BME Design-Fall 2025 - NICOLAS MALDONADO
Complete Notebook

PDF Version generated by

John Puccinelli

on

Dec 16, 2025 @12:29 PM CST

Table of Contents

Team contact Information

Nial Donohoo - Sep 05, 2025, 1:59 PM CDT

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Project description

John Puccinelli - Aug 14, 2013, 12:01 PM CDT

Course Number:

Project Name:

Short Name:

Project description/problem statement:

About the client:

Questions for Client 9/5/2025

HENRY SALITA - Sep 11, 2025, 1:21 PM CDT

Title: Questions for Client

Date: 9/5/2025

Content by: All group members

Present: all group members

Goals: To gain more information about what our client wants for our project.

Content:

Any materials for us to use, such as old walkers?
How many wheels does the walker have? Zero, two, or four?
What are the exact metrics you would like us to record?
How would you like to view that information that is collected (we don’t yet know what we will be able to do)?
Live updates?
Extract data form walker?
Little screen on walker?
What did you mean when you said previous designs compromised the structural integrity of the walker?
Safety guidelines?
Material restrictions or preference?
What's the budget?
Is there more information on who the walker is for? (height, age, ect.)

Conclusions/action items:

These are the questions before our client meeting, in this document I will add the notes we write down from the answers to these questions.

Action items:

- meet with client!

Client Meeting 1 9/11/25

Aidan BURICH - Sep 12, 2025, 12:19 PM CDT

Title: First Client Meeting

Date: 9/11/25

Content by: Group

Present: Group

Goals: Meet with the Client and understand what he expects from us for the project, and answer any other questions we have

Content:

- Background information on him and what he needs the walker for:
  - 58 Bed hospital Traumatic injury spinal cord injury, motor-vehical accidents
  - Average stay is 2 weeks been in acute care previously and bed bound
  - Goal 80% to community discharge → not nursing home
  - Majority goal is to graduate from walker to lesser device (cane, walking stick etc.)
  - No idea how much support is relying on the walker – no way of gauging how dependent
  - Medicare criteria – information on how far the client walked
  - Walking speed is sixth vital sign
- The client commented on the last smart walker project and what needs to improve
  - Last iteration: great device, to get load sensors in had to cut open the legs
  - Considered for a patent… but didn't meet criteria
  - Sensor to put on walker - to determine force
  - All have cap glide - could use to put sensor in or underneath it (easy take off and put on, wear down easily)
  - The walker the last team used infrared black and white to tell the speed
  - At very least some sort of pressure sensor
  - Drive medical is big supplier of walkers
  - Would be very motivating to patients
  - Possibility to tour hospital

- Questions we asked

1. What are the exact metrics you would like us to record?
   Ranked: pressure, speed, distance
   2 m/s to cross street
2. How would you like to view that information that is collected (we don't yet know what we will be able to do)?
   a. Live updates?
   b. Extract data from walker?
   c. Little screen on walker?
   Talked about bluetooth technology
3. What did you mean when you said previous designs compromised the structural integrity of the walker?
   Cut the legs
4. Safety guidelines? - Walker can't be edited in any way
5. Material restrictions or preference? - Has to be a regular walker and not edit the actual structure of the walker
6. What's the budget? - $500 (flexible)
7. Is there more information on who the walker is for? (height, age, ect.) - Many types of patients and have to be flexible for many types of people

8. Any materials for us to use, such as old walkers?
   Able to drop off previous walker within next week or so
   And a standard one ($35)
9. How many wheels does the walker have? Zero, two, or four?
   Two or zero

Conclusions/action items:

- The meeting with our client was very successful

- He clearly laid out what he wants for the project and what he expects us to do

- All the questions we had, he answered, which gave us a clear direction for the project

- Next steps are to start brainstorming and do some research on the technology we want to use for the project

10/15/25 Client Meeting 2

Aidan BURICH - Nov 01, 2025, 3:22 PM CDT

Title: Client Meeting 2

Date: 10/15/25

Content by: Group

Present: Group

Goals: Present our preliminary designs to the client and ask clarification questions

Content:

- Meeting was held over Zoom.

- First half of the meeting, we went over our preliminary presentation and explained why we went with the lidar and basic end cap design for the load cell

  - We chose the simple endcap design because of its simplicity and similarity to the endcaps already used on the walker

  - We chose the lidar because it is the most accurate and easy to set up and move from walker to walker.

- Our client was pleased with our ideas and agreed that they were the best options from our preliminary design

- The second half of the meeting was spent asking clarification questions to ensure we understood exactly what our client wanted

  - Our first concern with the lidar was where he has the patients walk.

  - The lidar needs uninterrupted vision of a wall or surface that is being walked towards. This was a concern because we were not sure if the clinic had that possibility.

  - He told us that this should not be a problem and sent us pictures of the area they usually walk. The pictures are below.

  - Our second concern was whether it was ok that the load cells were only on the back legs

  - He thought that would be fine. As long as it gives consistent reading and shows improvement, it doesn't necessarily have to tell exactly how much force the patient is putting on the walker.

- The meeting went really well and our client is very excited in our progress and can't wait for the final product.

Conclusions/action items:

- Our next steps are to start printing the load cell housing and order our load cells and lidar.

Client's Clinic Visit 11/21/25

Aidan BURICH - Dec 03, 2025, 6:14 PM CST

Title: Visit to Client's Clinic

Date: 11/21/25

Content by: Aidan

Present: Aidan, Nial, Caraolyn

Goals: Visit the Clinic and see where our design will be used

Content:

- The three of us Ubered out to his Fitchburg clinic

- We were given a tour of the facility

    - We learned it was only 2 years old

    - They are sponsored by Encompass, which allows them to spend lots of money trying to get their patients the best care

    - Our tour guide explained lots of the basic facts of the facility, like the number of rooms and the average stay

- We then talked to our client, and he showed us where he does most of his rehab

    - There was a room with countless pieces of expensive equipment

    - For example, he showed us a $300k device that can assist in walking patients upstairs and prevent getting hurt from falls.

Our client was very excited to show us how and who our device will help.

Conclusions/action items:

It was very rewarded seeing the facility our device will go to. It also put the human aspect into our project. Seeing who we are going to help made us want to work even harder on our project and produce a quality result

Action Items

- Solder the final components together

- Construct final prototype!!

