Final Presentation

Company 9 - EZ Move Company

Faraz Borghei, Sachin Momuli, Trevor Lee, David Song, Tommy Yang

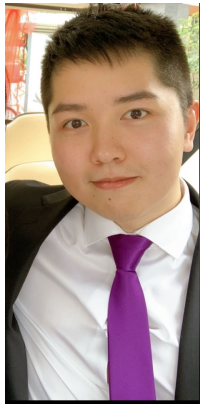
Team & Roles

David Song - Chief Executive Officer

Faraz Borghei - Chief Technical Officer

Sachin Momuli - Chief Communications Officer

Team & Roles



Tommy Yang - Chief Financial Officer

Trevor Lee - Chief Information Officer

Presentation Overview

- Introduction
- Technical Case
- Business Case
- Risk Analysis
- Engineering Standards
- Self-Reflection
- Conclusion & Summary
- Acknowledgements
- References
- Questions

Background

- Many aging seniors require the use of walking aids to assist their mobility [1]
- Seniors may find difficulty in moving objects around their house due to their mobility problems

[2]

[3]

Project Motivation

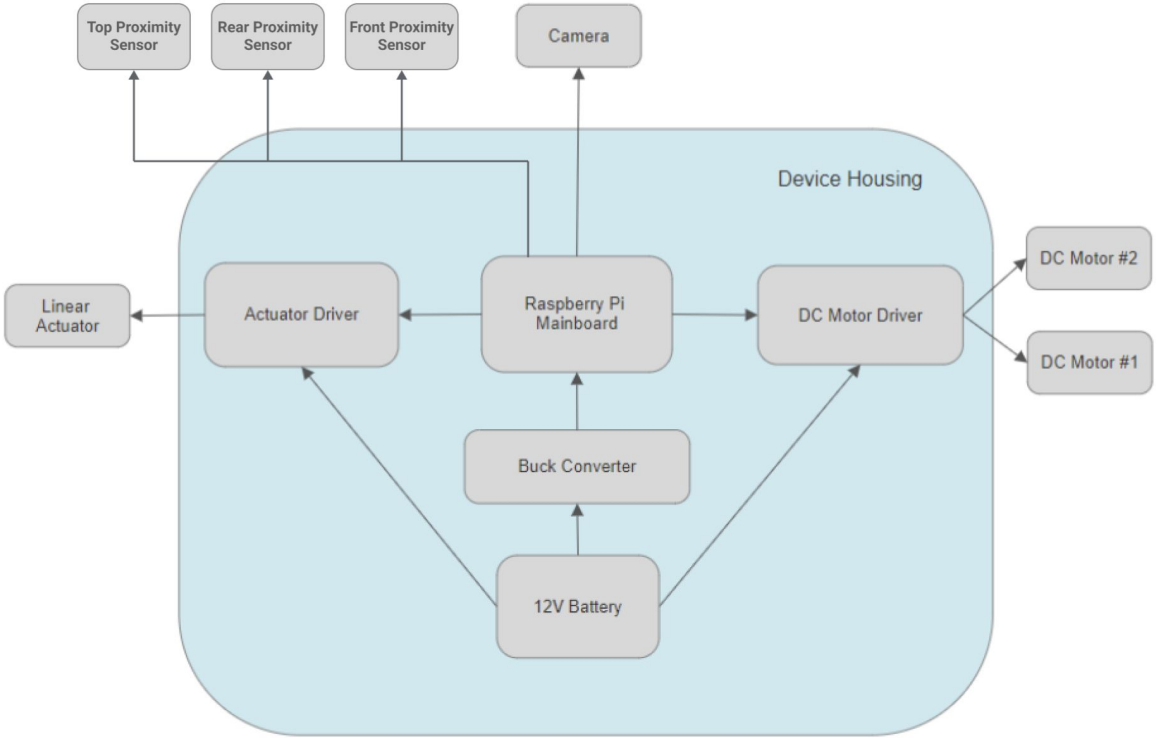
- Wanting to build a household assistive device for elderly people
  - Help customers independently care for themselves at home
  - Help to reduce the number of fall-related injuries for seniors

- No such product in market, targeted towards residential use
  - Great opportunity to enter the market, with growing elderly population
  - Possibility to attract more people

