INFLUX MEDICAL

Smart Abdominal Binder

"The Sole Meaning of Life is to Serve Humanity"

Presentation Outline

- Introduction to Influx Medical team members
- Project Objective
- Project Design
- Project Process
- Finance
- Conclusion
- Future Work
- Questions

InFlux Medical Team

Presentation Outline

- Introduction to Influx Medical team members
- Project Objective
  - Motivation
  - Current Solutions
  - Smart Abdominal
- Project Design
- Finance
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Project Objective
Motivation

- There are 86,000 people who live in Canada with SCI
  - estimated that there are over 4,300 new cases each year
  - $3.6 Billion annual cost (Spinal Cord Injury Canada Facts. (n.d.), 2014)
- Spinal cord injured patients have many of their bodily functions affected.
  - Areas in the brain normally control blood pressure and heart rate
    - Signals interrupted with SCI → Low Blood Pressure
    - Inactiveness → Low Blood Pressure

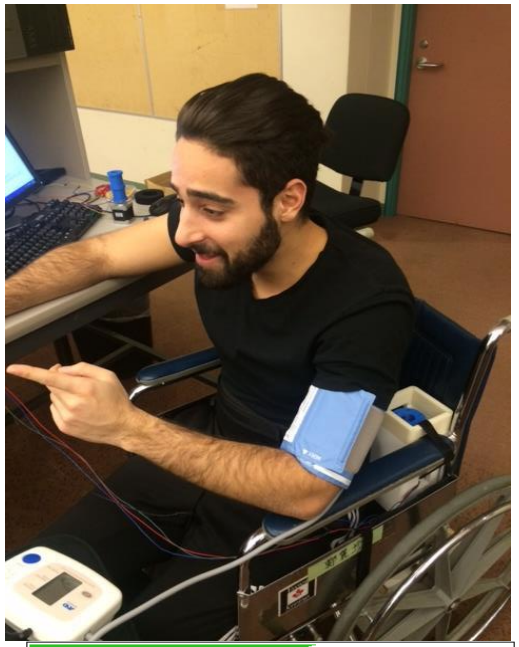
Presentation Outline
Current Solutions

- Management of OH in SCI patients
  - Medication
    - Ex. Midodrine → caused urinary bladder and autonomic dysreflexia
      - Successful candidates over shoot or give inefficient rise in BP
  - Elastic Binders
    - Static Pressure
    - Worn underneath clothing

(freshwaterblog, 2014) (dme-direct, 2014)

Project Objective
Smart Abdominal Binder

- Automated Mechanical Abdominal Binder
  - Mechanical Adjustable Abdominal Binder
    - Vary pressure through pulley system applies pressure to abdomen
      - Increase BP through compression (approx. 40 mmHg compression to increase BP by 30/14 mmHg)
  - Continuous BP monitoring



Presentation Outline

- Introduction to Influx Medical team members
- Project Objective
- Project Design
  - System Overview
  - Hardware Design
  - Software Design
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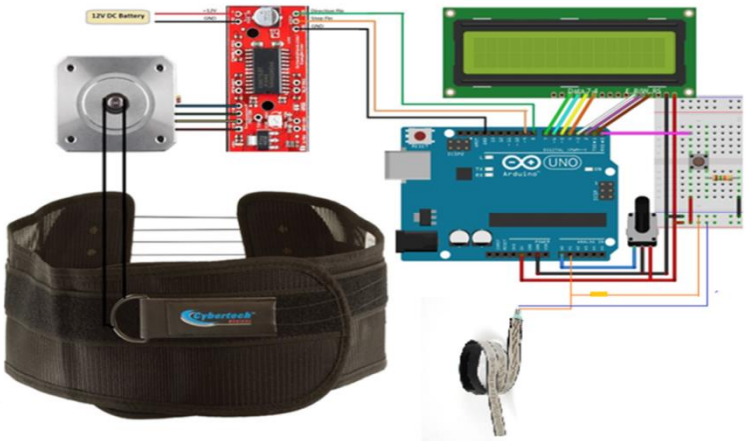
Project Design
System Overview