Progress Report 1 9/11/25

NICOLAS MALDONADO - Sep 05, 2025, 1:42 PM CDT

Aidan BURICH - Dec 03, 2025, 5:58 PM CST

Date: 10/14/2024 to 10/21/24

Project Title: Inflatable Joint Expander for Claw Put

Team Name: Joint Warriors

Client: Dr. Robert Herndon

Instructor: Jack Kegel; SA: Ella Lang

Team Members	Email
Lily Tappuo (Accountant)	ltappuo@wisc.edu
Samantha Caspersen (Communicator)	sjcaspersen@wisc.edu
Caitlin Costello (Code/CAD)	ccostello@wisc.edu
Sophie Kato (Videographer)	snkato@wisc.edu
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William Stoddert (Facilitator)	wstoddert@wisc.edu
Maya Stroemmen (Procurement Manager)	mrstroemmen@wisc.edu

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Progress_Report_1.pdf (197 kB)

Aidan BURICH - Dec 03, 2025, 6:16 PM CST

Title: Progress Report 1

Date: 9/11/25

Content by: Group

Present: Group

Goals: Show our client and advisor what we completed during the week and our goals for the next week

Content:

See attachment

Conclusions/action items:

- Complete next week's goals, detailed in the progress report

Progress Report 2 9/18/25

Aidan BURICH - Dec 03, 2025, 6:02 PM CST

Date: 10/21/2024 to 10/28/24

Project Title: Inflatable Joint Expander for Claw Pist

Team Name: Joint Warriors

Client: Dr. Robert Herndon

Instructor: Jack Kegel; SA: Ella Lang

Team Members	Email
Lily Tappuni (Accountant)	ltappuni@wisc.edu
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Progress_Report_2.pdf (245 kB)

Aidan BURICH - Dec 03, 2025, 6:16 PM CST

Title: Progress Report 2

Date: 9/18/25

Content by: Group

Present: Group

Goals: Show our client and advisor what we completed during the week and our goals for the next week

Content:

See attachment

Conclusions/action items:

- Complete next week's goals, detailed in the progress report

Progress Report 3 9/25/25

Aidan BURICH - Dec 03, 2025, 6:02 PM CST

Date: 10/21/2024 to 11/4/24

Project Title: Inflatable Joint Expander for Claw Pist

Team Name: Joint Warriors

Client: Dr. Robert Herndon

Instructor: Jack Kegel; SA: Ella Lang

Team Members	Email
Lily Tappuni (Accountant)	ltappuni@wisc.edu
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Aidan BURICH - Dec 03, 2025, 6:17 PM CST

Title: Progress Report 3

Date: 9/25/25

Content by: Group

Present: Group

Goals: Show our client and advisor what we completed during the week and our goals for the next week

Content:

See attachment

Conclusions/action items:

- Complete next week's goals, detailed in the progress report

Progress Report 4 10/2/25

Aidan BURICH - Dec 03, 2025, 6:03 PM CST

Date: 11/04/2024 to 11/10/24

Project Title: Inflatable Joint Expander for Claw Pist

Team Name: Joint Warriors

Client: Dr. Robert Herndon

Instructor: Jack Kegel; SA: Ella Lang

Team Members	Email
Lily Tappuni (Accountant)	ltappuni@wisc.edu
Samantha Caspersen (Communicator)	sjcaspersen@wisc.edu
Caitlin Costello (Code/CAD)	ccostello@wisc.edu
Sophie Kato (Videographer)	sukato@wisc.edu
Aidan Burich (Report Editor)	aburich@wisc.edu
William Stoudert (Facilitator)	wstoudert@wisc.edu
Maya Stroomen (Procurement Manager)	mstroomen@wisc.edu

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Progress_report_4.pdf (413 kB)

Aidan BURICH - Dec 03, 2025, 6:18 PM CST

Title: Progress Report 4

Date: 10/2/25

Content by: Group

Present: Group

Goals: Show our client and advisor what we completed during the week and our goals for the next week

Content:

See attachment

Conclusions/action items:

- Complete next week's goals, detailed in the progress report

Progress Report 5 10/9/25

Aidan BURICH - Dec 03, 2025, 6:03 PM CST

Date: 11/10/2024 to 11/15/24

Project Title: Inflatable Joint Expander for Claw Pist

Team Name: Joint Warriors

Client: Dr. Robert Herndon

Instructor: Jack Kegel; SA: Ella Lang

Team Members	Email
Lily Tappuni (Accountant)	ltappuni@wisc.edu
Samantha Caspersen (Communicator)	sjcaspersen@wisc.edu
Caitlin Costello (Code/CAD)	ccostello@wisc.edu
Sophie Kato (Videographer)	sukato@wisc.edu
Aidan Burich (Report Editor)	aburich@wisc.edu
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Progress_report_5.pdf (278 kB)

Aidan BURICH - Dec 03, 2025, 6:18 PM CST

Title: Progress Report 5

Date: 10/9/25

Content by: Group

Present: Group

Goals: Show our client and advisor what we completed during the week and our goals for the next week

Content:

See attachment

Conclusions/action items:

- Complete next week's goals, detailed in the progress report

Progress Report 6 10/16/25

Aidan BURICH - Dec 03, 2025, 6:03 PM CST

Date: 11/19/2024 to 11/26/24

Project Title: Inflatable Joint Expander for Claw Pist

Team Name: Joint Warriors

Client: Dr. Robert Herndon

Instructor: Jack Kegel; SA: Ella Lang

Team Members	Email
Lily Tappuni (Accountant)	ltappuni@wisc.edu
Samantha Caspersen (Communicator)	sjcaspersen@wisc.edu
Caitlin Costello (Code/CAD)	ccostello@wisc.edu
Sophie Kato (Videographer)	sukato@wisc.edu
Aidan Burich (Report Editor)	aburich@wisc.edu
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Maya Stroomen (Procurement Manager)	mstroomen@wisc.edu

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Aidan BURICH - Dec 03, 2025, 6:18 PM CST

Title: Progress Report 6

Date: 10/16/25

Content by: Group

Present: Group

Goals: Show our client and advisor what we completed during the week and our goals for the next week

Content:

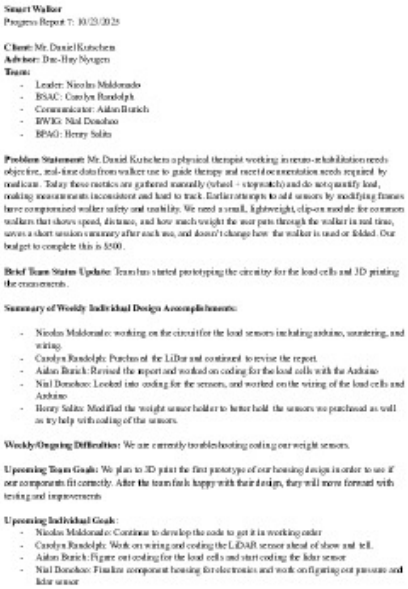
See attachment

Conclusions/action items:

- Complete next week's goals, detailed in the progress report

Progress Report 7 10/23/25

Aidan BURICH - Dec 03, 2025, 6:03 PM CST



Smart Walker
Progress Report 7: 10/23/2025

Client: Mr. Daniel Kutschera
Advisor: Duc-Huy Nyugen
Team:
- Leader: Nicolas Maldonado
- BSAC: Carolyn Randolph
- Communicator: Aidan Burich
- BWIG: Niel Donohoo
- BPAG: Henry Salito

Problem Statement: Mr. Daniel Kutschera a physical therapist working in neuro-rehabilitation needs objective, real-time data from walker use to guide therapy and meet documentation needs required by medicare. Today these metrics are gathered manually (wheel + stopwatch) and do not quantify load, making measurements inconsistent and hard to track. Earlier attempts to add sensors by modifying frames have compromised walker safety and usability. We need a small, lightweight, clip-on module for common walkers that shows speed, distance, and how much weight the user puts through the walker in real time, saves a short session summary after each use, and doesn't change how the walker is used or folded. Our budget to complete this is $500.