Our Solution: The EZ Table

- Remote controlled assistive courier device
- Reduce strain from lifting objects
    - Height adjustable tabletop
- Provide easily accessible storage space
    - Stores everyday items, medicines etc
- Operated through a smart device or remote control

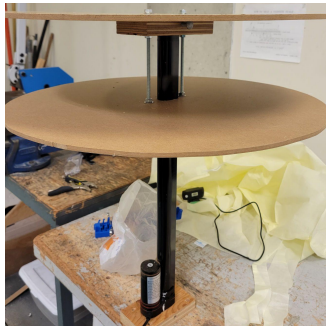
Technical Case: System-level Design

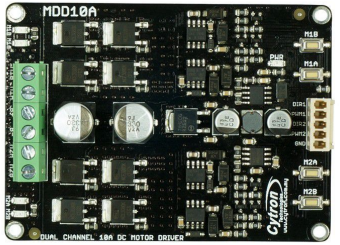


Technical Case: Hardware

- 2x 12V DC Brushless Motors
- Linear Actuator - (*56cm + 40cm*)
- Raspberry Pi 400 Microcontroller
- Ultrasonic Sensor (HC SR04) - x3
- Cytron 10A Motor Drivers (*MDD10A*)
- 12V SLA Battery
- Buck Converter

Secured with Pipe Straps and Velcro

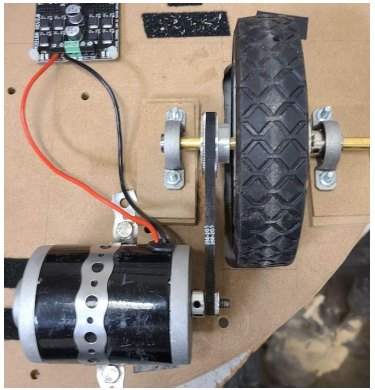


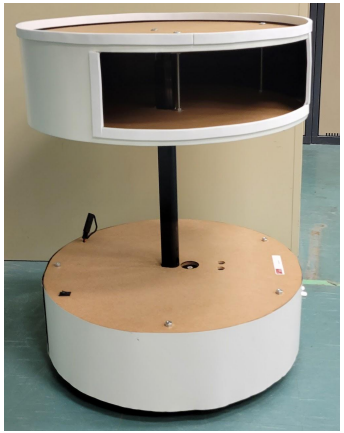


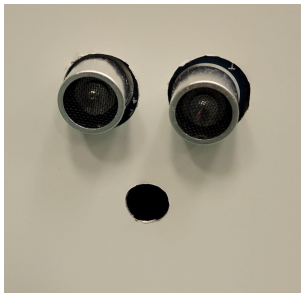
[5] [6]

Technical Case: Hardware

- Belt & Pulley System
- Durable MDF & Aluminium Sheet Enclosure
- Camera
- 2 Semi-pneumatic Wheels & 1 Caster

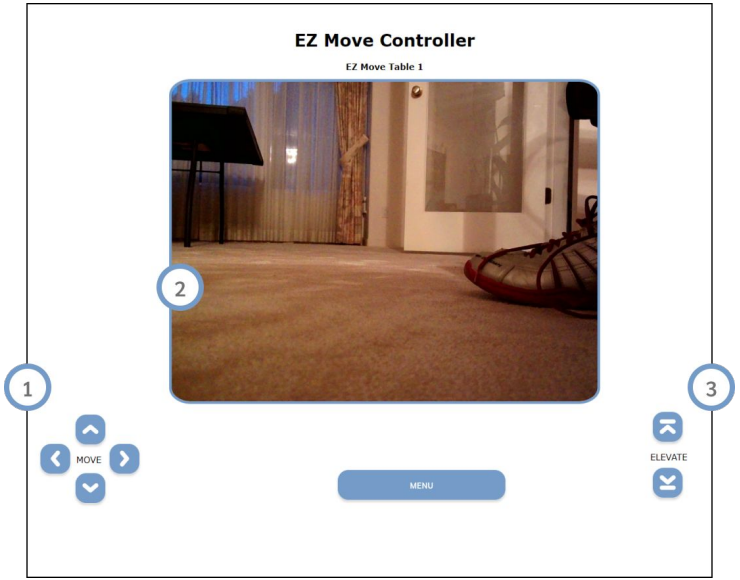






Technical Case: Software

- Built using a Raspberry Pi running a Flask web server
- Python controls the hardware and HTML/CSS/JavaScript for the front-end
- Large & Minimalistic UI elements for visibility and ease of use
- Real-time camera view from the table
  - Very minimal latency
- Easy to navigate for the average non-technical user
- Responsive dynamic design that scales for desktop & smartphone devices