- Mechanical Abdominal Binder
- Stepper Motor with Planetary Gearbox
- Pressure Sensor
- Blood Pressure Monitor
- Microcontroller
- User Interface



Hardware Design
Mechanical Abdominal Binder

- Cybertech S.P.I.N.E LO/L1-S1 (Lumbar1- Sacrum 1)
- Mechanical pulley system
- Utilizing the advantage mechanical pulley system provides a compression of 6:1 ratio
- Comes in various ranges of size with the ability to adjust the size within the range
- Single front fastener
- Specially designed mesh maximizing air–flow
- With an average body figure can apply up to 20 mmHg around the abdomen comfortably and maximum pressure of 35 mmHg

(Cybertech Medical, 2014), (Cybertech Medical, 2014)

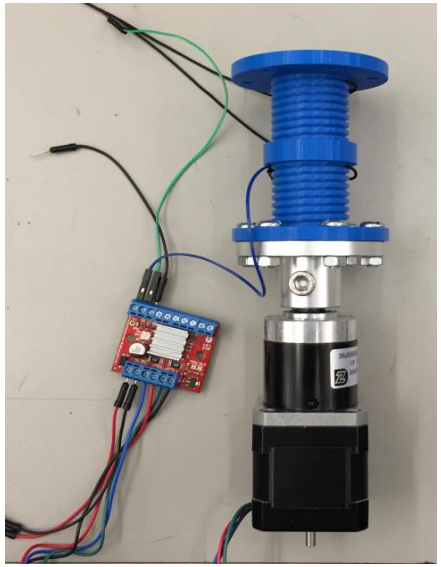
Hardware Design
Pressure Sensor kit

- FSR (Force Sensing Resistor) model 408
  - Rectangular strip ; Paper thin, 24" length and 6" width
  - Cheap, Flexible and suitable for the human skin with the range of 0.1 N to 100 N
  - Makes the system closed loop by providing the pressure to the Arduino
- Phidget voltage divider kit
  - Used to adjust the slope of the force curve of the sensor to the range needed (0-40 mmHg)
- Microlab M 669 Pico press
  - An accurate and calibrated pressure sensor
  - Used to match and calibrate the collected data from the FSR

(trossenrobotics, 2014)

Hardware Design
Pressure Supplier Unit

- Stepper Motor with planetary gearbox
  - NEMA 17
  - 1.8 degree for each step
  - Rated voltage of 2.8V and rated current of 1.68A
  - Output torque of 36 N/m
  - Torque is 1:27 ratio enhanced
- Big Easy Motor Driver
  - 1.4A max current limit
  - Needs 12-35V voltage supply