Brief Team Status Update: Team has started prototyping the circuitry for the load cells and 3D printing the enclosements.

Summary of Weekly Individual Design Accomplishments:

- Nicolas Maldonado: working on the circuit for the load sensors including arduino, soldering, and wiring.
- Carolyn Randolph: Purchased the LiDar and continued to revise the report.
- Aidan Burich: Revised the report and worked on coding for the load cells with the Arduino
- Niel Donohoo: Looked into coding for the sensors, and worked on the wiring of the load cells and Arduino
- Henry Salito: Modified the weight sensor holder to better hold the sensors we purchased as well as try help with coding of the sensors.

Weekly/Ongoing Difficulties: We are currently troubleshooting coding our weight sensors.

Upcoming Team Goals: We plan to 3D print the first prototype of our housing design in order to see if our components fit correctly. After the team finds happy with their design, they will move forward with testing and improvements

Upcoming Individual Goals:
- Nicolas Maldonado: Continue to develop the code to get it in working order
- Carolyn Randolph: Work on wiring and coding the LiDAR sensor ahead of show and tell.
- Aidan Burich: Figure out coding for the load cells and start coding the lidar sensor
- Niel Donohoo: Finalize component housing for electronics and work on figuring out pressure and lidar sensor

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Progress_Report_7.pdf (171 kB)

Aidan BURICH - Dec 03, 2025, 6:19 PM CST

Title: Progress Report 7

Date: 10/23/25

Content by: Group

Present: Group

Goals: Show our client and advisor what we completed during the week and our goals for the next week

Content:

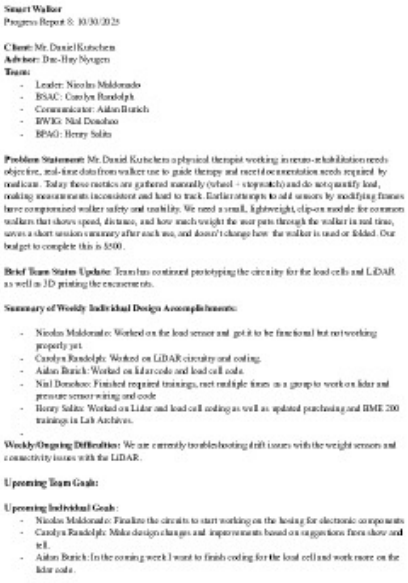
See attachment

Conclusions/action items:

- Complete next week's goals, detailed in the progress report

Progress Report 8 10/30/25

Aidan BURICH - Dec 03, 2025, 6:04 PM CST



Smart Walker
Progress Report 8: 10/30/2025

Client: Mr. Daniel Kutschera
Advisor: Duc-Huy Nyugen
Team:
- Leader: Nicolas Maldonado
- BSAC: Carolyn Randolph
- Communicator: Aidan Burich
- BWIG: Niel Donohoo
- BPAG: Henry Salita

Problem Statement: Mr. Daniel Kutschera a physical therapist working in neuro-rehabilitation needs objective, real-time data from walker use to guide therapy and meet documentation needs required by medicare. Today these metrics are gathered manually (wheel + stopwatch) and do not quantify load, making measurements inconsistent and hard to track. Earlier attempts to add sensors by modifying frames have compromised walker safety and usability. We need a small, lightweight, clip-on module for common walkers that shows speed, distance, and how much weight the user puts through the walker in real time, saves a short session summary after each use, and doesn't change how the walker is used or folded. Our budget to complete this is $500.

Brief Team Status Update: Team has continued prototyping the circuitry for the load cells and LiDAR as well as 3D printing the encasements.

Summary of Weekly Individual Design Accomplishments:

- Nicolas Maldonado: Worked on the load sensor and got it to be functional but not working properly yet.
- Carolyn Randolph: Worked on LiDAR circuitry and coding.
- Aidan Burich: Worked on lidar code and load cell code.
- Niel Donohoo: Finished required trainings, met multiple times as a group to work on lidar and pressure sensor wiring and code
- Henry Salita: Worked on Lidar and load cell codings as well as updated purchasing and BME 200 trainings in Lab Archives.

Weekly/Ongoing Difficulties: We are currently troubleshooting drift issues with the weight sensors and connectivity issues with the LiDAR.

Upcoming Team Goals:

Upcoming Individual Goals:
- Nicolas Maldonado: Finalize the circuits to start working on the hosing for electronic components
- Carolyn Randolph: Make design changes and improvements based on suggestions from show and tell.
- Aidan Burich: In the coming week I want to finish coding for the load cell and work more on the lidar code.

Download

Progress_Report_8.pdf (170 kB)

Aidan BURICH - Dec 03, 2025, 6:19 PM CST

Title: Progress Report 8

Date: 10/30/25

Content by: Group

Present: Group

Goals: Show our client and advisor what we completed during the week and our goals for the next week

Content:

See attachment

Conclusions/action items:

- Complete next week's goals, detailed in the progress report

Progress Report 9 11/6/25

Aidan BURICH - Dec 03, 2025, 6:04 PM CST

Smart Walker
Progress Report 8: 11/06/2025

Client: Mr. Daniel Kutschera
Advisor: Duc-Huy Nyugen
Team:
- Leader: Nicolas Maldonado
- BSAC: Carolyn Randolph
- Communicator: Aidan Burich
- BWIG: Niel Donohoo
- BPAG: Henry Soltis

Problem Statement: Mr. Daniel Kutschera a physical therapist working in neuro-rehabilitation needs objective, real-time data from walker use to guide therapy and meet documentation needs required by medicare. Today these metrics are gathered manually (wheel + stopwatch) and do not quantify load, making measurements inconsistent and hard to track. Earlier attempts to add sensors by modifying frames have compromised walker safety and usability. We need a small, lightweight, clip-on module for common walkers that shows speed, distance, and how much weight the user puts through the walker in real time, saves a short session summary after each use, and doesn't change how the walker is used or folded. Our budget to complete this is $500.

Brief Team Status Update: The team has made significant progress in terms of circuitry. We have the LiDAR sensor in mostly working order and are approaching the testing phase. We have created custom models for the load sensors and will continue to develop them.

Summary of Weekly Individual Design Accomplishments:

- Nicolas Maldonado: Worked on the load sensor calibration and general research on arduino
- Carolyn Randolph: Soldered the load cell wires for better connectivity, built a platform for load cell calibration and continued to work on finding calibration value.
- Aidan Burich:
- Niel Donohoo: Did additional research on load sensor calibration. Looked into laser pointer devices to put on top of lidar sensor to make sure its pointed in the correct direction.
- Henry Soltis: Worked on designing clamps or pressure holders for walker leg, as well as other 3D design modifications.
-

Weekly/Ongoing Difficulties: We are currently troubleshooting the load sensors in order to get them calibrated correctly

Upcoming Team Goals: Finish all circuits and begin testing and housing development

Upcoming Individual Goals:
- Nicolas Maldonado: Have working electronics to continue to housing development and testing
- Carolyn Randolph: Finish calibration and start integrating different components into combined system.
- Aidan Burich: Continue to work on legs in load cell code. Obtain batteries for Arduino.

