Optimaus

presents

AUTOFEED

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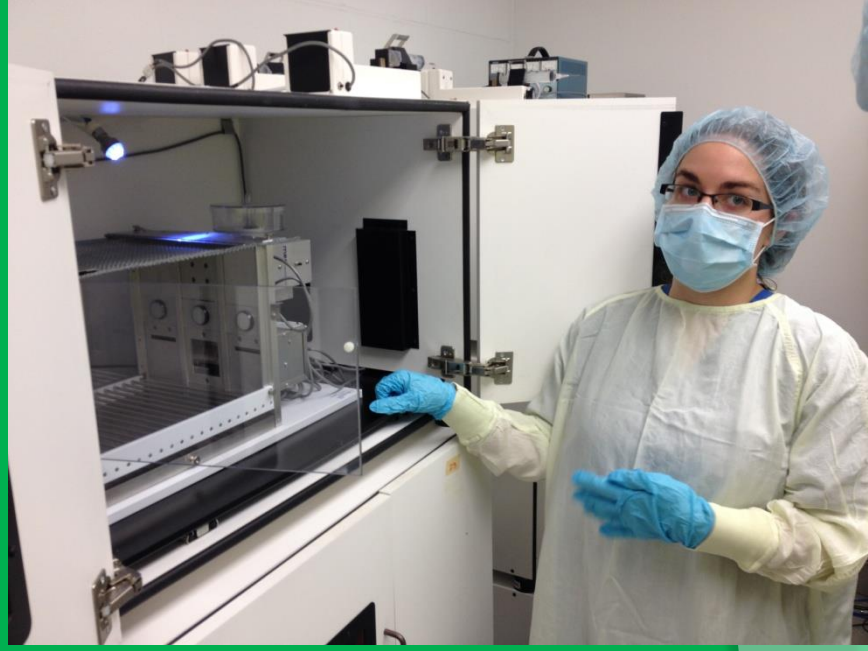
Presentation Outline

- Motivation/Introduction
- System Overview
  - Feeder
  - Google Calendar
  - Controller
  - Feedback Systems
  - Email Notifications
- Project Planning
- Competitors
- Cost per Unit
- Expenditures
- Business Case
- Future of AutoFeed
- Conclusion

Motivation



- Automate feeding method for lab animals
- Current method is done manually.
  - Time consuming and tedious
  - Cost ineffective
- Automating procedure will reduce man hours and allow for more complicated feeding schedule

Current Method

- Top bars have an indentation for the animals to eat the food through
- Prevents animals from taking food and storing it

Introducing AutoFeed

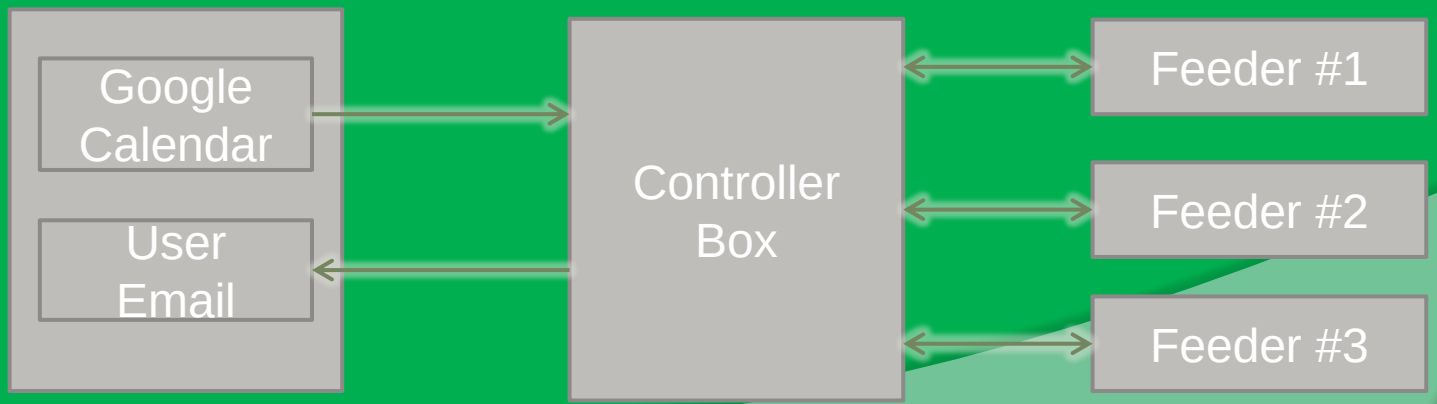
- Solution
  - Automate the feeding process and provide a friendly user interface