Hardware Design
Pressure Supplier Unit

Pressure Supplier Unit

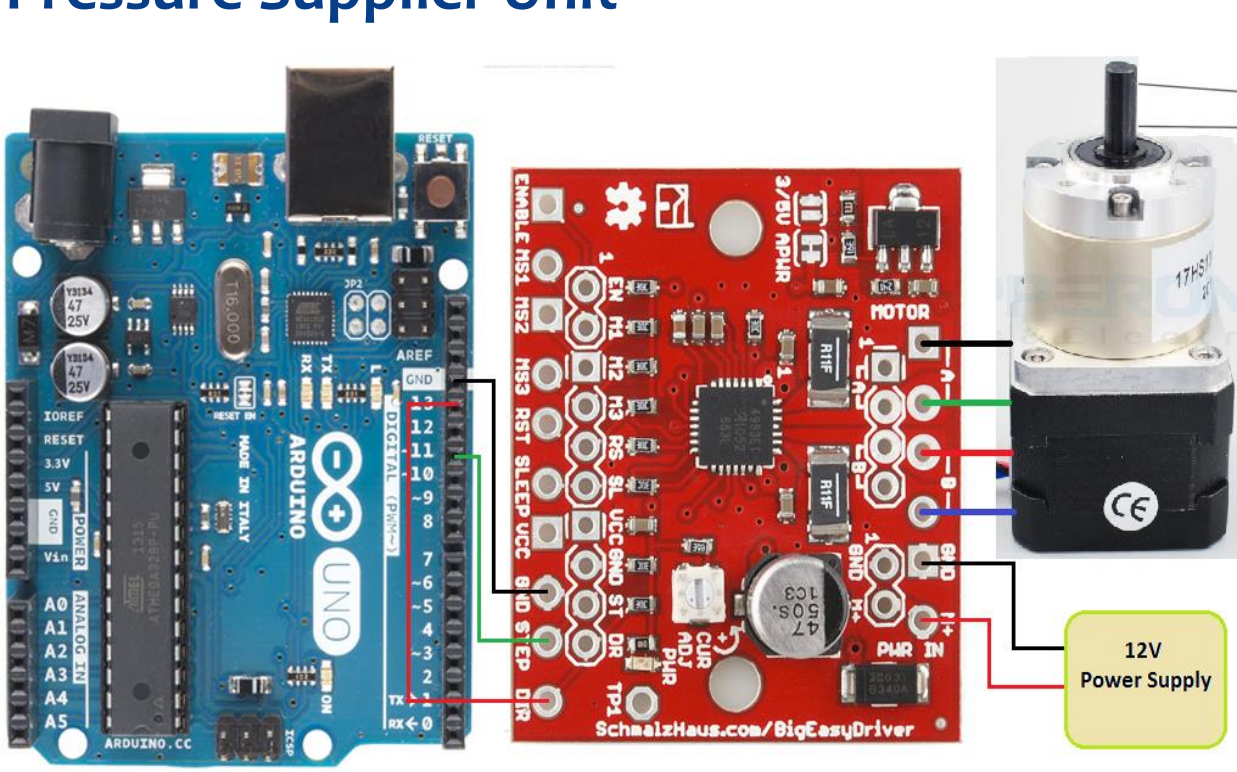
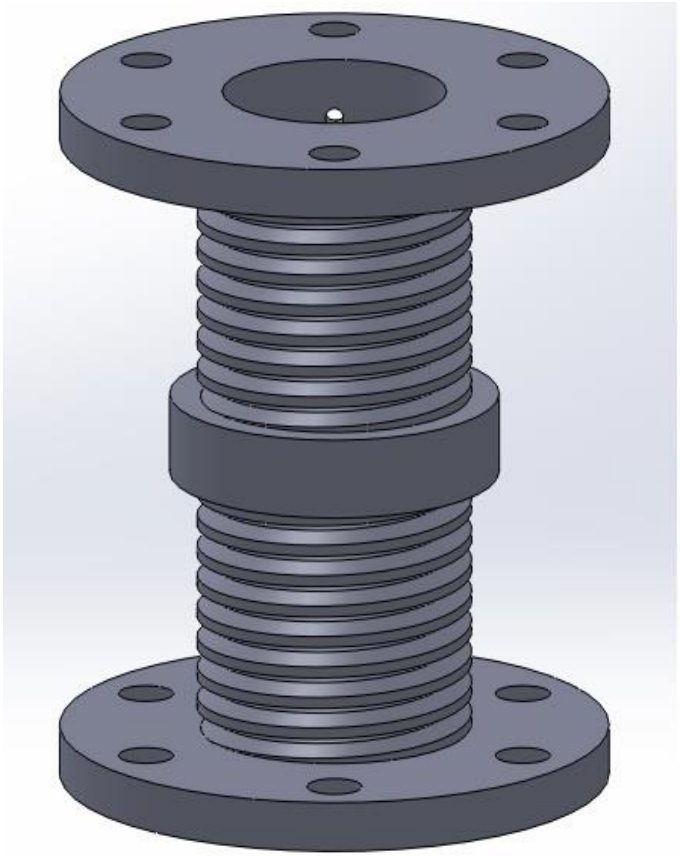


