# CFP Presentation

Team Affordable Insulin Pump

# Affordable Insulin Pump

- Team Introduction
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- Product Description
  - Infusion pumps are used by insulin dependent diabetic patients.
  - Delivers the insulin directly into the patient so they can control their blood sugar with minimal effort.
  - Current models are very expensive, even with health insurance

# Problem Statement

- Insulin pumps need to deliver insulin to insulin-dependent diabetics accurately.
  - Very expensive
  - Need to replace whole system if any part fails
- Affordable infusion pump kit that can be assembled by the user
  - Product needs to be able to safely and accurately deliver a precise dose of insulin to the customer on demand.
  - Easy to replace damaged parts
  - Fully customizable
  - Reduce the cost of conventional insulin pumps (with health insurance)

# Outline

1. Milestones/Key Dates
2. Budget
3. CFP
   a. Description
   b. Models
   c. Testing
   d. Demo
4. Summary

# Fall 2016 Milestones

| Date | Task/Milestone | Status | Comments |
|---|---|---|---|
| 29-Sep | Determine and Order Microcontroller, LCD Screen and Speaker | Complete | |
| 1-Oct | Design CAD model of keypad, Determine Sensors to be used and if Microchip is necessary. | Complete | |
| 7-Oct | Coding for LCD Screen and Speaker, Start CAD for Motor/Pump | In Progress | Speaker and LCD Coding to be updated to incorporate Keypad |
| ~~17-Oct~~ | ~~Begin to Electronic Configuration of Microchip~~ | ~~Eliminated~~ | Team determined this component was no longer necessary |
| 21-Oct | FEA analysis of Motor/Pump assembly | Complete | |
| 1-Nov | Order and Test Sensors, and Coding for Keypad | In Progress | Sensors need to be tested still. Keypad Delayed for CFP |
| 7-Nov | CAD Design for Pump Casing, and Start Coding the Motor/Pump | In Progress | Coding motor needs to incorporate keypad |
| 14-Nov | CFP assembly | Complete | |
| 18-Nov | Results evaluated for improvements needed on final design | Complete | |
| 23-Nov | CFP results assembled for CFP presentations | Complete | |
| 1-Dec | CFP presentation | Today | |