- System Characteristics
  - Scheduling is done through Google Calendar
  - Sliding door allows and restricts food access to the animals
  - Holds 300g of food (approx. 1 weeks worth of food for a sprague dawley rat).
  - Provide user feedback in the event of a malfunction

System Overview - Subsystems

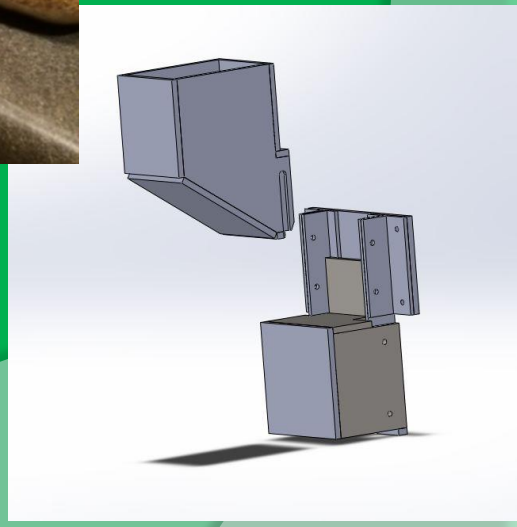
- **Feeder**
  - Hopper, Aluminum frame, Gear Box, Slider Door
- **Google Calendar Interface**
- **Controller Box**
  - Raspberry Pi, Servo Driver, RJ-45 Patch Panel, AC Power Adapter

Block Diagram



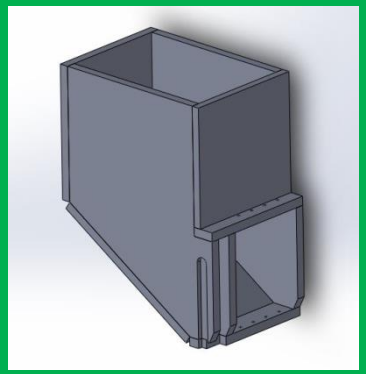
Feeder (Dispensing Mechanism)

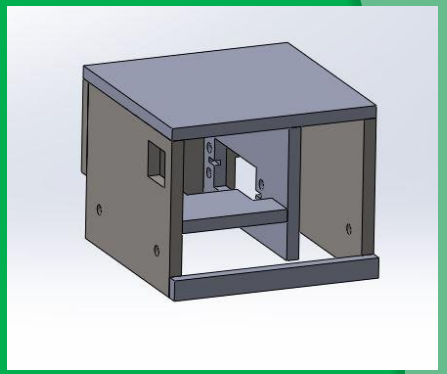
- Composed of 4 parts
  - Hopper
  - Gear box
  - Slider Door
  - Aluminum Frame
- Parts fit together interchangeably
- Connected to chassis by CAT5.e connector cables