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Progress_Report_9.pdf (172 kB)

Aidan BURICH - Dec 03, 2025, 6:19 PM CST

Title: Progress Report 9

Date: 11/6/25

Content by: Group

Present: Group

Goals: Show our client and advisor what we completed during the week and our goals for the next week

Content:

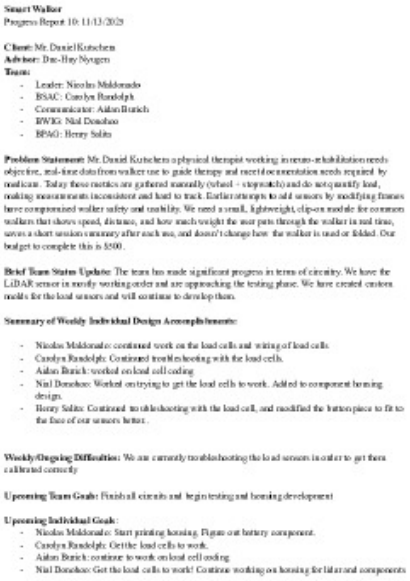
See attachment

Conclusions/action items:

- Complete next week's goals, detailed in the progress report

Progress Report 10 11/13/25

Aidan BURICH - Dec 03, 2025, 6:04 PM CST



Smart Walker
Progress Report 10: 11/13/2025

Client: Mr. Daniel Kutschera
Advisor: Duc-Huy Nyugen
Team:
- Leader: Nicolas Maldonado
- BSAC: Carolyn Randolph
- Communicator: Aidan Burich
- BWIG: Nial Donohoe
- BPAG: Henry Saltz

Problem Statement: Mr. Daniel Kutschera a physical therapist working in neuro-rehabilitation needs objective, real-time data from walker use to guide therapy and meet documentation needs required by medicare. Today these metrics are gathered manually (wheel + stopwatch) and do not quantify load, making measurements inconsistent and hard to track. Earlier attempts to add sensors by modifying frames have compromised walker safety and usability. We need a small, lightweight, clip-on module for common walkers that shows speed, distance, and how much weight the user puts through the walker in real time, saves a short session summary after each use, and doesn't change how the walker is used or folded. Our budget to complete this is $500.

Brief Team Status Update: The team has made significant progress in terms of circuitry. We have the LiDAR sensor in mostly working order and are approaching the testing phase. We have created custom models for the load sensors and will continue to develop them.

Summary of Weekly Individual Design Accomplishments:

- Nicolas Maldonado: continued work on the load cells and wiring of load cells.
- Carolyn Randolph: Continued troubleshooting with the load cells.
- Aidan Burich: worked on load cell coding
- Nial Donohoe: Worked on trying to get the load cells to work. Added to component housing design.
- Henry Saltz: Continued troubleshooting with the load cell, and modified the button piece to fit to the face of our sensors better.

Weekly/Ongoing Difficulties: We are currently troubleshooting the load sensors in order to get them calibrated correctly

Upcoming Team Goals: Finish all circuits and begin testing and housing development

Upcoming Individual Goals:
- Nicolas Maldonado: Start printing housing. Figure out battery component.
- Carolyn Randolph: Get the load cells to work.
- Aidan Burich: continue to work on load cell coding
- Nial Donohoe: Get the load cells to work! Continue working on housing for lid and components

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Progress_Report_10.pdf (172 kB)

Aidan BURICH - Dec 03, 2025, 6:20 PM CST

Title: Progress Report 10

Date: 11/13/25

Content by: Group

Present: Group

Goals: Show our client and advisor what we completed during the week and our goals for the next week

Content:

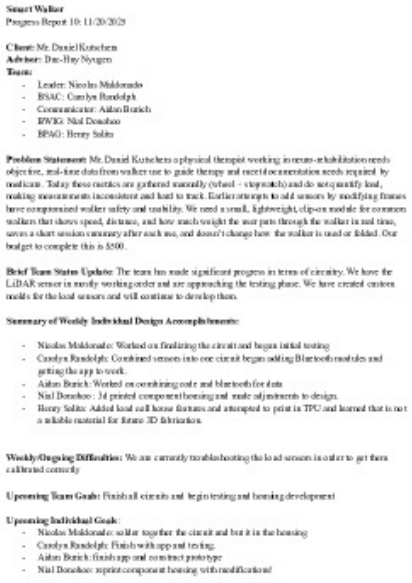
See attachment

Conclusions/action items:

- Complete next week's goals, detailed in the progress report

Progress Report 11 11/20/25

Aidan BURICH - Dec 03, 2025, 6:05 PM CST



Smart Walker
Progress Report 10: 11/20/2025

Client: Mr. Daniel Kutschera
Advisor: Duc-Huy Nyugen
Team:
- Leader: Nicolas Maldonado
- BSAC: Carolyn Randolph
- Communicator: Aidan Burich
- BWIG: Nial Donohoe
- BPAG: Henry Salita

Problem Statement: Mr. Daniel Kutschera a physical therapist working in neuro-rehabilitation needs objective, real-time data from walker use to guide therapy and meet documentation needs required by medicare. Today these metrics are gathered manually (wheel + stopwatch) and do not quantify load, making measurements inconsistent and hard to track. Earlier attempts to add sensors by modifying frames have compromised walker safety and usability. We need a small, lightweight, clip-on module for common walkers that shows speed, distance, and how much weight the user puts through the walker in real time, saves a short session summary after each use, and doesn't change how the walker is used or folded. Our budget to complete this is $500.

Brief Team Status Update: The team has made significant progress in terms of circuitry. We have the LiDAR sensor in mostly working order and are approaching the testing phase. We have created custom molds for the load sensors and will continue to develop them.

Summary of Weekly Individual Design Accomplishments:

- Nicolas Maldonado: Worked on finalizing the circuit and began initial testing
- Carolyn Randolph: Combined sensors into one circuit began adding Bluetooth modules and getting the app to work.
- Aidan Burich: Worked on combining code and bluetooth for data
- Nial Donohoe: 3d printed component housing and made adjustments to design.
- Henry Salita: Added load cell house features and attempted to print in TPU and learned that is not a suitable material for future 3D fabrication.

Weekly/Ongoing Difficulties: We are currently troubleshooting the load sensors in order to get them calibrated correctly

Upcoming Team Goals: Finish all circuits and begin testing and housing development

Upcoming Individual Goals:
- Nicolas Maldonado: solder together the circuit and but it in the housing
- Carolyn Randolph: Finish with app and testing.
- Aidan Burich: finish app and construct prototype
- Nial Donohoe: reprint component housing with modifications!

