PUSHER SYNDROME ASSIST DEVICE

FINAL REPORT

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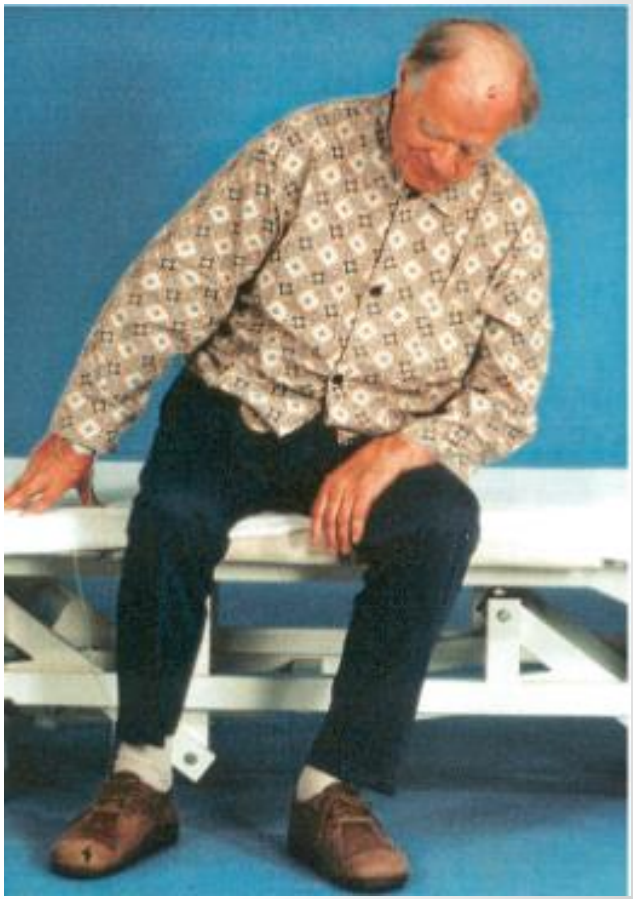
CLIENT: Audra Sturmoski, *PT, MSPT, NCS*

BACKGROUND

- Pusher Syndrome
  - 10% of hemiparetic patients
  - Characteristic leaning posture
    - Distorted sense of gravity
  - Risk of fall or injury
  - Physical therapy



NEED

- Device-based solution to detect and notify of leaning posture
  - Feedback to patient without PT monitoring
  - Extend amount of posture feedback
    - Improve default posture in shorter time
- Physical therapy setting
  - Future use at home

SOLUTION

- Developed an Android software application
  - Cost-effective and accessible method of distributing software in volume
  - Devices include necessary sensors
- Designed accompanying phone caddy and harness
  - Hold the phone securely to the patient

REQUIREMENTS

- Software
  - Obtain positional data
    - Accurate to 0.5 degrees
  - Alerts user in real-time when leaning past threshold
    - 6.66 Hz sampling rate
  - Intuitive GUI
    - Use by minimally trained therapists and elderly patients
  - Ability to modulate threshold value, feedback type

REQUIREMENTS

- Phone caddy
  - Fit any Android smartphone
  - Hold phone stably and securely
  - Useable with minimal dexterity
- Harness
  - Safe and comfortable
  - Adjustable to fit all patients
  - Hold phone caddy stably and securely
  - Useable with minimal dexterity

SOFTWARE

- Device requirements
  - Android 2.3 (Gingerbread) or later
    - December 2010, 98.3% of devices
  - 4 MB of free storage space
  - 10 MB available RAM
  - Accelerometer and magnetometer
    - Present on Android 2.3+ devices
  - CPU requirement
    - Met by all Android 2.3+ devices
    - 1.2 GHz processor shows 4% usage