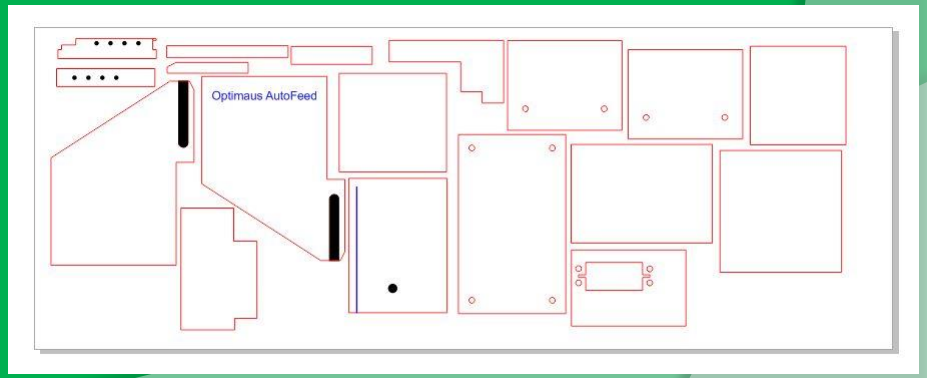


Feeder – Hopper, Gear Box, and Door

- Designed in CAD and then laser cut for precision
- Use 0.2 inch Acrylic sheets
- Bonded together chemically using methylene chloride
- Continuous servo used to close door slowly, and with relatively low strength to prevent animal harm







Feeder – Aluminum Frame

- SFU Manual Milling Machine used for precision cuts and smooth finish
- Gear box is bolted directly to the frame
- Frame is mounted onto the side of the existing cage in line with the hole

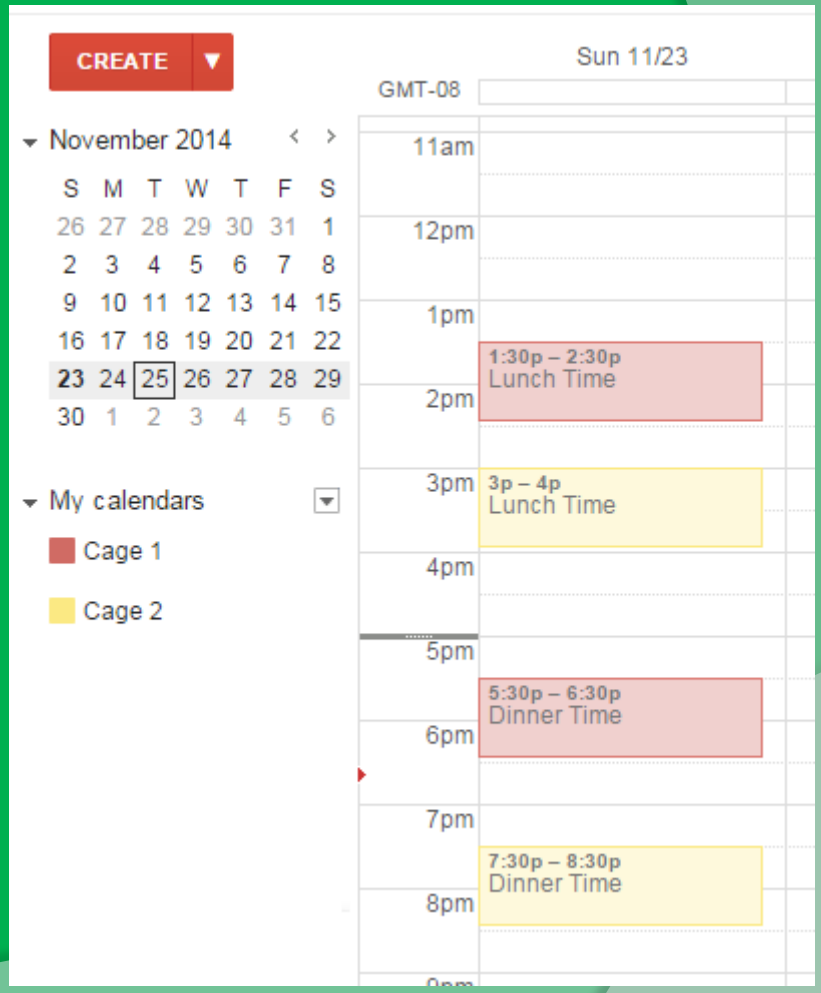
In Action

Our rat, Spi, eating out of the dispensing mechanism while sliding door is closes