Download

Progress_Report_11.pdf (190 kB)

Aidan BURICH - Dec 03, 2025, 6:20 PM CST

Title: Progress Report 11

Date: 11/25/25

Content by: Group

Present: Group

Goals: Show our client and advisor what we completed during the week and our goals for the next week

Content:

See attachment

Conclusions/action items:

- Complete next week's goals, detailed in the progress report

Progress Report 12 12/4/25

Aidan BURICH - Dec 03, 2025, 6:21 PM CST

Title: Progress Report 12

Date: 12/4/25

Content by: Group

Present: Group

Goals: Show our client and advisor what we completed during the week and our goals for the next week

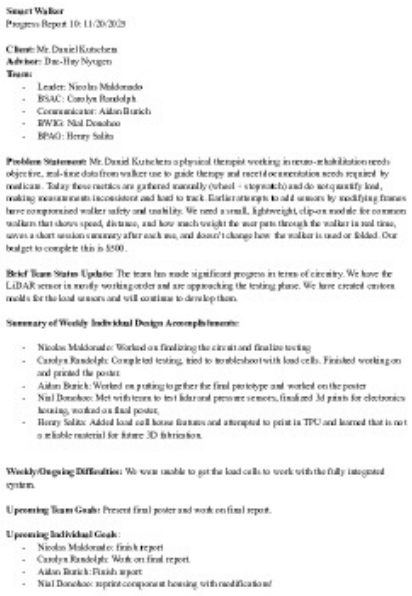
Content:

See attachment

Conclusions/action items:

- Complete next week's goals, detailed in the progress report

Aidan BURICH - Dec 05, 2025, 3:56 PM CST



Smart Walker
Progress Report 10: 11/20/2025

Client: Mr. Daniel Kutschera
Advisor: Duc-Huy Nyugen
Team:
- Leader: Nicolas Maldonado
- BSAC: Carolyn Randolph
- Communicator: Aidan Burich
- BWIG: Niall Donohoe
- BPAG: Henry Salita

Problem Statement: Mr. Daniel Kutschera a physical therapist working in neuro-rehabilitation needs objective, real-time data from walker use to guide therapy and meet documentation needs required by medicare. Today these metrics are gathered manually (wheel + stopwatch) and do not quantify load, making measurements inconsistent and hard to track. Earlier attempts to add sensors by modifying frames have compromised walker safety and usability. We need a small, lightweight, clip-on module for common walkers that shows speed, distance, and how much weight the user puts through the walker in real time, saves a short session summary after each use, and doesn't change how the walker is used or folded. Our budget to complete this is $500.

Brief Team Status Update: The team has made significant progress in terms of circuitry. We have the LiDAR sensor in mostly working order and are approaching the testing phase. We have created custom molds for the load sensors and will continue to develop them.

Summary of Weekly Individual Design Accomplishments:
- Nicolas Maldonado: Worked on finalizing the circuit and finalize testing
- Carolyn Randolph: Completed testing, tried to troubleshoot with load cells. Finished working on and printed the poster
- Aidan Burich: Worked on putting together the final prototype and worked on the poster
- Niall Donohoe: Met with team to test lateral pressure sensors, finalized 3d prints for electronics housing, worked on final poster,
- Henry Salita: Added load cell horse features and attempted to print in TPU and learned that is not a reliable material for future 3D fabrication.

Weekly/Ongoing Difficulties: We were unable to get the load cells to work with the fully integrated system.

Upcoming Team Goals: Present final poster and work on final report.

Upcoming Individual Goals:
- Nicolas Maldonado: finish report
- Carolyn Randolph: Work on final report
- Aidan Burich: Finish report
- Niall Donohoe: reprint component housing with modifications!

Download

Progress_Report_12.pdf (214 kB)

Advisor Meeting 1 9/11/25

Aidan BURICH - Sep 12, 2025, 12:25 PM CDT

Title: First Advisor Meeting

Date: 9/11/25

Content by: Aidan

Present: Group

Goals: Meet with our advisor to understand his expectations and share our first progress report

Content:

- We met with Dr. Nguyen on our Thursday meeting time
- We talked about the past iterations of the project and his expectations on how we should use it
- We also talked about each person's research for the week and how it furthered our understanding of walkers and how it will benefit this project
- The meeting was short as we are just getting started and had not met with our client yet

Conclusions/action items:

- Meet with client (which happened 20 minutes after this meeting)
- Continue research
- Start to brainstorming ideas for the walker
- Get the previous group's project to more fully understand how it works and how we can improve it.

Advisor Meeting 2 9/19/25

Aidan BURICH - Nov 01, 2025, 4:06 PM CDT

Title: Advisor Meeting 2

Date: 9/19/25

Content by: Group

Present: Group

Goals: Meet with our advisor to explain client needs and background research

Content:

- We met with Dr. Nguyen on our Friday meeting time

- We talked about lots of the preliminary research each group member did.

  - Most people did research on how walkers are used and how we might be able to add attachments to the walker without causing a structural change to the walker

- We also talked about our client's expectations in regards to the project and what he wants for the final product

  - Tracks weight, distance and speed of the walker

  - Does not edit the structure of the walker at all

- Dr. Nguyen also gave some of his input and ideas that were very helpful

Conclusions/action items:

- Start making CAD drawings for preliminary designs

- Continue research

Advisor Meeting 3 9/25/25

Aidan BURICH - Nov 01, 2025, 4:22 PM CDT

Title: Advisor Meeting 3

Date: 9/25/25

Content by: Group

Present: Group

Goals: Meet with our advisor to explain preliminary designs

Content:

- We met with Dr. Nguyen on our Thursday meeting time

- The group talked and decided everyone should come to this meeting with one or two ideas for the load cell housing and movement sensors

- Each person presented their ideas, and Dr. Nguyen gave his input and advice on each, which was taken into consideration in the design matrix

- We were able to narrow down our 3 ideas for the design matrix for the load cell housing and movement sensors

Conclusions/action items:

- Start Preliminary Presentation

- Create Design Matrix

Advisor Meeting 4 10/10/25 Zoom

Aidan BURICH - Nov 01, 2025, 4:25 PM CDT

Title: Advisor Meeting 4

Date: 10/10/25

Content by: Group

Present: Group

Goals: Meet with our advisor to explain what each member did over the week

Content:

- We met with Dr. Nguyen over Zoom

- We briefly talked about the research everyone did throughout the week

- Also talked about feedback fruits

- It was a very short meeting because it was over Zoom

Conclusions/action items:

- Continue research on which load cells and lidar to buy

- Hopefully order both within the next week

Advisor Meeting 5 10/17/25

Aidan BURICH - Nov 02, 2025, 8:39 PM CST

Title: Advisor Meeting 5

Date: 10/17/25

Content by: Group

Present: Group

Goals: Meet with our advisor to talk about load cells and lidars

Content:

- We met with Dr. Nguyen on our Friday meeting time

- We talked about the research each member did in regards to the type of load cells and lidars to buy.

- Other group members presented ideas on housing for the battery and lidar.

Conclusions/action items:

- Order load cells and lidar

- Start coding load cells and lidar

Advisor Meeting 6 10/23/25

Aidan BURICH - Nov 02, 2025, 8:39 PM CST

Title: Advisor Meeting 6

Date: 10/23/25

Content by: Group

Present: Group

Goals: Meet with our advisor to explain recent findings and problems

Content:

- We met with Dr. Nguyen on our Thursday meeting time

- We were able to show Dr. Nguyen our design for the load cell housing

- We talked about the coding we have been doing for the load cells

- We explained the major problems we have been having

- His advice was to keep making small tweaks and talk to someone more familiar with Arduino, like the Bio-Instrumentation professor

Conclusions/action items:

- Continue to code the load cells and make improvements

- Code the lidar when it comes.