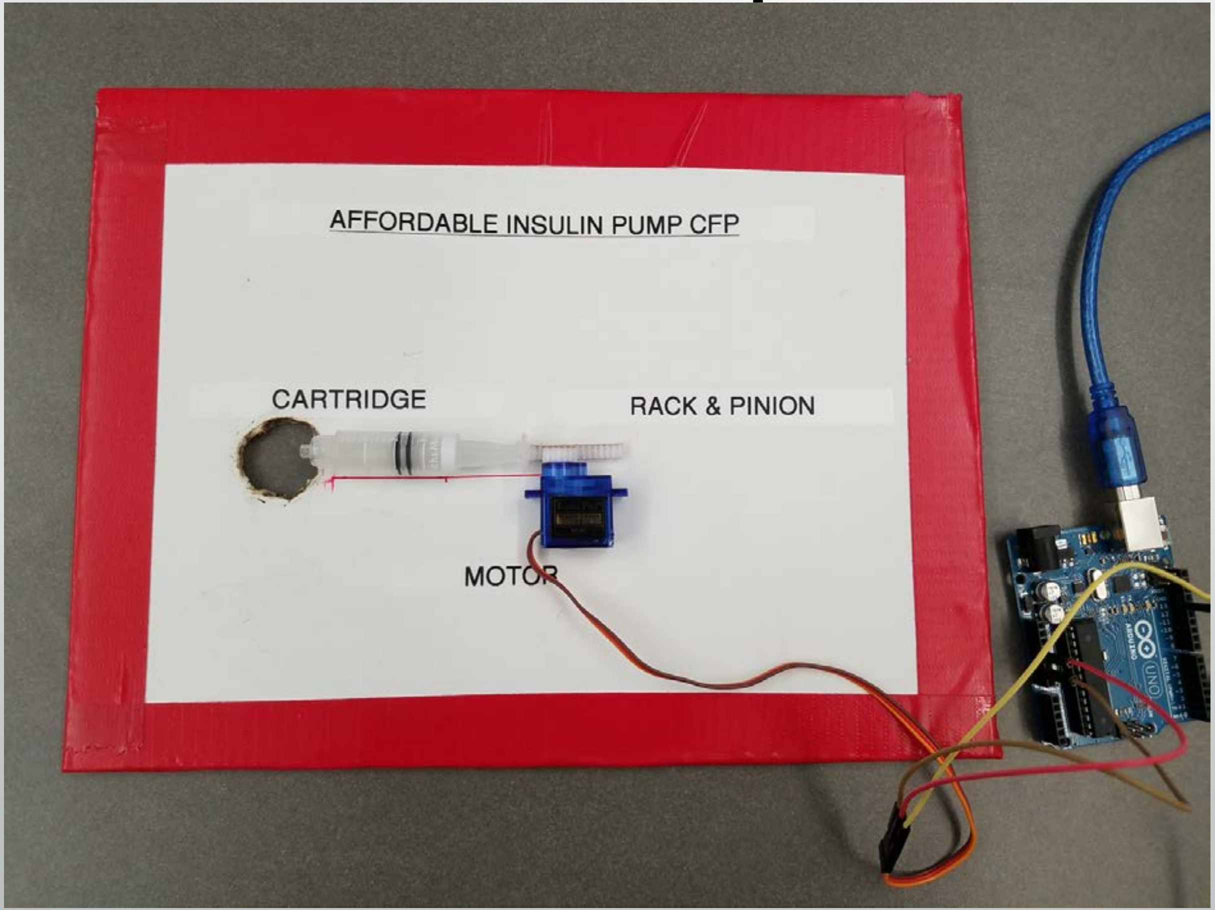
# Spring 2017 Milestones

| Date | Task/Milestone | Status | Comments |
|---|---|---|---|
| 19-Dec | Update Code for Speaker | | |
| 19-Dec | Update Code for LCD | | |
| 11-Jan | Configure Memory Card and Determine Power Management of System | | |
| 18-Jan | Testing of Pump Delivery System | | |
| 10-Feb | Make adjustments to the Insulin Pump Casing | | |
| 24-Feb | Test the Motor/Pump configuration with Cartridge | | |
| 6-Mar | 3D Print Casing | | |
| 17-Mar | Assemble Entire System Together | | |
| 27-Mar | Testing Entire Insulin Pump Assembly (in Casing) | | |
| 28-Mar | Design revisions and recommendations | | |
| 13-Apr | Design Day | | |

# Budget

| Current Purchase | | | | | | |
|---|---|---|---|---|---|---|
| Item | Price | Quantity | Cost | | Total Budget | 400 |
| *Motor* | 32.99 | 1 | 32.99 | | Total Cost | 70.11 |
| *Cartridge* | 0 | 1 | 0 | | Current Budget | 329.89 |
| *LCD Screen* | 19.13 | 1 | 19.13 | | | |
| *Microcontroller* | 8.99 | 1 | 8.99 | | | |
| *Speaker* | 9 | 1 | 9 | | | |
| | | | | | | |
| **Future Purchase** | | | | | | |
| **Item** | **Price** | **Quantity** | **Cost** | | | |
| *Sensor* | 57.99 | 3 | 173.97 | | | |
| *Case* | 19.99 | 1 | 19.99 | | Total Budget | 400 |
| *Circuitboard* | 2.99 | 1 | 2.99 | | Additional Cost | 206.93 |
| *Breadboard* | 2.99 | 1 | 2.99 | | Future Budget | 122.96 |
| *Jumper Cables* | 6.99 | 1 | 6.99 | | | |

