a physical therapist

  - Device will respond based off threshold

- Extend the amount of time spent learning correct orientation

- Physical Therapy Setting

  - Home Setting

# Specifications

| Device Specifications | |
|---|---|
| **Cost** | < $150 for the patient or <$1000 for the rehabilitation facility |
| **Weight** | <2.3kg |
| **Sampling Rate** | >6.66Hz |
| **Operable Displacement Range** | ±45 degrees in the coronal plane |
| **Precision** | >0.5 degrees |
| **Ease of Use** | Physical therapist and/or patient can operate with minimal technical training |
| **Wearable** | Must not interfere with sitting, standing, and walking comfortably<br>Must be able to operate for at least 60 minutes at a time |

# Design Categories

1. Sensor Design

2. Attachment Design

3. Feedback Design

# Design Alternatives - Sensor

- Pressure Sensor

- Tilt Switch

    ○ Gradient Tilt Switch

- Electrolytic Capacitive Tilt Sensor

- Microsoft Kinect for Windows

- Accelerometer/Gyroscope

    ○ Smartphone

# Design Alternatives - Sensor

- Pressure Sensor

- ~~Tilt Switch~~

  - Gradient Tilt Switch

- Electrolytic Capacitive Tilt Sensor

- Microsoft Kinect for Windows

- ~~Accelerometer/Gyroscope~~

  - Smartphone

# Design Alternatives - Sensor
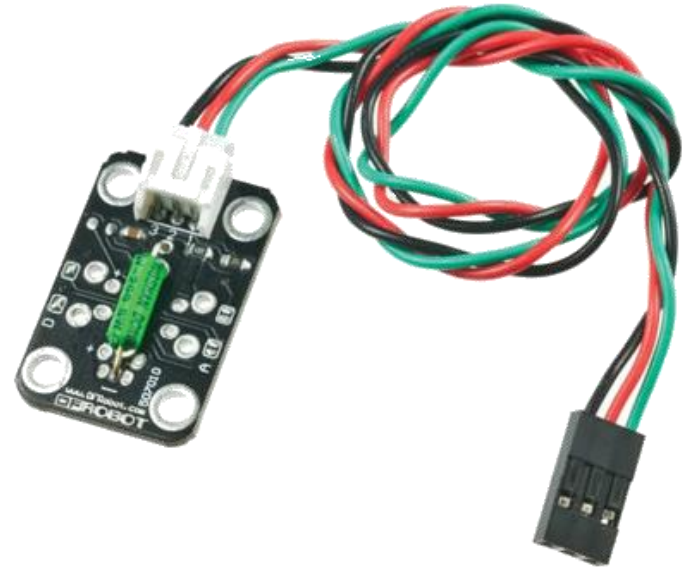
## Pressure Sensor

- Pros:
  - Inexpensive

- Cons:
  - Cannot be used while walking
  - Wired
  - Tedious setup

# Design Alternatives - Sensor

## Gradient Tilt Switch

- Pros:
  - Gradient feedback
  - Robust measurement
- Cons:
  - Complex circuit
  - Difficult user-interface

# Design Alternatives - Sensor

## Electrolytic Capacitive Tilt Sensor

- Pros:
  - Precision
  - Robust measurement
- Cons:
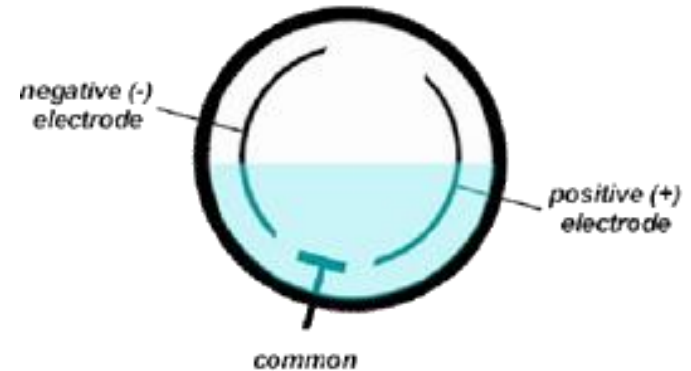  - Sampling rate
  - AC power supply
  - Small displacement range



figure 2 - sensor at +15 degrees, positive electrode submerged further than negative electrode into fluid