Google Calendar User Interface

Scalable to 114 cages per user at our current poll rate (every 20 seconds)

- From the User Perspective:
  - Create a Calendar
    - Each Calendar controls its own individual Cage
  - Create an Event on a Calendar
    - Start time = Open Door
    - End time = Close Door



Google Calendar User Interface

- Demonstration
  - https://www.google.com/calendar

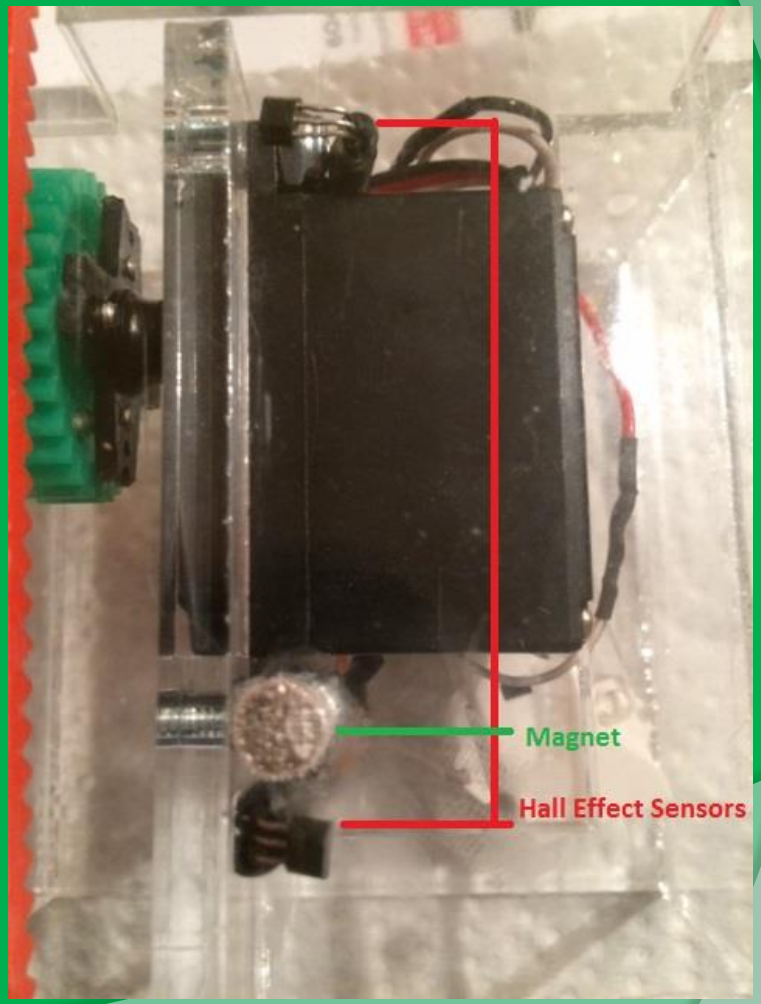
Controller

```
2014:11:30:17:36:0 -- *** POLLING THE GOOGER ***
2014:11:30:17:36:2 -- (1) : opening door
2014:11:30:17:36:2 -- (1) : stopping door
2014:11:30:17:36:6 -- (1) : stopping door
2014:11:30:17:36:20 -- *** POLLING THE GOOGER ***
2014:11:30:17:36:26 -- (1) : stopping door
2014:11:30:17:36:40 -- *** POLLING THE GOOGER ***
2014:11:30:17:36:46 -- (1) : stopping door
2014:11:30:17:37:0 -- *** POLLING THE GOOGER ***
2014:11:30:17:37:2 -- (1) : closing door
2014:11:30:17:37:6 -- (1) : stopping door
2014:11:30:17:37:6 -- (1) : failure to closed
2014:11:30:17:37:20 -- *** POLLING THE GOOGER ***
2014:11:30:17:37:22 -- (1) : closing door
2014:11:30:17:37:26 -- (1) : stopping door
2014:11:30:17:37:26 -- (1) : failure to closed
2014:11:30:17:37:40 -- *** POLLING THE GOOGER ***
2014:11:30:17:37:42 -- (1) : closing door
2014:11:30:17:37:46 -- (1) : stopping door
2014:11:30:17:37:46 -- (1) : final failure to close: sending email
```