SOFTWARE

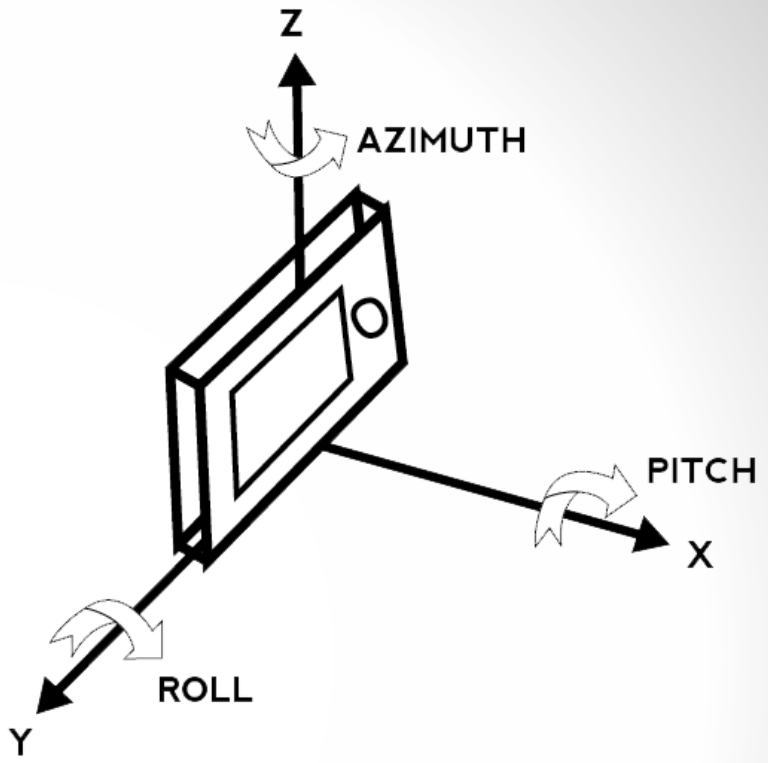
- Specifications
  - Precise to 1.0×10^{-6} degrees
  - ±90° range in coronal plane
  - Sensor sampling rate of 16.67 Hz
  - Time lag negligible while app is in use
    - Intentional 1.5 second delay for threshold response

SOFTWARE

- Development costs

ITEM	HOURS	COST (@ $150/HR)
User interface planning	5	$750
User interface development	10	$1500
Sensor, feedback development	15	$2250
Debugging	5	$750
FUTURE GOALS		
Local non-PHI data storage	5	$750
HIPAA-secure database for patient and physician access	50	$7500
Complete user preferences	5	$750
Fall sensor	7	$1050
TOTAL	**104**	**$15,200**