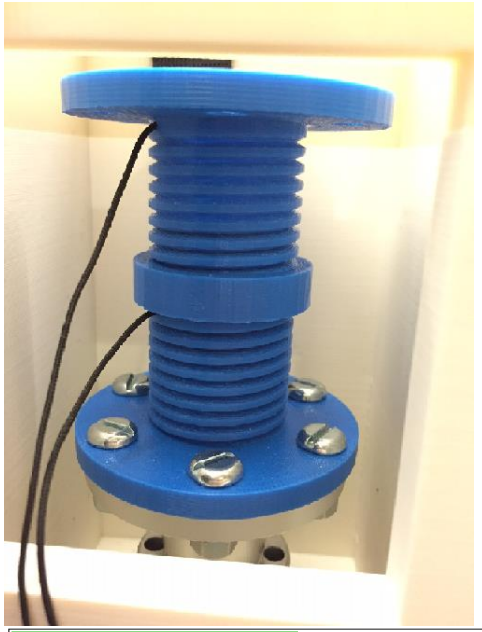
Figure: Motor system pin layout and the mechanism logic to the smart abdominal binder.

(braceability, 2014), (omc-stepperonline, 2014), (sparkfun, 2014) , (sparkfun, 2014)

Hardware Design
Solidworks and 3D Printing

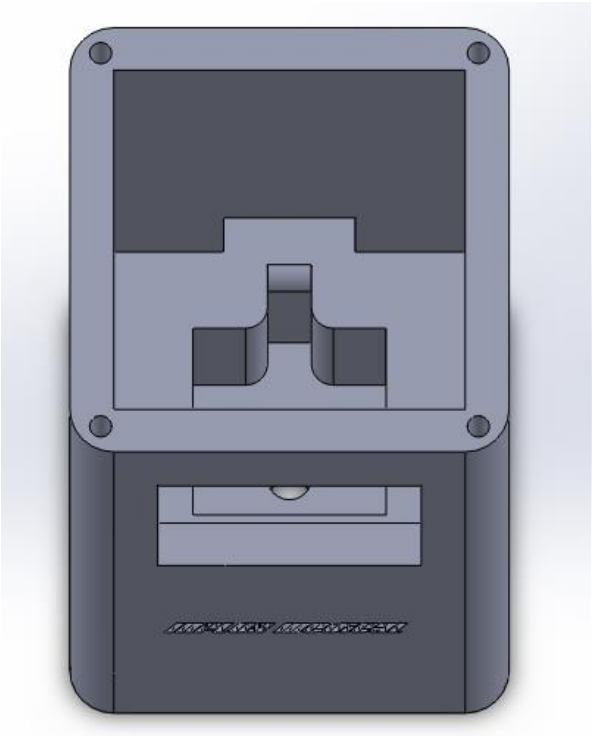
- Spool with grooves
  - Well-dimensioned
    - 30mm diameter
    - 70mm in height
  - Help on winding process
  - Prevent wire tangle problem