# Design Alternatives - Sensor

## Microsoft Kinect for Windows

- Pros:
  - Mobility
  - User Interface
- Cons:
  - Cost
  - Availability of computers
  - Sensor Range

# Design Alternatives - Sensor

## Smartphone

- Pros:
    - Future development
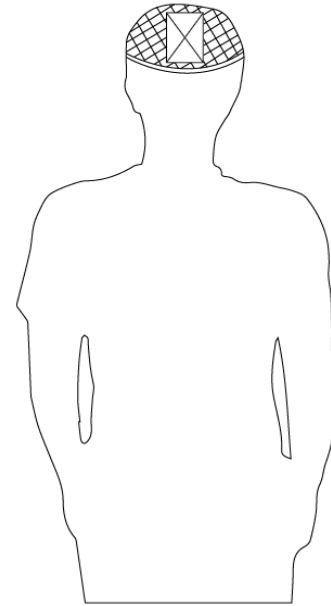    - Familiar user-interface
    - Updates
- Cons:
    - Cost

| | Weight | Pressure Sensor | Tilt Sensor | Gradient Tilt | Electrolytic | Kinect | Accel/Gyro | Smartphone |
|---|---|---|---|---|---|---|---|---|
| Cost | 7 | 8 | 8 | 7 | 8 | 3 | 7 | 5 |
| Weight | 8 | 7 | 9 | 7 | 6 | 10 | 6 | 7 |
| Precision | 7 | 4 | 6 | 7 | 10 | 8 | 8 | 8 |
| Displacement Range | 5 | 5 | 6 | 7 | 4 | 10 | 10 | 10 |
| Robustness | 6 | 5 | 2 | 6 | 6 | 9 | 8 | 9 |
| Sampling Rate | 4 | 7 | 10 | 7 | 2 | 8 | 7 | 7 |
| Ease of Use | 7 | 3 | 7 | 6 | 5 | 7 | 6 | 9 |
| Safety | 10 | 7 | 8 | 8 | 7 | 10 | 8 | 9 |
| Mobility | 9 | 4 | 7 | 7 | 2 | 7 | 7 | 7 |
| Calibration | 9 | 6 | 6 | 7 | 7 | 8 | 7 | 9 |
| Durability | 6 | 7 | 7 | 6 | 6 | 9 | 7 | 8 |
| Growth Potential | 5 | 2 | 1 | 4 | 4 | 7 | 6 | 10 |
| Total | | 456 | 545 | 557 | 480 | 666 | 599 | 674 |

| | Weight | Pressure Sensor | Tilt Sensor | Gradient Tilt | Electrolytic | Kinect | Accel/Gyro | Smartphone |
|---|---|---|---|---|---|---|---|---|
| Cost | 7 | 8 | 8 | 7 | 8 | 3 | 7 | 5 |
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| Growth Potential | 5 | 2 | 1 | 4 | 4 | 7 | 6 | 10 |
| Total | | 456 | 545 | 557 | 480 | 666 | 599 | 674 |

# Design Alternatives - Attachment

- **Hat**
- Necklace
- Harness
- Vest
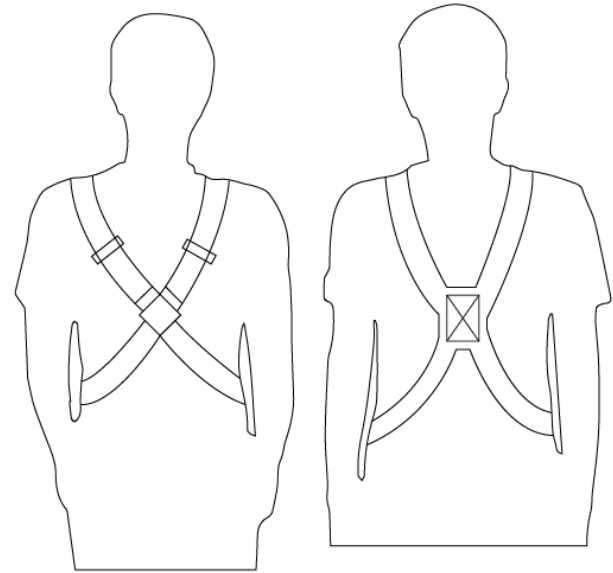- Belt
- Belt with shoulder straps