Advisor Meeting 7 11/6/25

Aidan BURICH - Dec 03, 2025, 5:44 PM CST

Title: Advisor Meeting 7

Date: 11/6/25

Content by: Group

Present: Group

Goals: Meet with our advisor to explain recent findings and problems

Content:

- We met with Dr. Nguyen on our Thursday meeting time
- We showed Dr. Nguyen the updated load cell housing designs
- We explained the slow but steady progress we have been making on the load cell code
    - We are now getting data, but it is inconsistent
- We showed the lidar
- We were able to code the lidar pretty quickly and showed our progress on that code

Conclusions/action items:

- Continue to code the load cells and make improvements
- Make prints of new load cell holders
- Update load cell housing with lidar dimensions

Advisor Meeting 8 11/14/25

Aidan BURICH - Dec 03, 2025, 5:51 PM CST

Title: Advisor Meeting 8

Date: 11/14/25

Content by: Group

Present: Group

Goals: Meet with our advisor to explain recent findings and problems

Content:

- We met with Dr. Nguyen at our Friday meeting time

- We again showed our progress on the load cell code

  - We figured out a new configuration to allow the cells to compress correctly

- We showed our new load cell print and the updates we want to make again

- Dr. Nguyen also gave his input on the new load cell housing design and how it can be improved

Conclusions/action items:

- Continue to code the load cells and fix code problems

- Make updated prints of load cell holders

Advisor Meeting 9 11/21/25

Aidan BURICH - Dec 03, 2025, 5:57 PM CST

Title: Advisor Meeting 9

Date: 11/21/25

Content by: Group

Present: Group

Goals: Meet with our advisor to explain recent findings and problems

Content:

- We met with Dr. Nguyen on our Friday meeting time

- We showed Dr. Nguyen the updated and final load cell housing designs

- We were also finally able to get the load cells to work and showed him how accurate they were

    - It was a problem with the positive and negative configuration, which we also explained to him

- We showed the long wires off the load cells and explained why they needed to be that size in order to reach the battery

- We also showed him our component housing, but there will need to be adjustments to the size, which we explained

- Dr. Nguyen reminded us that we don't have much time and have to really put it into gear to have time to test and construct the entire prototype

Conclusions/action items:

- Make final component housing print

- Test! Test! Test!

- Put all components onto to walker and finish the prototype

10/10/25 Design Matrix

Aidan BURICH - Nov 01, 2025, 4:06 PM CDT

Title: Design Matrix

Date: 10/10/25

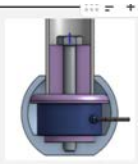
Content by: Group

Present: Group

Goals: Design Matrix

Content:

- Load Cell Housing Design Matrix

		 1. Tennis Baller		 2. End-Cap 2.0		 3. Hand Gripper	
Criteria	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Accuracy of Data	25	5/5	25	5/5	25	3/5	15
Simplicity	25	4/5	20	5/5	25	4/5	20
Usability	20	5/5	20	5/5	20	3/5	12
Safety	15	4/5	12	5/5	15	3/5	9
Ease of Set-up	15	3/5	9	3/5	9	5/5	15
Total (Out of 100):		86		94		71	

Accuracy of Data (25):
Both the Tennis Baller and End-Cap 2.0 received a full score of 5/5, demonstrating that these designs can reliably measure weight distribution and walking metrics without significant error. The Hand Gripper, however, received a 3/5, as its accuracy is compromised if the user squeezes the handle incorrectly. This makes the Hand Gripper less reliable for collecting consistent rehabilitation data.

Simplicity (25):
The End-Cap 2.0 scored the highest with 5/5 due to its straightforward design and ease of integration onto the walker. The Tennis Baller also performed well, earning 4/5, though its slightly more complex structure makes it less seamless. The Hand Gripper also scored 4/5, but its added components make it less intuitive for consistent use.

Usability (20):
Both the Tennis Baller and End-Cap 2.0 scored perfectly (5/5), as they can be used naturally during walking without altering how a patient interacts with the walker. The Hand Griper only scored 3/5 due to its reliance on the squeezing action, which could decrease stability and make the walker less functional in real-world rehabilitation settings.

Safety (15):

The End-Cap 2.0 received the top score of 5/5, since it maintains complete surface contact with the floor and does not compromise walker stability. The Tennis Baller followed with a 4/5, as it reduced the surface area, which could increase the risk of tipping. The Hand Gripper scored the lowest (3/5), as its design could compromise grip stability and lead to safety concerns during patient use.

Ease of Set-up (15):
The Hand Gripper scored the highest (5/5), since it can be easily attached without extensive modifications. Both the Tennis Baller and End-Cap 2.0 scored 3/5, as they require more effort to install correctly on the walker's legs.

Total Scores (100):
The End-Cap received the highest score of 94/100, primarily due to its strong accuracy, simple design, and easy integration with the walker. Then the Tennis Baller was given a slightly lower score of 86/100 because, although it performed similarly in accuracy and usability, it scored lower in safety due to its reduced surface area on the bottom of the walker, which has the potential to make it less stable. The Hand Gripper received the lowest score of 71/100 because even though it will be easy to attach, it will cause a decrease in grip stability and could produce inaccurate data readings if squeezed incorrectly, which lowered its safety and usability scores. Overall, the End-Cap design was our best choice due to its reliability, simplicity, and compatibility with existing walker components.

- Movement Sensors Design Matrix

		 1. Infrared Sensor		 2. Rotary Encoder		 3. Lidar Sensor	
Criteria	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Accuracy of Data	25	3/5	15	5/5	25	4/5	20
Structural Impact	20	4/5	16	1/5	4	5/5	20
Safety	15	5/5	15	3/5	9	5/5	15
Reliability of Sensors	15	3/5	9	5/5	15	4/5	12
Ease of Set-up	15	3/5	9	1/5	3	4/5	12
Cost	10	5/5	10	3/5	6	2/5	4
Total (Out of 100):		74		62		83	

Accuracy of Data (25):
The rotary encoder scored the highest (5/5) for accuracy, as it provides precise measurement of distance and rotations. The lidar also performed strongly (4/5), offering accurate distance and speed tracking with minimal error. The infrared sensor scored the lowest (3/5), as it is less consistent and can be influenced by environmental conditions.

Structural Impact (20):
The lidar scored best (5/5) because it mounts externally and does not interfere with the walker's stability or structure. The Infrared sensor also performed well (4/5), being small and lightweight, although it still affected the structure more than the Lidar, due to its position next to the wheels. The rotary encoder scored lowest (1/5), as it requires direct attachment to a wheel, which compromises structural simplicity.

Safety (15):

Both the lidar and infrared sensors scored 5/5, as they pose minimal risk to walker safety. Their designs allow for minimal change to the critical areas of the walker. The Rotary Encoder scored 3/5 due to its mechanical integration, which introduces potential hazards if not properly secured.