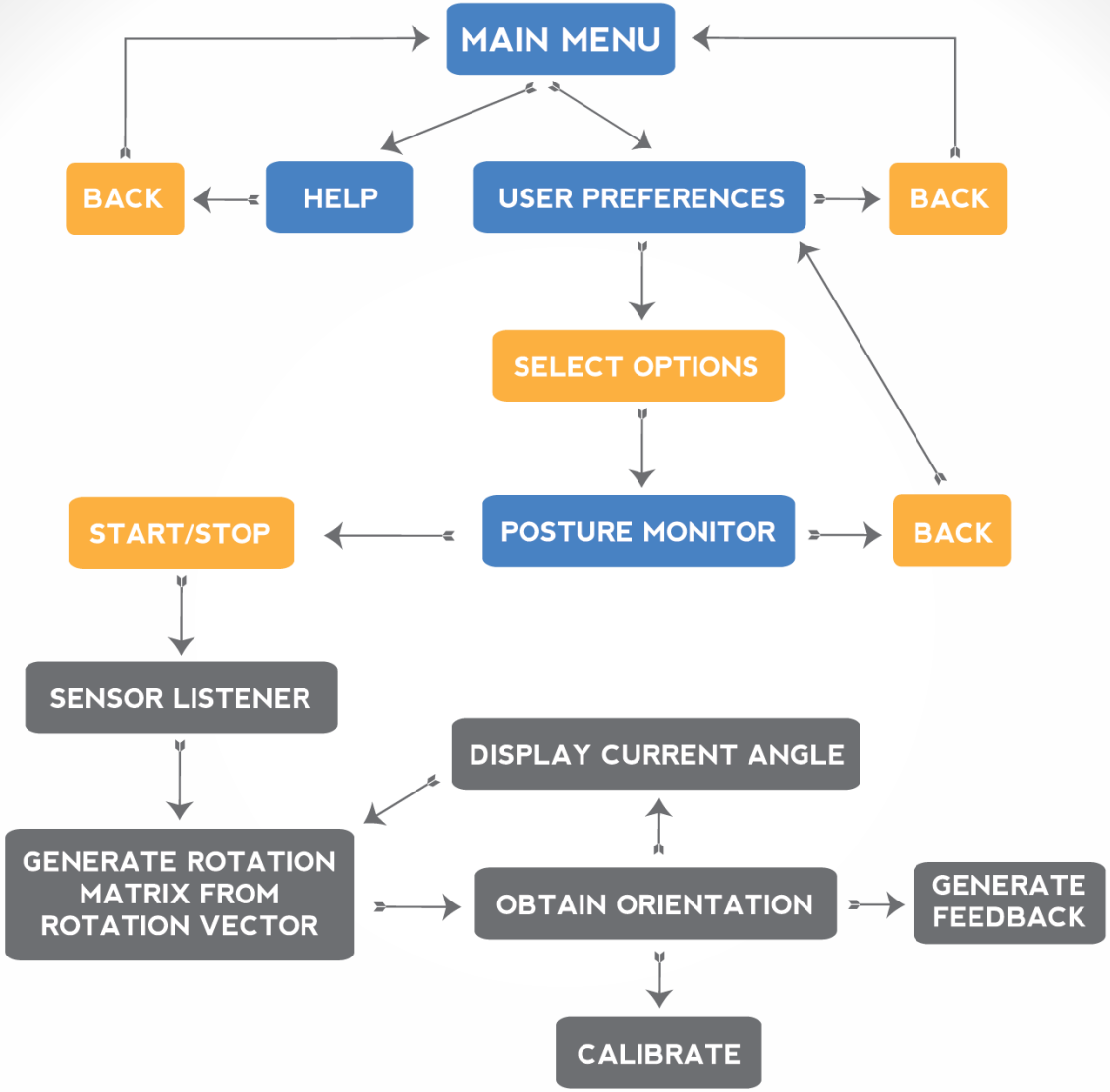
SOFTWARE



- Orientation data
  - Interested in pitch
- Calibration
  - Prevents need for perfect orientation of device with respect to patient
  - Uses first data point after “Start” is pressed as a reference point for all future position data