# Design Alternatives - Attachment

- Hat
- **Necklace**
- Harness
- Vest
- Belt
- Belt with shoulder straps

# Design Alternatives - Attachment

- Hat

- Necklace

- **Harness**

- Vest

- Belt

- Belt with shoulder straps

# Design Alternatives - Attachment

- Hat

- Necklace

- Harness

- **Vest**

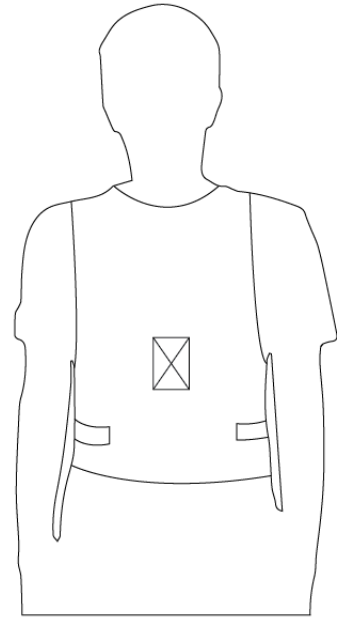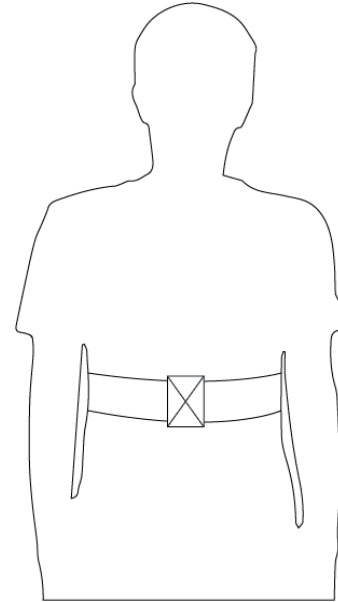- Belt