- Raspberry Pi – Linux OS
- Runs the AutoFeed application
  - Polls Google every 20 seconds
  - Creates list of actionable items
  - Feedback sensors determines actions required
  - Multiple feeders can be controlled concurrently
  - Email notifications in the event of a malfunction

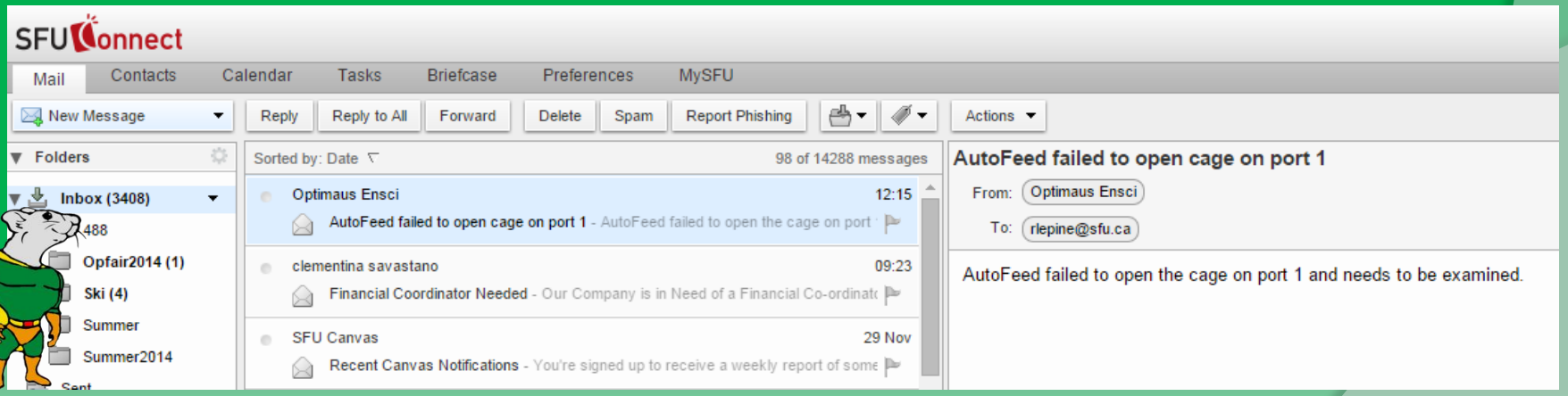
Feedback System

- One sensor for each door position (open/close)
- The magnet on the sliding door will trigger the sensors
- Communicates to Raspberry Pi to stop the motor