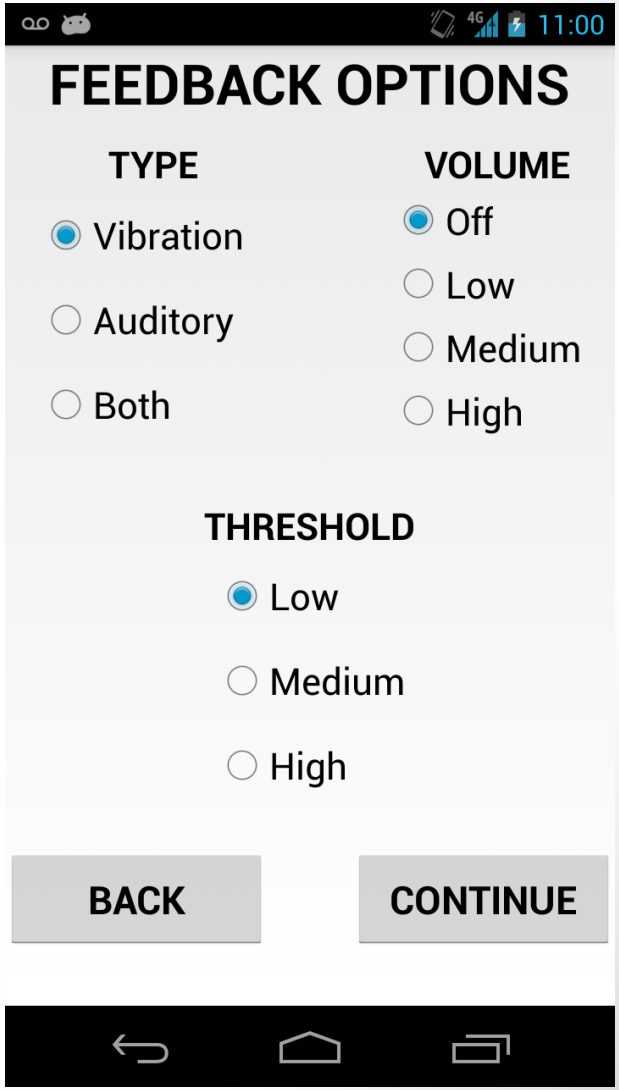
SOFTWARE

- Rotation vector algorithm
  - Code from SDK of Android 2.3 and later
  - Obtains rotation vector from accelerometer and magnetometer data
    - Transforms the phone's position, described by this vector, to the earth's reference frame, creating a rotation matrix
      - Matrix describes interplay between position of the phone and the reference frame of the earth
      - Orientation is obtained from this rotation matrix


MAIN MENU
BACK
HELP
USER PREFERENCES
BACK
SELECT OPTIONS
START/STOP
POSTURE MONITOR
BACK
SENSOR LISTENER
DISPLAY CURRENT ANGLE
GENERATE ROTATION MATRIX FROM ROTATION VECTOR
OBTAIN ORIENTATION
GENERATE FEEDBACK
CALIBRATE
KEY:
JAVA CLASS
USER INPUT
JAVA METHOD