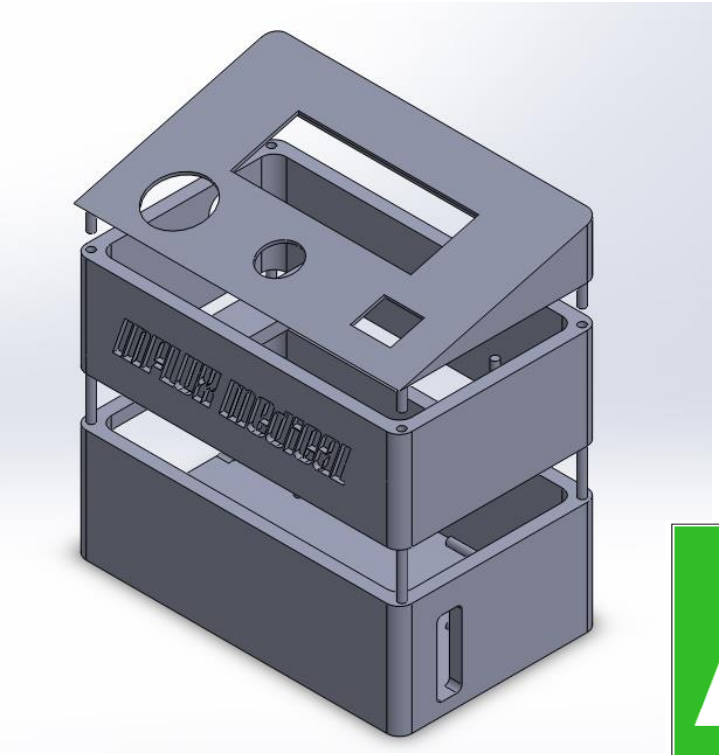




Hardware Design
Solidworks and 3D Printing

- Motor Enclosure and Arduino Enclosure





Software Design
Arduino Uno

- 12V power input from battery
- Outputs 5V needed by LCD and pressure sensor
- 13 digital pins
- Pin 13 for Dir and 11 for step of motor driver
- Pin 12 for rotary encoder push button
- Pin 10 for start and stop push button
- Pin 4-9 for LCD
- Pin 2 and 3 for rotary encoder rotation steps, 2 interrupts 1 per direction.
- Pin 0 and 1 for transfer and receive on the RS232 shield
- Pin A0 analog input for pressure sensor
- Pin A1 and A2 for LEDs

Software Design
RS232 shield

- Adds DB9 port to Arduino.
- Used to connect to the BPM to communicate with MCU
- DCE device Data circuit-terminating equipment
- Pin 2 receives and pin 3 transmits data on DCE device
- Null modem adapter to communicate between 2 DCE devices

Software Design
GUI

- 2 physical buttons and 1 rotary encoder
- 1 power button, one system start and stop button ,1 adjustment knob for pressure and time.
- Backlit16x2 LCD display , HD44780 controller
- Easy visibility high contrast indoors
- Ease of use with Liquid Crystal library with Arduino

Software Design
BPM

- Model : A&D UA767PC
- Has pressure adjustments
- Easy to start measurement with 1 blue button.
- Hold blue button to display past readings.
- Documented instructions obtained from company to communicate via serial port.
- Measurements can be taken automatically by sending the right command code.
- DCE device , null modem connect between it and the RS232 shield.
- Has a RS232C port , compact 3.5mm plug
- Cable is RS232C to DB9
- Commands are byte arrays in HEX

(AND, 2014)

Software Design
BPM

- Idle mode shows clock
- Send anything to wake.
- After it wakes, its LCD shows dash lines
- Send open communication port
- Dash lines will scroll horizontally.
- Send a reading using , reading starts after 1 minute
- Manufacturer code to measure without delay disabled by FDA
  After measurement is done. BPM sends bytes to the MCU
- Convert received data from byte to decimal

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Finance
Budget

- Budget doubled during development: $415 - $853.12
  - Design changed: Inflatable belt unit -> Mechanical Binder
  - Motor power shortage: small -> bigger
  - For user safety: Fan embedded(not in original design)
  - LCD damage: green -> blue
  - Spool and Enclosure: 3D printed
  - Pressure sensor package: more precise replacement
  - Clothing: belt or shirt -> Cybertech Brace (mechanical binder)
  - Power Unit: only rechargeable battery -> adding battery charger & AC/DC adapter (spare)
  - Wrong Cable: default cable for BPM -> specific cable (male to male, null modem adapter)
  - Shipping and Handling fees underestimate
  - Small components were not included: resistors, capacitors, headers, jumper wires, tapes, Velcro, push buttons, etc.