Reliability (15):
The rotary encoder scored the highest (5/5) since it provides consistent, reliable readings. The lidar followed with a strong 4/5 rating, although it can be sensitive to reflective surfaces. The Infrared sensor scored the lowest (3/5), as it is prone to inaccuracies depending on the lighting and surface conditions.

Ease of Set-up (15):
The lidar (4/5) and infrared (3/5) are both relatively simple to attach without significant modifications. The rotary encoder scored the lowest (1/5), since it requires precise mechanical integration that complicates the setup.

Cost (10):
The infrared sensor scored the highest (5/5) as the most affordable option. The rotary encoder scored moderately (3/5), while the lidar scored the lowest (2/5), reflecting its significantly higher cost.

Total Scores (100):
Overall, the lidar scored the highest with a score of 83/100 due to its strong accuracy/reliability, minimal structural impact, and straightforward setup. One of its main drawbacks is its high cost. Infrared placed second with a score of 74/100 because it is cheap, safe, and low-impact, but only has moderate accuracy/reliability. Lastly, the rotary encoder had the lowest score of 62/100. This is because, although it offers the best accuracy and reliability, its downsides include its structural impact, setup complexity, and some safety concerns. Overall, lidar offers the best total performance despite its high cost.

Conclusions/action items:

Next Steps

- Order load cells and lidar

- 3D print load cell housing for weight testing

10/30/25 Lidar Code

Aidan BURICH - Nov 01, 2025, 5:39 PM CDT

Title: Lidar Code

Date: 10/30/25

Content by: Group

Present: Group

Goals: Complete working lidar code

Content:

- The following is the working code for the Lidar:

```
#include <Wire.h>
#include <LIDARLite.h>

LIDARLite myLidarLite;

// ----- Rate limit -----
unsigned long lastRead = 0;
const unsigned long interval = 50; // ~20 Hz

// ----- Speed state -----
float prev_ft = NAN;
unsigned long prev_ms = 0;
bool ema_initialized = false;
float speed_ema_ft_s = NAN; // start as NAN so first line shows only distance

// ----- Toggle between text vs plot output -----
#define PLOT_OUTPUT 1   // set to 0 if you want the old text prints

inline float cmToFeet(int cm) { return cm * 0.0328084f; }

void printReading(bool bias)
{
  unsigned long now = millis();
  int dist_cm = myLidarLite.distance(bias);
  if (dist_cm <= 0) return;

  float dist_ft = cmToFeet(dist_cm);

  // Speed calc
  float inst_speed_ft_s = NAN;
  if (prev_ms != 0) {
    float dt_s = (now - prev_ms) / 1000.0f;
    if (dt_s > 0) {
      inst_speed_ft_s = (prev_ft - dist_ft) / dt_s; // + if approaching
      const float alpha = 0.25f;
      if (!ema_initialized) {
        speed_ema_ft_s = inst_speed_ft_s;
        ema_initialized = true;
      } else {
        speed_ema_ft_s = alpha * inst_speed_ft_s + (1 - alpha) * speed_ema_ft_s;
      }
```

```
    }
  }

  // ----- Output -----
#if PLOT_OUTPUT
  // Arduino Serial Plotter likes: label:value [tab] label:value ...
  Serial.print("distance_ft:");
  Serial.print(dist_ft, 2);
  Serial.print("\tspeed_ft_s:");
  if (isnan(speed_ema_ft_s)) {
    Serial.println(0);     // first sample has no speed yet; plot zero
  } else {
    Serial.println(speed_ema_ft_s, 2);
  }
#else
  Serial.print("Distance: ");
  Serial.print(dist_ft, 2);
  Serial.print(" ft");

  if (!isnan(speed_ema_ft_s)) {
    float mph = speed_ema_ft_s * 0.681818f;
    Serial.print(" | Speed: ");
    Serial.print(speed_ema_ft_s, 2);
    Serial.print(" ft/s (");
    Serial.print(mph, 2);
    Serial.print(" mph)");
  }
  Serial.println();
#endif

  prev_ft = dist_ft;
  prev_ms = now;
}

void setup() {
  Serial.begin(115200);
  myLidarLite.begin(0, true);
  myLidarLite.configure(0);
}

void loop() {
  unsigned long now = millis();
  if (now - lastRead >= interval) {
    lastRead = now;
    printReading(true);
  }
}
```

Conclusions/action items:

- Order a new Arduino that will go in the lidar housing

- Order proper batteries and adapters

- Finish coding load cells

Load Cell Code 11/19/25

Aidan BURICH - Dec 03, 2025, 6:34 PM CST

Title: Load Cell Code

Date: 11/19/25

Content by: Group

Present: Group

Goals: Complete working load cell code

Content: See Below

Conclusion/Action Items:

- Our goal now is to combine the code and figure out the wifi system with the Arduino to display data

The following is the complete Load Cell Code:

```
/*
  --------------------------------------------------------------------------------------
  HX711_ADC
  Arduino library for HX711 24-Bit Analog-to-Digital Converter for Weight Scales
  Olav Kallhovd sept2017
  --------------------------------------------------------------------------------------
*/

/*
  Settling time (number of samples) and data filtering can be adjusted in the config.h file
  For calibration and storing the calibration value in eeprom, see example file "Calibration.ino"

  The update() function checks for new data and starts the next conversion. In order to acheive maximum effective
  sample rate, update() should be called at least as often as the HX711 sample rate; >10Hz@10SPS, >80Hz@80SPS.
  If you have other time consuming code running (i.e. a graphical LCD), consider calling update() from an interrupt routine,
  see example file "Read_1x_load_cell_interrupt_driven.ino".

  This is an example sketch on how to use this library
*/

#include <HX711_ADC.h>
#include <EEPROM.h>

//pins:
const int HX711_dout = 4; //mcu > HX711 dout pin
const int HX711_sck = 5; //mcu > HX711 sck pin

//HX711 constructor:
HX711_ADC LoadCell(HX711_dout, HX711_sck);

const int calVal_eepromAdress = 0;
unsigned long t = 0;

void setup() {
  Serial.begin(57600); delay(10);
  Serial.println();
  Serial.println("Starting...");

  LoadCell.begin();
  //LoadCell.setReverseOutput(); //uncomment to turn a negative output value to positive
```

```
 float calibrationValue; // calibration value (see example file "Calibration.ino")
 calibrationValue = -0.46; // uncomment this if you want to set the calibration value in the sketch
#if defined(ESP8266)|| defined(ESP32)
 //EEPROM.begin(512); // uncomment this if you use ESP8266/ESP32 and want to fetch the calibration value from eeprom
#endif
 //EEPROM.get(calVal_eepromAdress, calibrationValue); // uncomment this if you want to fetch the calibration value from eeprom

 unsigned long stabilizingtime = 2000; // preciscion right after power-up can be improved by adding a few seconds of stabilizing time
 boolean _tare = true; //set this to false if you don't want tare to be performed in the next step
 LoadCell.start(stabilizingtime, _tare);
 if (LoadCell.getTareTimeoutFlag()) {
   Serial.println("Timeout, check MCU>HX711 wiring and pin designations");
   while (1);
 }
 else {
   LoadCell.setCalFactor(calibrationValue); // set calibration value (float)
   Serial.println("Startup is complete");
 }
}

void loop() {
 static boolean newDataReady = 0;
 const int serialPrintInterval = 0; //increase value to slow down serial print activity

 // check for new data/start next conversion:
 if (LoadCell.update()) newDataReady = true;

 // get smoothed value from the dataset:
 if (newDataReady) {
   if (millis() > t + serialPrintInterval) {
     float i = LoadCell.getData();
     Serial.print("Load_cell output val: ");
     Serial.println(i);
     newDataReady = 0;
     t = millis();
   }
 }

 // receive command from serial terminal, send 't' to initiate tare operation:
 if (Serial.available() > 0) {
   char inByte = Serial.read();
   if (inByte == 't') LoadCell.tareNoDelay();
 }

 // check if last tare operation is complete:
 if (LoadCell.getTareStatus() == true) {
   Serial.println("Tare complete");
 }


}
```