# CFP Setup

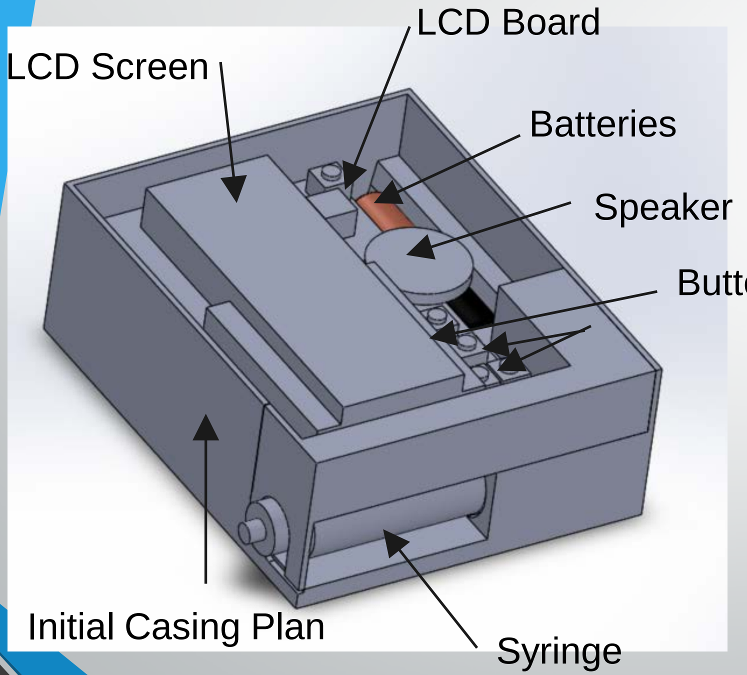


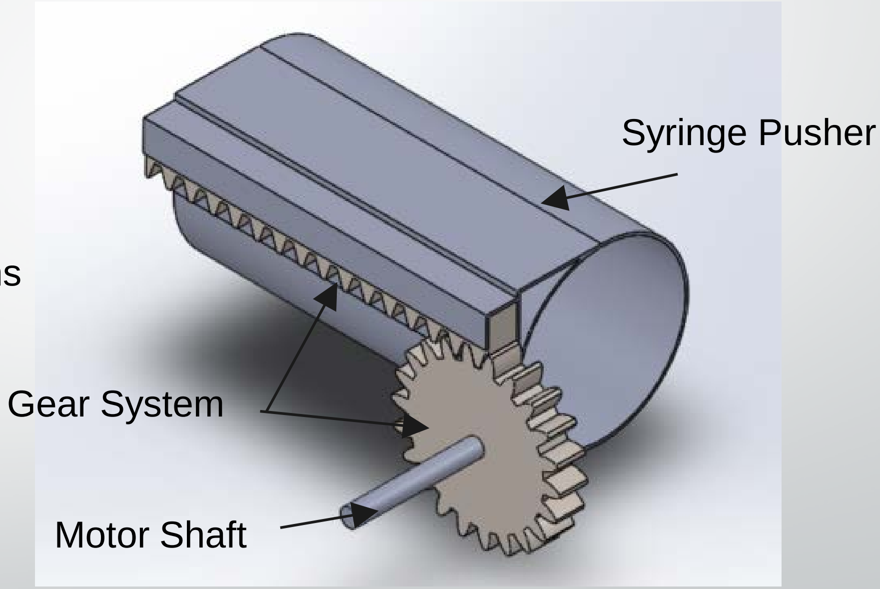
# CFP Description

Rack and Pinion Model:

- A simple rack and pinion system, connected to a motor, is used in order to create the linear motion necessary to activate a syringe, and push insulin into the body.
- The pinion(small gear) is located on the shaft of the motor. As the motor turns the pinion teeth comes into contact with the rack(linear gear), generating linear motion. This linear motion propels the syringe push rod into the syringe cylinder.
- In order to make this presentation more presentable, the system was set up on a poster board .
- In order to make the CFP measureable, a small graduated cylinder is placed under the board to measure the displaced fluid.