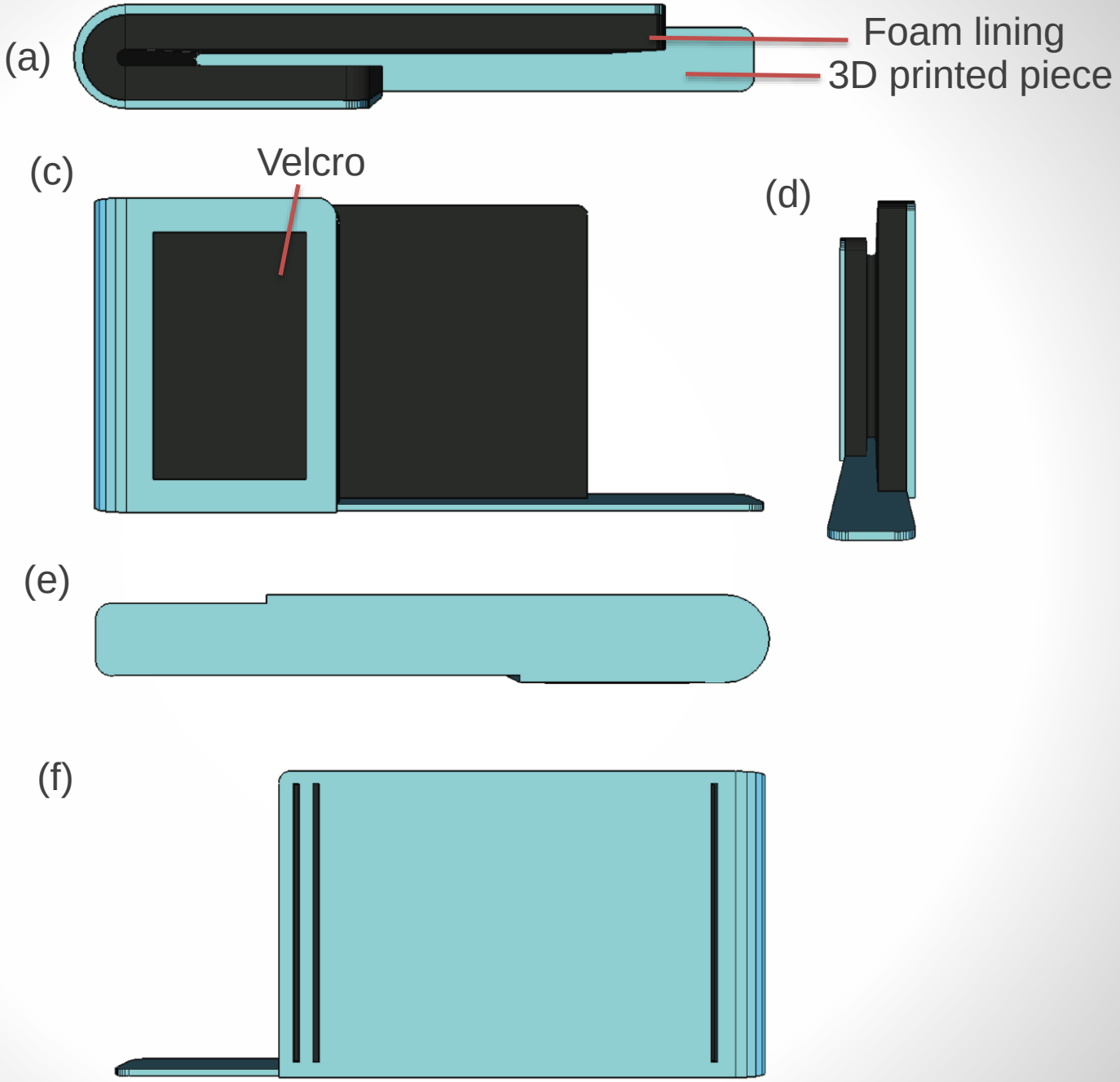
GUI


12:11
PUSHER SYNDROME
ASSIST DEVICE
BEGIN
HELP


11:00
FEEDBACK OPTIONS
TYPE
Vibration
Auditory
Both
VOLUME
Off
Low
Medium
High
THRESHOLD
Low
Medium
High
BACK
CONTINUE

HARDWARE

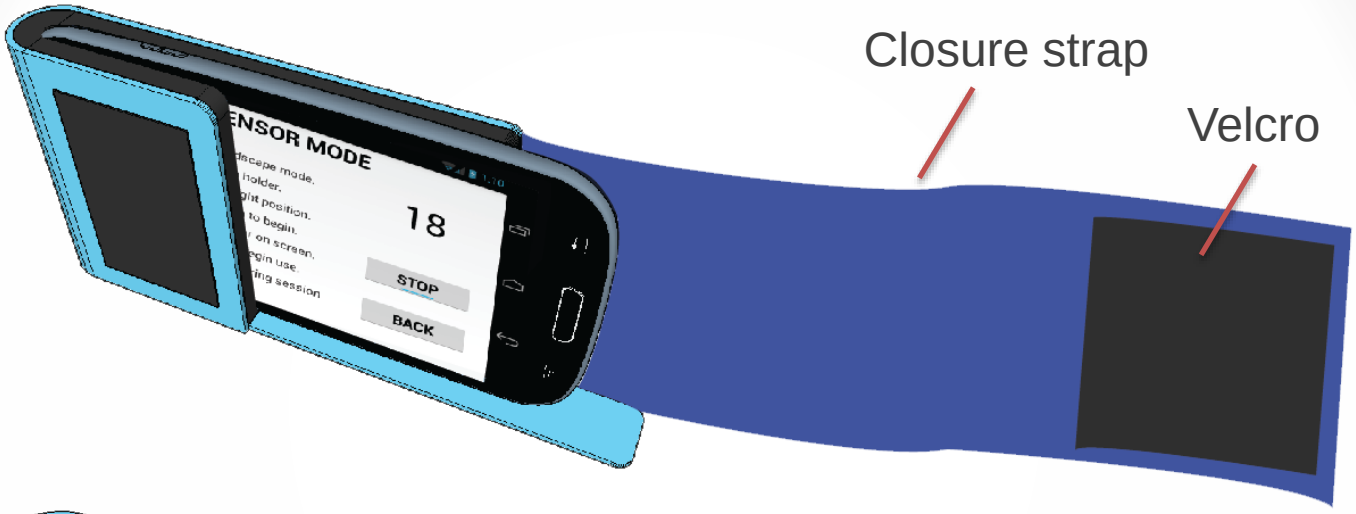
- Phone caddy



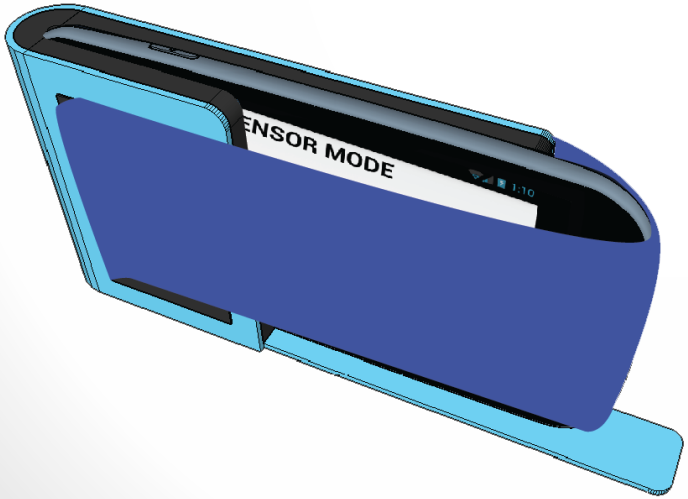
(a) Top
(b) Left side
(c) Front
(d) Right side
(e) Bottom
(f) Back