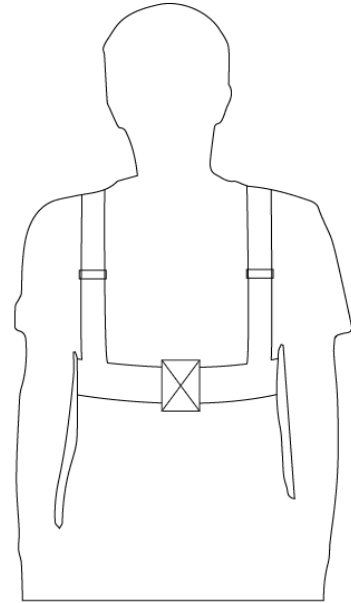- Belt with shoulder straps

# Design Alternatives - Attachment

- Hat

- Necklace

- Harness

- Vest

- **Belt**

- Belt with shoulder straps

# Design Alternatives - Attachment

- Hat
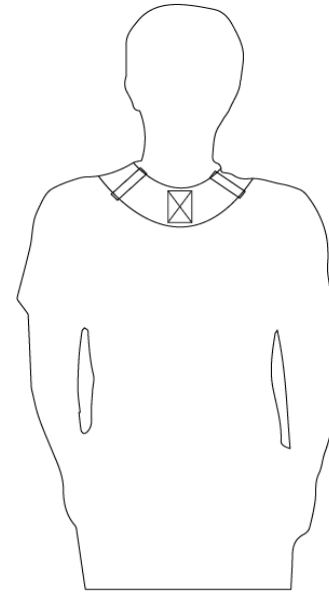
- Necklace

- Harness

- Vest

- Belt

- **Belt with shoulder straps**

# Pugh Chart - Attachment

|  | Weight | Hat | Necklace | Harness | Vest | Belt | Belt with shoulder straps |
|---|---|---|---|---|---|---|---|
| **Aesthetics** | 5 | 1 | 5 | 9 | 5 | 9 | 9 |
| **Weight** | 8 | 8 | 8 | 7 | 6 | 7 | 7 |
| **Cost** | 7 | 7 | 7 | 7 | 5 | 7 | 7 |
| **Comfort** | 7 | 4 | 5 | 7 | 6 | 7 | 8 |
| **Adjustability** | 8 | 7 | 8 | 9 | 3 | 9 | 9 |
| **Safety** | 10 | 9 | 8 | 9 | 9 | 8 | 8 |
| **Mobility** | 9 | 10 | 9 | 8 | 5 | 9 | 8 |
| **Stability** | 9 | 1 | 3 | 9 | 8 | 7 | 9 |
| **Durability** | 6 | 8 | 9 | 9 | 9 | 9 | 9 |
| **Total** |  | **439** | **479** | **568** | **435** | **549** | **565** |

# Pugh Chart - Attachment

| | Weight | Hat | Necklace | Harness | Vest | Belt | Belt with shoulder straps |
|---|---|---|---|---|---|---|---|
| **Aesthetics** | 5 | 1 | 5 | **9** | 5 | 9 | 9 |
| **Weight** | 8 | 8 | 8 | **7** | 6 | 7 | 7 |
| **Cost** | 7 | 7 | 7 | **7** | 5 | 7 | 7 |
| **Comfort** | 7 | 4 | 5 | **7** | 6 | 7 | 8 |
| **Adjustability** | 8 | 7 | 8 | **9** | 3 | 9 | 9 |
| **Safety** | 10 | 9 | 8 | **9** | 9 | 8 | 8 |
| **Mobility** | 9 | 10 | 9 | **8** | 5 | 9 | 8 |
| **Stability** | 9 | 1 | 3 | **9** | 8 | 7 | 9 |
| **Durability** | 6 | 8 | 9 | **9** | 9 | 9 | 9 |
| **Total** | | 439 | 479 | **568** | 435 | 549 | 565 |

# Design Alternatives - Feedback

- Auditory

  o Fast reaction time

  o Background noise

- Vibration

  o More accurate response

  o Slower reaction time

  o Uncomfortable

# Design Alternatives - Feedback

- Multimodal System

  o Prevents system overload

  o Decrease chance of missing feedback

- Auditory and Vibration

  o Controled by user-interface

  o Allow for user's preferences

# Smartphone Choice

- Android

- Windows Phone

- Blackberry

- iPhone

- iPod Touch

# Smartphone Choice

- Android (Droid Mini)

- Windows Phone (Lumia 620)

- ~~Blackberry~~

- iPhone (iPhone 5)

- iPod Touch

# Pugh Chart - Smartphone

| | Weight | iPhone | iPod Touch | Windows | Android |
|---|---|---|---|---|---|
| **Cost** | 8 | 5 | 8 | 7 | 6 |
| **Unification** | 6 | 8 | 8 | 6 | 6 |
| **Development** | 7 | 6 | 6 | 6 | 8 |
| **Weight** | 8 | 8 | 8 | 8 | 8 |
| **Size** | 7 | 8 | 8 | 8 | 8 |
| **Battery Life** | 6 | 8 | 8 | 5 | 8 |
| **Market Share** | 3 | 7 | 8 | 3 | 8 |
| **Feedback** | 7 | 8 | 6 | 8 | 8 |
| **Future Potential** | 5 | 8 | 5 | 8 | 8 |
| **Total** | | **415** | **413** | **389** | **428** |

# Pugh Chart - Smartphone

| | Weight | iPhone | iPod Touch | Windows | Android |
|---|---|---|---|---|---|
| **Cost** | 8 | 5 | 8 | 7 | **6** |
| **Unification** | 6 | 8 | 8 | 6 | **6** |
| **Development** | 7 | 6 | 6 | 6 | **8** |
| **Weight** | 8 | 8 | 8 | 8 | **8** |
| **Size** | 7 | 8 | 8 | 8 | **8** |
| **Battery Life** | 6 | 8 | 8 | 5 | **8** |
| **Market Share** | 3 | 7 | 8 | 3 | **8** |
| **Feedback** | 7 | 8 | 6 | 8 | **8** |
| **Future Potential** | 5 | 8 | 5 | 8 | **8** |
| **Total** | | 415 | 413 | 389 | **428** |