# Solidworks Renderings



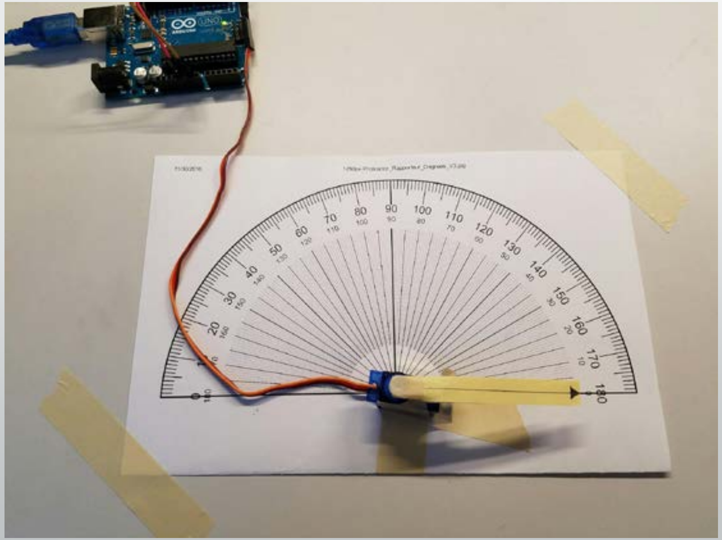



# Test Process

1. Motor Position
    a. Program the motor to go a specified degree.
    b. Measure degree travelled using a protractor to confirm accuracy.
2. Change in Volume
    a. Set volume will be placed into the cartridge and the location of the plunger will be marked
    b. The motor will be set to a degree, displacing the plunger and allowing the fluid to flow through the tube into a bowl and then measured with a graduated syringe that has an accuracy of a hundredth of a mL.
    c. The distance the plunger moved and the amount of fluid displaced will be noted and compared.
3. Battery Life
    a. Using a Multimeter, the amperage of the motor will be tested while it is plugged into the power but not turning. It will be measured again while the motor is turning.

# Test Results

- Motor Position
  - Using a protractor, several degrees were programmed into the motor, each degree was marked.
  - When testing the accuracy of the degrees, we found that the degrees travelled were close to the degrees programmed. Error increased as the angle increased.
  - The error will be compensated for in the future coding



# Test Results

- Motor Position

| Input Degree | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| 20° | 21° | 21° | 21° |
| 40° | 42° | 42° | 42° |
| 70° | 74° | 75° | 75° |
| 90° | 96° | 97° | 97° |
| 110° | 117° | 118° | 118° |
| 140° | 148° | 149° | 149° |
| 160° | 169° | 169° | 169° |

# Test Results

- Change in Volume

  Each test was compared to values calculated with gear equivalence diameter (r=5.189mm), the ratio of fluid displacement to plunger displacement (R=1mL/9.1mm), and the following equations.

  - Theta*r = linear displacement
  - Linear displacement *R = theaoretical fluid displacement

- Test 1: Motor was programmed to go to 180 degrees and stop. Fluid measured should be approximately 1.66 mL.
  - Actual fluid measured averaged to 1.74 mL
- Test 2: The motor was programmed to go 36 degrees, which would approximately be 20 units and .2 mL
  - When tested, the liquid had a displacement of roughly .2 mL. Originally our calculations showed that this should have been done with a movement of 20 degrees, however we found that this did not displace quite .2mL. After the first increment however, there is a displacement of .2 mL with 20 degrees. The volume of the output fluid matched the .2 mL

# Test Results

- Change in Volume

| Test | 0-180° | 0-20° |
|---|---|---|
| 1 | 1.78 | 0.21 |
| 2 | 1.73 | 0.22 |
| 3 | 1.66 | 0.21 |
| 4 | 1.72 | 0.19 |
| 5 | 1.79 | 0.19 |
| | | |
| Average | 1.736 | 0.204 |

# Test Results

- Battery Life
  - Using a Multimeter, the amperage of the motor was tested to be roughly 265 mA

Battery life calculation gives us 45.66 hrs for the motors

  - Previous calculation shows that the motor should last for 63.58 hrs, but that was for a DC motor, not a servo.

| Measurement | Amps |
| --- | --- |
| 1 | 265 |
| 2 | 263 |
| 3 | 267 |
| 4 | 265 |
| 5 | 265 |
| **Avg.** | 265 |