HARDWARE

(a)



(b)



(a) Closure strap open
(b) Closure strap closed

HARDWARE

- Analysis of all Android phones made to date

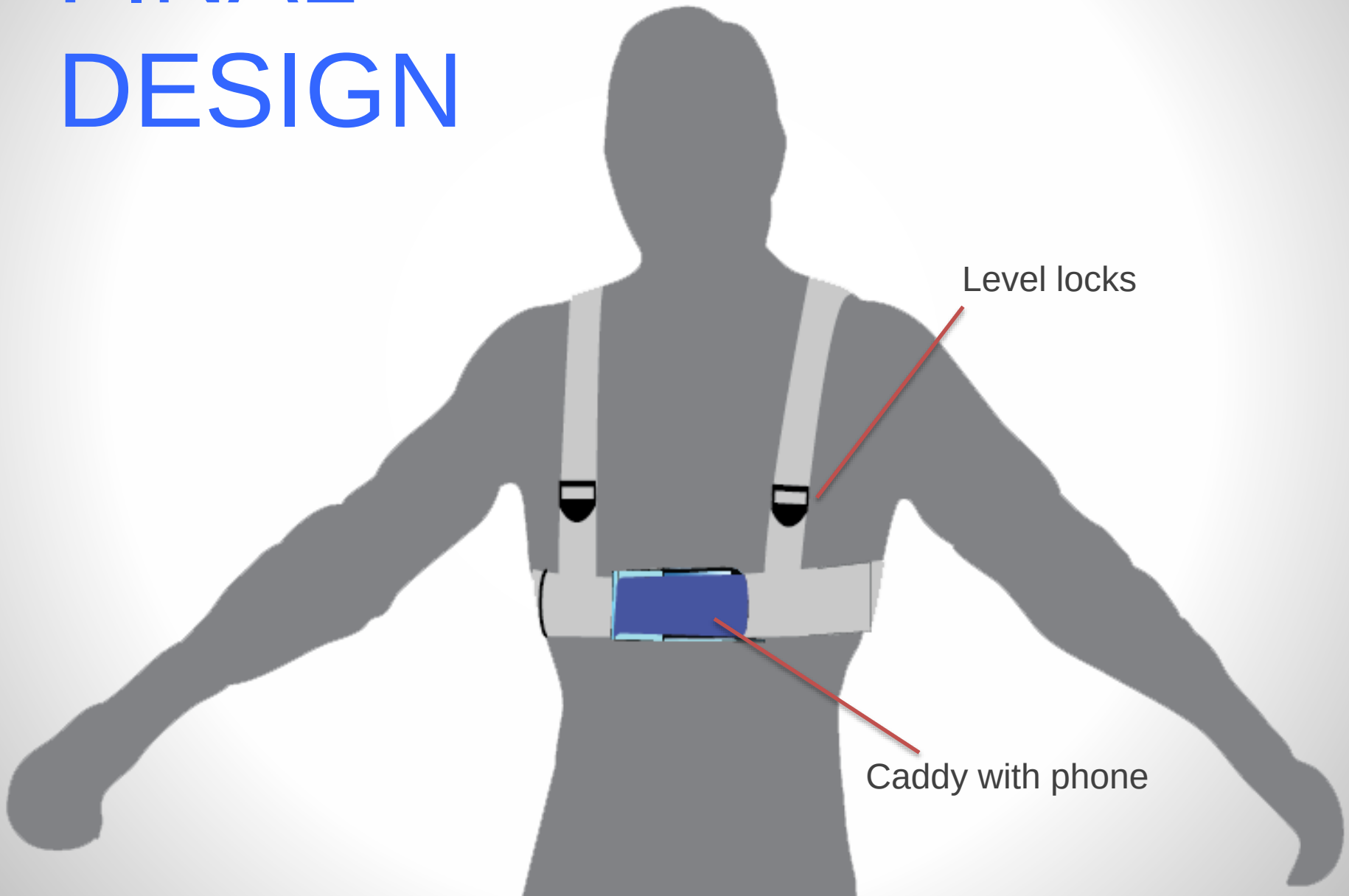
DIMENSION	LOWEST	HIGHEST	RANGE
Length	4.10 in	5.45 in	1.35 in
Width	2.30 in	2.79 in	0.49 in
Thickness	0.28 in	0.63 in	0.35 in