# Final Chosen Design

- Sensor:
  - Android smartphone, such as the Droid Mini

- Attachment:
  - Harness

- Feedback:
  - Auditory and Vibrational

# Design Schedule



|  | SEPTEMBER | | | | | OCTOBER | | | | | NOVEMBER | | | | | DEC. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 2 | 9 | 16 | 23 | 30 | \| | 7 | 14 | 21 | 28 | \| | 4 | 11 | 18 | 25 | \| | 2 | 10 |

PROJECT INITIATION
PROJECT SELECTION
PROJECT SCOPE
BACKGROUND RESEARCH
PROJECT SPECIFICATION
PRELIMINARY WRITTEN REPORT
PRELIMINARY ORAL REPORT
WEBSITE

CONCEPT GENERATION
ANALYSIS OF DESIGNS
RISK ANALYSIS
FEASIBILITY REPORT
PROGRESS WRITTEN REPORT
PROGRESS ORAL REPORT

MECHANIAL DRAWINGS
REQUIRED PARTS
FINAL DESIGN ANALYSIS
FINAL WRITTEN REPORT
FINAL ORAL REPORT
PROJECT POSTER

: IN PROGRESS        : DEADLINE

# Member Responsibilities

| | JAKE | DAVID | PAT |
|---|---|---|---|
| IDEA GENERATION | ■ | ■ | ■ |
| **DEVICE COMPONENTS** | | | |
| SENSOR/INTERNAL COMPONENTS | | | ■ |
| FEEDBACK SYSTEM | | | ■ |
| USER INTERFACE | ■ | | |
| WEARABLE COMPONENT | | ■ | |
| ATTACHMENT TO PATIENT | | ■ | |
| MATHEMATICAL CALCULATIONS | | | ■ |
| **RESEARCH** | | | |
| FEASIBILITY | ■ | ■ | ■ |
| LITERATURE SEARCH | ■ | | ■ |
| EXISTING PRODUCTS | ■ | | |
| PRICES + QUOTES | | ■ | |
| RISK ASSESSMENT | ■ | ■ | ■ |
| WEBSITE | ■ | | |
| CLIENT INTERACTION | ■ | | |
| **PRESENTATIONS** | | | |
| PRELIMINARY | | | ■ |
| PROGRESS | ■ | | |
| FINAL | | ■ | |
| **REPORTS** | | | |
| INITIALIZING | | ■ | |
| EDITING | ■ | ■ | ■ |
| FIGURES AND SKETCHES | ■ | ■ | |
| SCHEDULING | ■ | | |
| INTELLECTUAL PROPERTY | | | ■ |