# Test Results

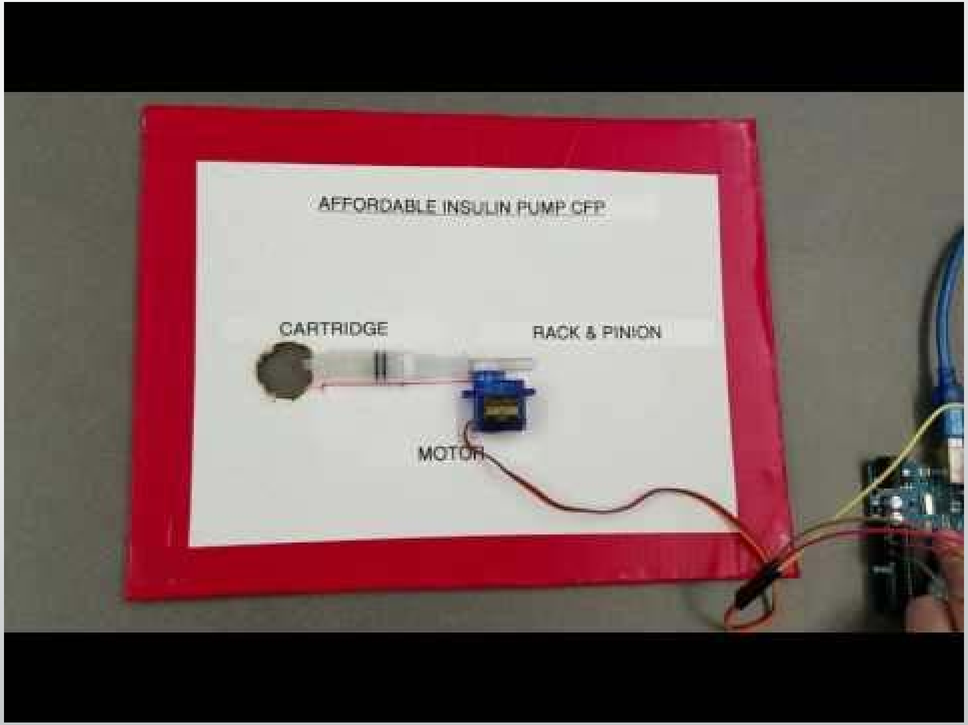
- Battery Life

| Battery (AA) Parameters | |
|---|---|
| Average Time | AT |
| Average Use | AU |
| Active Load (In use) | AL |
| Battery Capacity | BC |
| Percent Dead Count | DP |
| Circuit Load(not used) | CL |
| **Battery Life** | **BL** |

$$BL = \frac{(BC*DP)}{\left[CL+\left(AL*\left(\frac{AT}{24}\right)*AU\right)\right]}$$

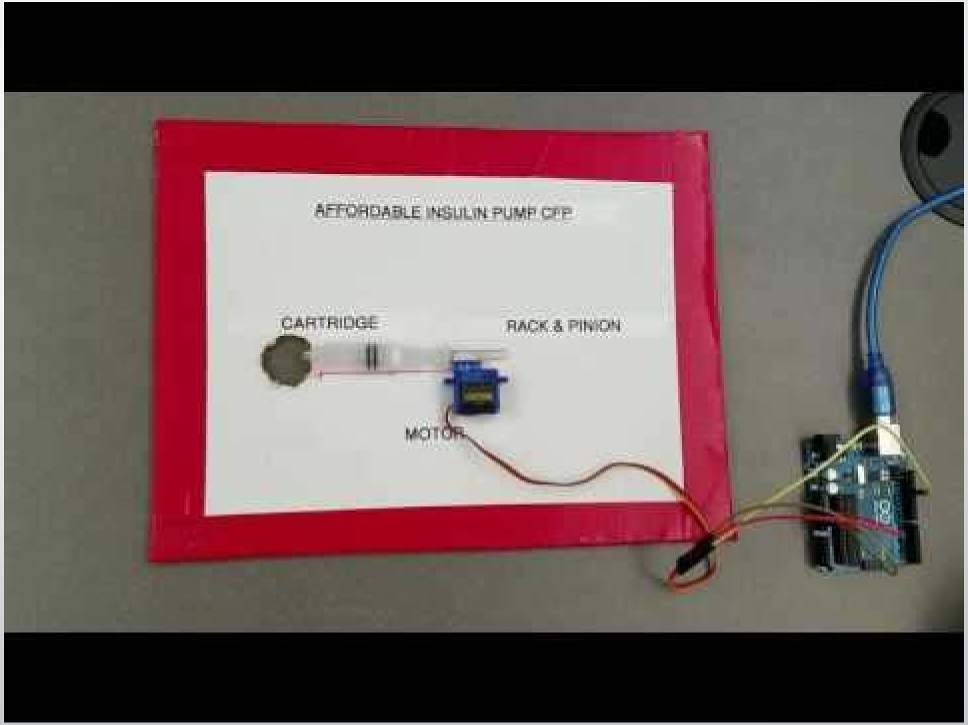
# Demo

- 0.2 mL increments



# Demo

- 0.2 mL, 0° to 36° to 0°



# Summary

**CFP:**

- Linear motion needed for standard insulin cartridge.
- Rack and pinion method used to transfer motor motion to cartridge direction
- Simple math of degrees -> linear motion used to calculate displacement in the syringe
- Demo allows us to fine tune the gearing needed for an accurate system (yet to be done)

**What’s Next:**

1. Fine tune gears
2. Fix the Coding
3. Set up user-device interactions
4. Set up safety checks
5. Recreate casing to fit system