Technical Case: Materials

- Base built with ½ inch MDF
- Tabletop built with ¼ inch MDF
- Multi Purpose Aluminium Sheet for enclosure
- Velcro and pipe straps to secure main components (Battery, motors/drivers)

[8]

[7]

[4]

Technical Case: Cradle-to-cradle

Component recycling:

- MDF & Aluminium exterior - Recyclable
- Raspberry Pi 400, Linear Actuator, Motors, Drivers & Battery
    - Repurpose for other applications

Technical Case: Projected Timeline

PROJECT TITLE	EZ Table	COMPANY NAME	EZ Move Company
PROJECT CEO	David Song	DATE	05/24/22

					PHASE ONE																PHASE TWO													
					WEEK 1					WEEK 2					WEEK 3						WEEK 4					WEEK 5					WEEK 6				
	TASK TITLE	START DATE	DUE DATE	DURATION	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F
1	Project Refinement																																	
1.1	PoC Feedback Review	5/13/22	5/18/22	4																														
1.2	Finalizing project upgrades	5/16/22	5/23/22	7																														
1.3	ESSEF Funding Application	5/16/22	5/20/22	5																														
1.4	Project Refinement Presentation & report	5/18/22	5/26/22	8																														
2	Implementation																																	
2.1	Machine Shop Work	5/30/22	6/3/22	5																														
2.2	Movement Calibration and testing	6/2/22	6/8/22	5																														
2.3	Tabletop Integration	6/6/22	6/10/22	5																														
2.4	Software Refinement	6/8/22	6/16/22	7																														
2.5	Integration Testing	6/17/22	7/4/22	12																														

					PHASE THREE																PHASE FOUR													
					WEEK 7					WEEK 8					WEEK 9						WEEK 10					WEEK 11					WEEK 12				
	TASK TITLE	START DATE	DUE DATE	DURATION	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F
2.5	Integration Testing (cont.)	6/17/22	7/4/22	17																														
3	Final Stage																																	
3.1	Evaluation and Feedback	7/4/22	7/12/22	7																														
3.2	User Manual	7/11/22	7/21/22	9																														
3.3	Robust Testing	7/5/22	7/26/22	16																														
4	Demo	7/25/22	8/12/22	5																														

Technical Case: Actual Timeline

PROJECT TITLE	EZ Table	COMPANY NAME	EZ Move Company
PROJECT CEO	David Song	DATE	08/04/22

					PHASE ONE															PHASE TWO														
					WEEK 1					WEEK 2					WEEK 3					WEEK 4					WEEK 5					WEEK 6				
	TASK TITLE	START DATE	DUE DATE	DURATION	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F
1	Project Refinement																																	
1.1	PoC Feedback Review	5/13/22	5/18/22	5																														
1.2	Finalizing project upgrades	5/16/22	5/23/22	7																														
1.3	ESSEF Funding Application	5/16/22	5/20/22	4																														
1.4	Project Refinement Presentation & report	5/18/22	5/26/22	8																														
2	Implementation																																	
2.1	Machine Shop Work	6/2/22	6/16/22	14																														
2.2	Movement Calibration and testing	6/2/22	6/8/22	6																														
2.3	Tabletop Integration	6/13/22	6/17/22	4																														
2.4	Integration Testing	6/17/22	7/11/22	24																														

					PHASE THREE															PHASE FOUR															
					WEEK 7					WEEK 8					WEEK 9					WEEK 10					WEEK 11					WEEK 12				
	TASK TITLE	START DATE	DUE DATE	DURATION	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F
2.5	Integration Testing (cont.)	6/17/22	7/11/22	24																														
3	Final Stage																																	
3.1	Evaluation and Feedback	7/11/22	7/22/22	11																														
3.2	User Manual	7/29/22	8/2/22	3																														
3.3	Additional Machine Shop Work	7/21/22	8/2/22	11																														
3.2	Robust Testing	7/25/22	8/2/22	7																														
2.4	Software Refinement	7/26/22	8/2/22	6																														
4	Demo	8/1/22	8/4/22	3																														