# Questions?

# References

# References

# Design Alternatives - Sensor

## Tilt Switch

- Pros:
  - Inexpensive
  - Lightweight
- Cons:
  - Not robust
  - No potential for growth
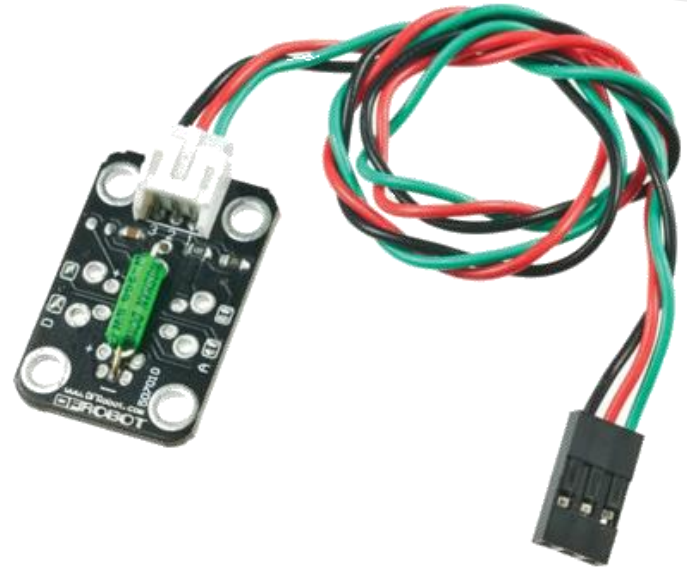
# Design Alternatives - Sensor
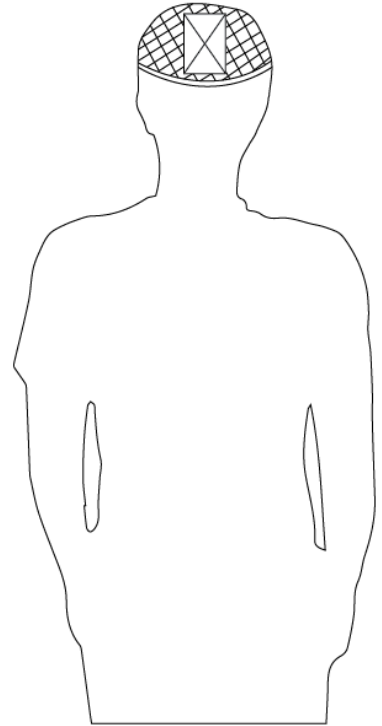
## Accelerometer/Gyroscope

- Pros:
  - Robust
  - Displacement Range
- Cons:
  - Cost
  - Difficult user-interface
  - Ease of use
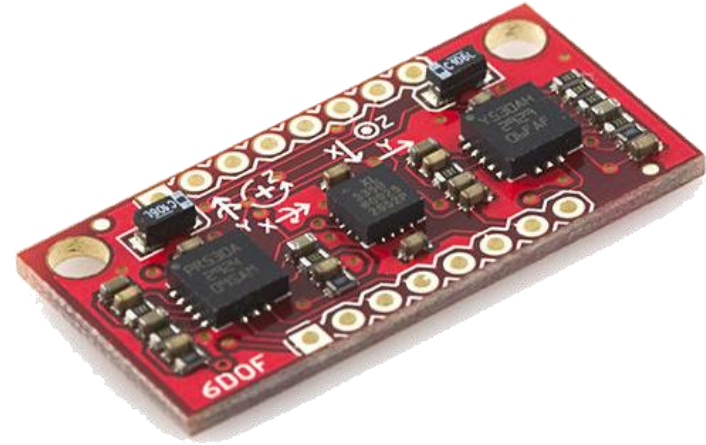
# Design Alternatives - Attachment
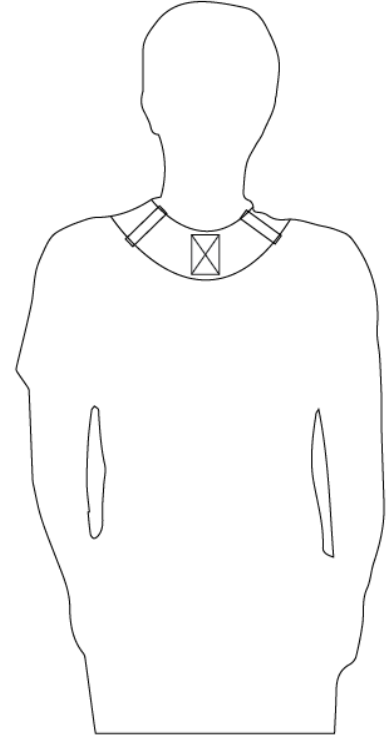
## Hat