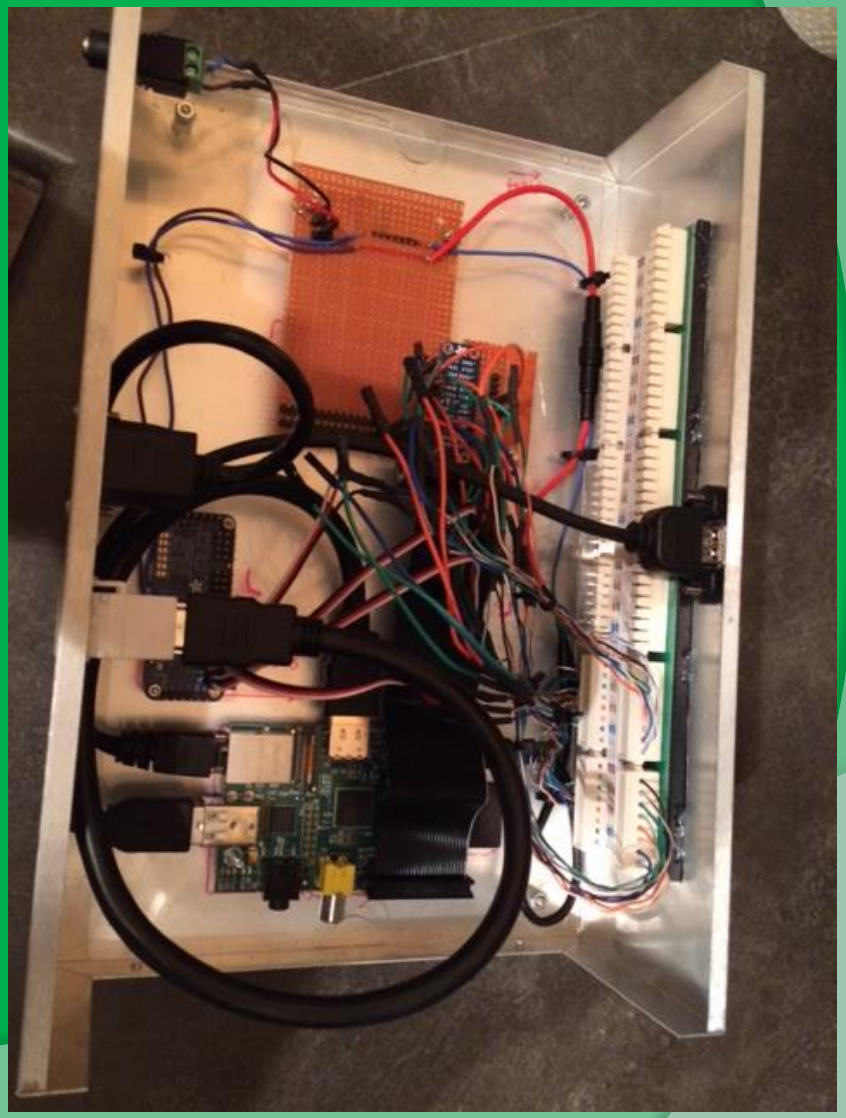
Email notifications

- A failure will cause an email to send to the host Google account
- Forwarding filters can be created or deleted in the Gmail settings
  - All recipients must accept to have emails forwarded to them
- User can dynamically customize who receives the error emails



The Rat's Nest (Controller Box)

- Contains and protects electronics
- Designed to look unintimidating
- Only necessary ports are exposed to the user (RJ-45 ports, Power, Etc.)