Business Case: Market and Budget

- Elderly users who need help with mobility
- Personal use service robots for have a market share of USD $35.9 billion in 2022
- Forecasted compound annual growth rate of 35.8% until 2030
- Our target audience is approximately 16.3% of the total market
- Estimated capture of 1% of the available market
- Budget will be from financing loans from banks, friends/family, and possible investment from other companies

Business Case: Costs

- Direct-to-consumer model that consists of an e-commerce platform
- Advertising: Television infomercials, newspaper advertising, and online advertising
- Assume all Equipment Comes with Lease Space

Fixed Costs Of Gamma Prototype

Fixed Costs and Assumptions	Estimate Price for a year $(CAD)
Warehouse Space Lease	($6,000 x 12)= ($72,000)
Salaries	($50,000 x 5) = ($250,000)
Utilities	($250 x 12) = ($3,000)
Advertising/Marketing	$20,000
Total Sum	($345,000)

Fixed Costs Of Mass Production

Fixed Costs and Assumptions	Estimate Price for a year $(CAD)
Warehouse Space Lease	($6,000 x 12)= ($72,000)
Salaries +Laborers	($50,000 x 5)+($30,000 x 2) = ($310,000)
Utilities	($300 x 12) = ($3,600)
Advertising/Marketing	$20,000
Total Sum	($405,000)

Break Even Point Calculation

Gamma Prototype parts cost

Part	Description Total Cost $(CAD)
Microcontroller	Raspberry Pi 400 (**$120.00**)
Motors x2	120W Brush DC Motor High Speed (**$126.28**)
Battery	12V SLA Battery (**$30.00**)
Linear Actuator	Artilife Linear Actuator (**$70.00**)
Motor Drivers x2	Cytron Motor Driver (**$52.51**)
Camera	PAPALOOK AF925 Webcam (**$50.00**)
Drive Wheels x2	Semi Pneumatic Wheels (**$26.00**)
Wheel Hubs x2	Flange Coupling Connector (**$6.50**)
Electrical Wires	Jumper Wires (**$13.00**)
Hardware Material	Medium Density Fiberboard (**$43.00**)
Remote Control	Wireless Remote Control (**$30.00**)
Base and Top Cover	Multi-purpose Aluminum Sheet (**$33.00**)
Gear pulley system	Gears and pulleys (**$100.00**)
Miscellaneous	Caster wheels, Brackets, Screws (**$50.00**)
Sum of all Parts	**$750.29**

Mass Production parts cost

Part	Description Total Cost $(CAD)
Microcontroller	Raspberry Pi 4 (**$60.75**)
Motors x2	120W Brush DC Motor High Speed (**$38.94**)
Battery	DC 12V Lithium-Ion 6800mAh (**$14.34**)
Linear Actuator	Artilife Linear Actuator (**$70.00**)
Motor Drivers x2	Cytron Motor Driver (**$37.60**)
Camera	Raspberry Pi Camera Module (**$3.18**)
Drive Wheels x2	Semi Pneumatic Wheels (**$26.00**)
Wheel Hubs x2	Flange Coupling Connector (**$6.50**)
Electric Wires	Jumper Wires (**$1.00**)
Hardware Material	Medium Density Fiberboard (**$10.00**)
Remote Control	2.4GHz Wireless Remote Control (**$7.18**)
Base and Top Cover	Multi-purpose Aluminum Sheet(**$10.00**)
Gear pulley system	Gears and Belts ($**20.00**)
Miscellaneous	Caster wheels, Brackets, Screws (**$15.00**)
Sum of all parts	**$320.49**

Break Even Point Calculation

Gamma Prototype

- Fixed Costs: $345,000
- Cost of parts: $750.29
- Initial price point: $1000.00

Break-Even Point (Units) = Fixed Costs ÷ (Revenue per Unit – Variable Cost per Unit)