Finance
Market & Competition

- Market
  - Short-staffed situation in Canadian hospitals (nurses)
  - Relieves family members from all day long supervision
  - Saves money (cheaper than having a private carer)
  - Comfortable, dynamic and easy for patients to operate (user-controlled)
  - Light, small and exquisite to be carried by a wheelchair
  - Suitable for mass manufacture, no particular technology
- Competition
  - No such products in the market
  - Similar ideas, different implementation, which is not precise and secure enough
  - Mechanical method
  - Pharmacological method
  - Case 1: Compression stockings
  - Case 2: Compression pumps
  - Case 3: Compression elastic bandage

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  - Schedule
  - Challenges and Changes
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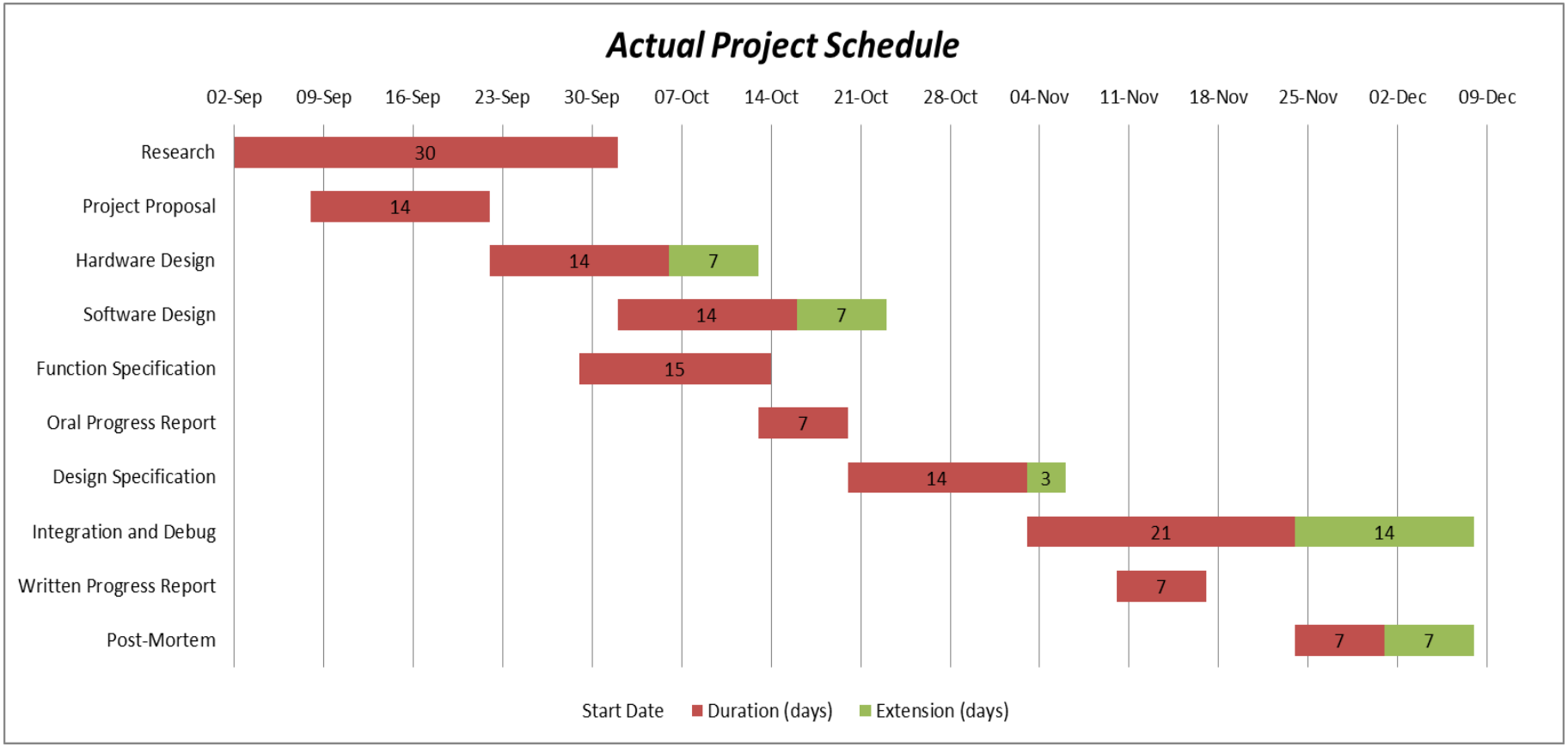
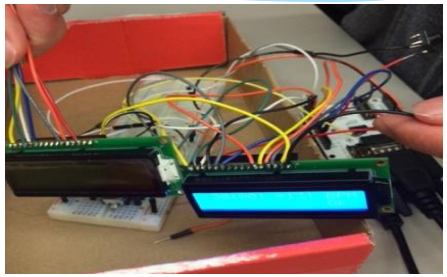
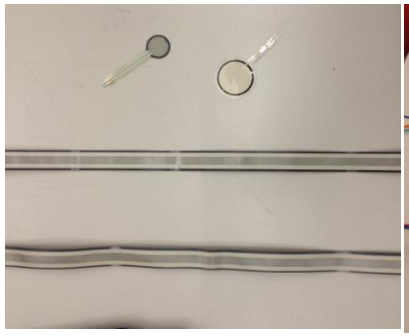
Project Process Schedule