- Pros:
  - Mobility
  - Cost
- Cons:
  - Aesthetics
  - Lack of precision

# Design Alternatives - Attachment

## Necklace

- Pros:
  - Arm motion

- Cons:
  - Could spin around neck
  - Not discreet

# Design Alternatives - Attachment
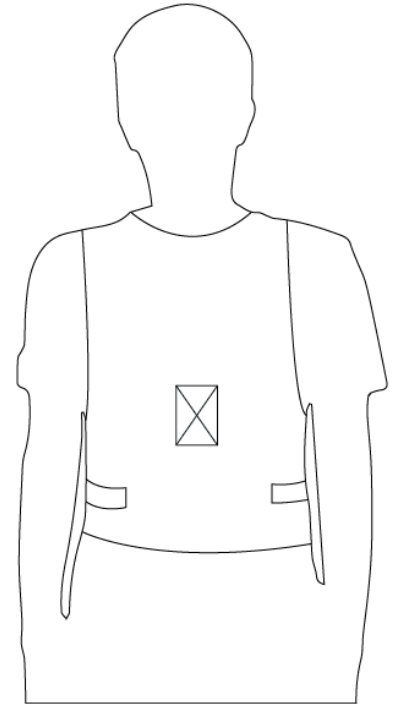
## Backpack

- Pros:
  - Stable
  - Adjustable
- Cons:
  - Complicated
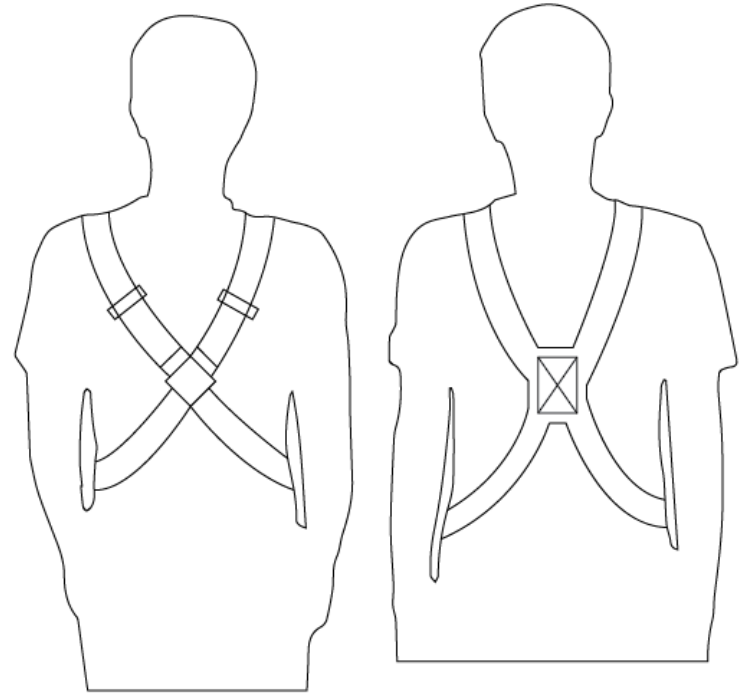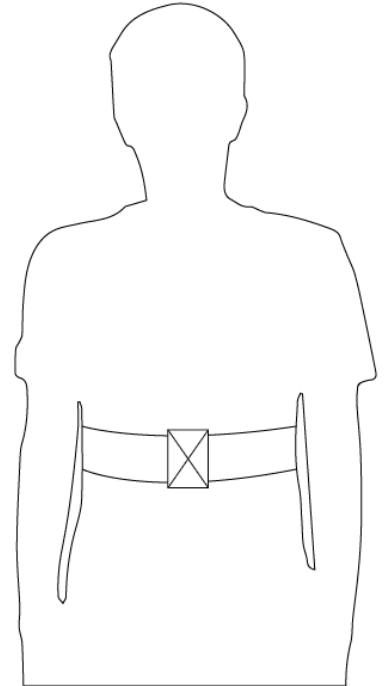
# Design Alternatives - Attachment

## Vest

- Pros:
  - Stability
- Cons:
  - Discreet
  - Size not adjustable
  - Lots of material

# Design Alternatives - Attachment

## Belt

- Pros:
  - Discreet
  - Minimal material
- Cons:
  - Rotation around torso
  - Uncomfortable

# Design Alternatives - Attachment

## Belt with Shoulder Straps

- Pros:
  - Increased stability
  - Better weight distribution
- Cons:
  - Possibly uncomfortable