Break Even Point (*Gamma*) =345,000/(1000-750.29) = **1381.6 Units**

Mass Production

- Fixed Costs: $405,000
- Cost of parts: $320.49
- Initial price point: $1000.00

Break Even Point (*Production*) =405,000/(1000-320.49) = **596.01 Units**

Business Case: Competition

- AI-based multi-purpose robots such as Samsung’s Bot Handy
- Toyota’s Gantry Robot hangs from ceiling
- Upcoming solutions are pricey
- Features range from pouring wine to cleaning the dishes.
- In contrast, our product is much more affordable

[9]

[10]

Business Case: Ideal Customer and Considerations

- Our ideal customers are elderly individuals who require some sort of mobility assistance
- Our customers live in their own home as opposed to a specialized care facility

Considerations made for our customers:

  - Simple user interface with minimal setup through our included remote control
  - Marketing through infomercials and newspapers with phone-based sales, in addition to online
  - Automatic proximity stop to prevent injury due to collisions

Risk Analysis: Potential Risks and Mitigations

Risks/ Hazards	Mitigations
Electrical discharge from electrical components	Aluminium enclosure to seal the base
Table tipping to sides (*Load placed on edges*)	Achieved very low center of mass
Potential Collision	Ultrasonic Sensor restricts movement
Sharp exposed edges around the corner	Foam insulation tape to cover the edges
Object falling off the sides of table top	Built a railing around the edges
Movement after releasing control keys	Slightly reduced by belt & pulley system
Debris from the wheels	*Eventually* add dust shield around wheels

Risk Analysis: Plan B

- What would we do if original commercialization plan fails?
  - In the event that our plan A fails, we plan to **exit the market**

- How exactly do we exit the market?
  - Merging with a large company
    - Integrations of assets and Intellectual property into R&D or existing product
  - Complete liquidation and sell all assets to recoup initial investments

Adherence to Standards

CSA C22.2 NO. 0.23-15	Canadian Standards Association: General requirements for battery-powered appliances.

- Onboard 12V SLA battery and charging circuit
- Ensures safety for the user and longevity of the power system
- Complied with battery pack format and maximum voltage ratings

ISO 13482:2014	Robots and robotic devices – Safety requirements for personal care robots.

- Operation of the robot alongside human users, domestic animals, and property
- Focuses on collision hazards
- Complied with collision safety precautions such as the proximity sensors

Adherence to Standards (Cont.)

CSA ISO/IEC/IEEE 8802-11:19	Wireless LAN medium access control (MAC) and physical layer (PHY) specifications.

- Specifies wireless communication requirements of the LAN connection used for the web application
- Complied with built in Wifi capability of Raspberry Pi 400

IEC TR 61997:2001	Guidelines for the User Interface in Multimedia Equipment for General Purpose Use

- Design of software components for use in multimedia devices
- Focus on operation and comprehensibility for the basic user
- Complied with understandability and visibility of buttons, and location of components such as the power switch

Self-Reflection

What feedback from the course and meetings was incorporated?

- Prototype - Refinement progress meeting
  - Optional Physical controller
  - Avoid 3D Printing
- Future-proofing progress meeting
  - Sensors
  - Belt & Pulley system - Conserve power supplied to motors
- Business-pitch progress meeting
  - Pick up the pace for completion of prototype
  - Need to emphasize simplicity of product manual for end user

Self-Reflection Continued...

- What would our team do differently?
  - Would want to explore more into different components
  - Meet up and finish goals earlier than later
  - Decide and order the parts earlier due to delays in shipping

- What did our team learn?
  - Learned about hardware and microcontroller driven design
  - Manage uncertainties and plan for backups
  - Teamwork and regular meetings are crucial for successful completion of prototype
  - Considering all inputs and explore different possible solutions

Conclusion and Summary

- what was promised Initially?
  - Remote controlled courier device
    - Via Web & physical controller
  - Adjustable tabletop
  - Allow Movement only when at minimum height
  - Camera Feedback on Web

- Importance of Project Management & teamwork
- Further Improvements can be made for Final Version
  - Accurate & Reliable Sensors
  - Fast moving linear actuator - (*now - 68 sec*)
  - Braking System
  - Wheels & Caster

Acknowledgements

We would like to thank the following people for their support and guidance throughout the development of this project :

- Dr. Andrew Rawicz
- Michael Hegedus
- Chris Hynes
- Usman Ahmed

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Questions