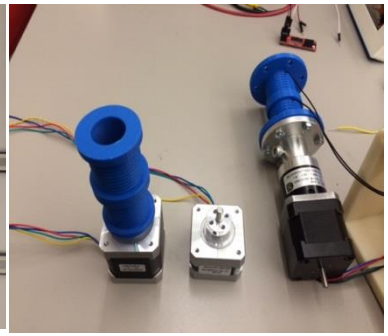


Project Process
Challenges and Changes

- Group
- BPM
  - FDA disabled measurement command
    - Command XOFF
      - Delay before communication mode (approx. 5 min)
- Pressure Sensor
  - Voltage reading varied
- Stepper Motor
  - Planetary Gearbox
- 3D Printing
  - Time constraint for enclosures.
- LCD
  - Wire contact problems causing strange characters and behaviors.







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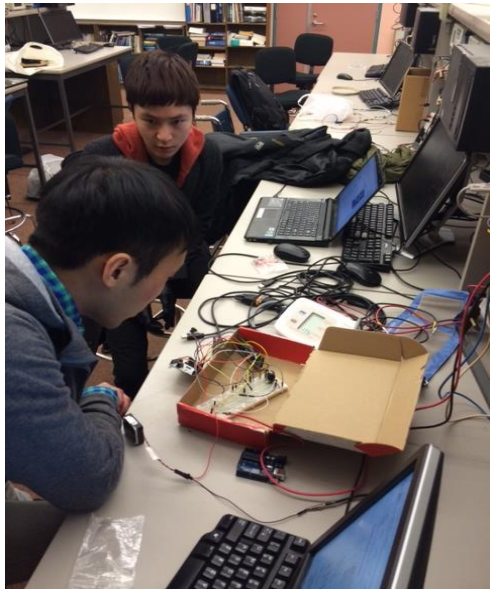
Conclusion

- Developed Mechanically Contractible Binder
  - Continuous physiological measurement
  - Provide sufficient pressure
  - Safe
- Accomplish proof-of-concept
  - Design/Functional Specifications

Future Work

- Safe & Marketable
  - Standards and regulations (Health Canada, FDA, etc.)
- Additional Features
  - Force sensors and gyroscopes
  - T-shirt garment with SAB integrated
  - Larger area around abdomen covered
- Co-op



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Questions?

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