  - Caddy designed to accommodate all of them
    - Foam lining compresses to accommodate thickness
    - Velcro closure strap stretches to accommodate length
    - Width is open to the air, no restriction
      - Walls are high enough to protect the screen

HARDWARE

- Harness
  - Shoulder straps are adjustable
    - Size of patient or any physical irregularities
  - Belt portion closes by Velcro
  - Constructed from polyester-Spandex blend
    - Slight stretch, comfortable, cleanable

FINAL DESIGN



HARDWARE (PROTOTYPE)

ITEM	COMPANY	COMPONENT	PRICE ($)	SHIPPING ($)
2 1/2 inch fabric	CTS	ELASTIC-04K212W	3.00	2.50
1 1/2 inch fabric	AHH	W20I-RBPO-ELAS-1500-BK	6.46	10.90
Ladder Locks	AHH	LLP150	2.58	“
Velcro Hook	AHH	VRN200	1.50	“
Velcro Loop	AHH	VRN200	3.00	“
2 1/2 inch loop	Berkeley Point	S0139-Rxxx	4.48	6.95
3D Printing	Shapeways	N/A	35.94	6.50
Foam insert	Foam Factory	Polyethylene Foam Roll	3.59	12.99
TOOLS				
Fabric Cutter	AHH	TWC001	130.00	20.00
Sewing Awl	AHH	STH001	18.00	“
77 Adhesive	3M	62487649303	13.60	6.95
TOTAL			222.15	66.79
TOTAL + SHIPPING				**288.94**

HARDWARE (PRODUCTION)

ITEM	COMPANY	COMPONENT	QUANTITY	UNIT PRICE ($)	EXTENDED PRICE ($)	SHIPPING ($)	UNIT SHIPPING ($)
2 1/2 inch fabric	CTS	ELASTIC-04K212W	4266 Yards	0.52	522.00	82.23	0.08223
1 1/2 inch fabric	AHH	W20I-RBPO-ELAS-1500-BK	1750 Yards	1.98	1978.37	375.00	0.375
Ladder Locks	AHH	LLP150	2000	0.65	645.00	75.00	0.075
Velcro Hook	AHH	VRN200	150 yards	0.25	251.13	20.00	0.02
Velcro Loop	AHH	VRN200	700 yards	1.16	1163.39	175.00	0.175
2 1/2 inch loop	Berkeley Point	S0139-Rxxx	1000	3.81	3810.00	0.00	0.00
3D Printing	Shapeways	N/A	1000	35.94	35940.00	6.50	0.01
Foam insert	Foam Factory	Polyethylene Foam Roll	1 60" x50' Roll	0.17	169.99	0.00	0.00
Assembly				8.00	8000.00	N/A	N/A
TOTAL				52.48	52,479.88	733.73	0.73
TOTAL + SHIPPING						**53,213.61**	**53.21**

CONCLUSION

- When assembled, prototype would be fully functional and useable in a PT setting
  - Solved the required problems necessary for a successful Pusher Syndrome Assist Device
- Future directions add useful functionalities
  - Storage and analysis of data
  - Fall sensor
- Intellectual property

CONCLUSION

- What did we learn?
  - There is nothing simple about design
  - Improved skills
    - Jake, Java/app development
    - David, CAD
    - Pat, conceptualized design and logistics
- What would we do differently?
  - More exhaustive initial brainstorming
  - Better time management

DEMONSTRATION

QUESTIONS?