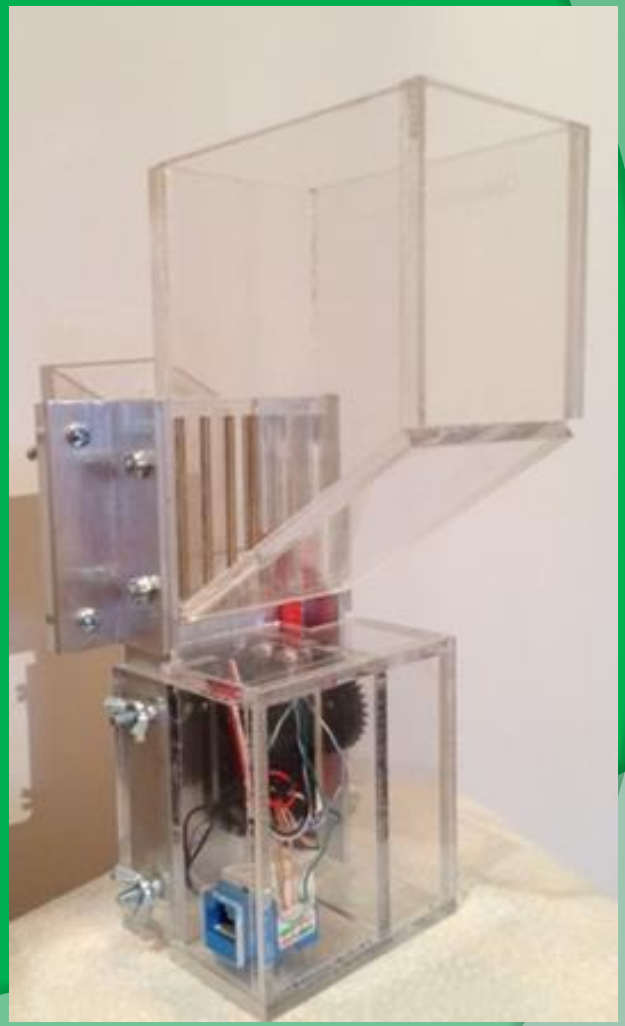
Project Planning

Competitors

- **Automatic Mouse Feeder for Controlled Feeding**
  - **Price $250**
  - **LED display**
  - **Not as intuitive as Google Calendar**
  - **Limited to single cage**
  - **Not remotely programmable**
  - **Does not meet needs of ARC lab**

Cost per Feeder Unit

Item	Cost ($)
Servo Motor	16.67
Acrylic	15.00
Bars	~1.06
Aluminum base	4.00
Hall Effect Sensors	5.95
Magnets	0.30
Gears	0.95
Fasteners	~0.50
RJ45 Port	0.59
Ethernet Cable (3ft)	~2.05
Manufacturing Cost	~30.00
Total	~77.07



Cost per Controller

Item	Cost ($)
Raspberry Pi	34.99
Patch Panel	55.50
Cords and Wires	36.00
Hardware Components	55.00
Adapters	16.00
AC Adapter	12.50
Exterior box	18.50
Fasteners and Stand offs	6.60
Strip Board	3.89
Fuse and holder	1.80
GPIO pins	3.00
Base plate	3.00
Assembling Cost	30.00
Total	276.78

Expenses: Actual vs. Predicted

Actual		
Item	Quantity	Cost ($)
Acrylic Sheets*	4	132.99
Drill Rods	3	14.18
Patch Panels	2	126.66
Power Adapter	1	7.95
Servo Motors*	5	83.65
Methylene Chloride	1	9.01
Hardware Components	N/A	168.32
Glue	1	4.47
Servo Driver	1	14.95
Total		**562.18**

Predicted		
Item	Quantity	Cost ($)
Acrylic Sheets*	4	30.60
Lego Gears and Racks	10	28.85
DC Motors	10	38.00
Push Buttons*	20	17.00
Transistors	15	3.00
Raspberry Pi	1	39.95
8GB SD Card	1	15.00
Raspberry Pi Power Supply	1	9.50
Power Adapter AC/DC	10	79.50
USB Cables	2	6.00
Tax 12%		39.29
Contingencies 15%		55.00
Total		**421.69**

Business Case

- Target Market: Animal Research Labs
- Controller sold for $2000
  - Cost = $276.78
  - Profit = $1723.22
- Each feeder sold for $500
  - Cost = $77.07
  - Profit = $422.93
- Assuming experiments run with 16 cages operating concurrently
  - 16 feeders + 1 controller = (16 X $500) + $2000 = $10,000
  - Profit = (16 cages X $422.93) + $1723.22 = $8490.10

Future Plans

- Sell a few feeder units and the controller to the SFU ARC at material cost
- Re-design feeder to allow weighing of the food during feeding times
- Implement our own web application to replace Google calendar
- Refine manufacturing process to streamline our production
- Review component selection to reduce cost

Conclusions

- AutoFeed will automate the feeding procedures for laboratory experiments
- We were thorough in our design, both mechanically and in our software
- We enjoyed the experience, learned a lot, and we look forward to the future of this project

Acknowledgements

- Gary Shum and Gary Houghton
  - For letting us use the Laser Cutter
- Ash Parameswaran
  - Technical advice
- Teresa Dattolo
  - Design advice and ARC tour
- Animal Research Center staff
  - Allowing us to tour the facility

Thank you for your time!

- Questions?