Combined Code With Bluetooth 11/25/25

Aidan BURICH - Dec 03, 2025, 6:40 PM CST

Title: Combined Code

Date: 11/25/25

Content by: Group

Present: Group

Goals: Combine all code to upload to Arduino and so it works with wifi

Content:

- To get it to work with wifi, you have to connect your device to the Arduino

- The 'network' is called "Smart Walker" and the password is "12345678"

- You must look up the website IP in the search bar

The following is the complete working code:

```
#include "HX711.h"
#include <Wire.h>
#include <LIDARLite.h>
#include <WiFiS3.h>

// Load Cell
#define calibration_factor -18670.0
#define DOUT 3
#define CLK 2
HX711 scale;

// LIDAR
LIDARLite myLidarLite;

// WiFi Access Point
const char* ssid = "Smart_Walker";
const char* password = "12345678";
WiFiServer server(80);

// Update timing
unsigned long lastRead = 0;
const unsigned long sensorInterval = 50;   // 20 Hz
const unsigned long webpageInterval = 1000; // 1s refresh

// Speed State
float prev_ft = NAN;
unsigned long prev_ms = 0;
float speed_ema_ft_s = NAN;
bool ema_initialized = false;

// Latest values
float distance_ft = 0;
float speed_ft_s = 0;
float weight_lbs = 0;

// Trial Control
bool trialRunning = false;
float trialWeightSum = 0;
```

```
unsigned long trialWeightCount = 0;

// NEW: Trial metrics
float trialStartDist = NAN;
float trialEndDist = NAN;

// NEW: Avg speed during trial
float trialSpeedSum = 0;
unsigned long trialSpeedCount = 0;

// Convert LIDAR cm → feet
inline float cmToFeet(int cm) { return cm * 0.0328084f; }

// Calculate LIDAR distance + smoothed speed
void updateLidar(float &dist_out, float &speed_out) {
  unsigned long now = millis();
  int d = myLidarLite.distance(true);
  if (d <= 0) return;

  float dist_ft = cmToFeet(d);
  float instant = 0;

  if (prev_ms) {
    float dt = (now - prev_ms) / 1000.0;
    if (dt > 0) {
      // NOTE: speed = previous − current (walking toward sensor positive)
      instant = (prev_ft - dist_ft) / dt;

      const float alpha = 0.25;
      if (!ema_initialized) {
        speed_ema_ft_s = instant;
        ema_initialized = true;
      }
      else {
        speed_ema_ft_s = alpha * instant + (1 - alpha) * speed_ema_ft_s;
      }
    }
  }
  prev_ft = dist_ft;
  prev_ms = now;

  dist_out = dist_ft;
  speed_out = speed_ema_ft_s;
}

// Return HTML for 1s auto refresh
void sendWeb(WiFiClient &client) {
  client.println("HTTP/1.1 200 OK");
  client.println("Content-Type: text/html");
  client.println("Connection: close");
  client.println();
  client.println("<!DOCTYPE html><html><head>");
  client.println("<meta charset='UTF-8'>");
  client.println("<meta name='viewport' content='width=device-width'>");
  client.println("<meta http-equiv='refresh' content='1'>");
  client.println("<style>");
  client.println("body{font-family:Arial;text-align:center;}");
  client.println("h1{margin-top:18px;}");
  client.println("div{font-size:1.5em;margin:10px;}");
  client.println(".btn{padding:10px 20px;margin:5px;font-size:1em;border:none;border-radius:6px;}");
```

```
  client.println(".start{background:#4CAF50;color:white;}");
  client.println(".stop{background:#d32f2f;color:white;}");
  client.println("</style>");
  client.println("</head><body>");
  client.println("<h1>Smart Walker Live Telemetry</h1>");
  client.print("<div>Status: ");
  client.print(trialRunning ? "RUNNING" : "STOPPED");
  client.println("</div>");
  client.print("<div>Weight (lbs): "); client.print(weight_lbs, 2); client.println("</div>");
  client.print("<div>Distance (ft): "); client.print(distance_ft, 2); client.println("</div>");
  client.print("<div>Speed (ft/s): "); client.print(speed_ft_s, 2); client.println("</div>");
  client.println("<a href='/start'><button class='btn start'>Start Trial</button></a>");
  client.println("<a href='/stop'><button class='btn stop'>Stop Trial</button></a>");
  client.println("<p>Page auto-refreshes every 1 second.</p>");
  client.println("</body></html>");
}

// SETUP
void setup() {
  Serial.begin(115200);

  // Sensors
  Wire.begin();
  delay(200);
  scale.begin(DOUT, CLK);
  scale.set_scale(calibration_factor);
  scale.tare();

  myLidarLite.begin(0, true);
  myLidarLite.configure(0);

  // WiFi
  WiFi.beginAP(ssid, password);
  delay(500);
  Serial.print("WiFi AP IP: ");
  Serial.println(WiFi.localIP());
  server.begin();
}

// LOOP
void loop() {
  unsigned long now = millis();

  // SENSOR LOOP (20 Hz)
  if (trialRunning && now - lastRead >= sensorInterval) {
    lastRead = now;

    // Weight
    weight_lbs = scale.get_units(10);

    // Distance + speed
    updateLidar(distance_ft, speed_ft_s);

    // Track average weight
    trialWeightSum += weight_lbs;
    trialWeightCount++;

    // NEW — track speed average
    if (!isnan(speed_ft_s)) {
      trialSpeedSum += speed_ft_s;
```

```
        trialSpeedCount++;
    }

    // NEW — track end distance always
    trialEndDist = distance_ft;

    Serial.print("weight:"); Serial.print(weight_lbs,2);
    Serial.print("\tdist:"); Serial.print(distance_ft,2);
    Serial.print("\tspeed:"); Serial.println(speed_ft_s,2);
}

// WEB REQUEST HANDLING
WiFiClient client = server.available();
if (client) {
    while (client.connected() && !client.available()) delay(1);
    String req = client.readStringUntil('\r');
    client.flush();

    // Handle start/stop trial
    if (req.indexOf("GET /start") >= 0) {
        trialRunning = true;

        // reset metrics
        trialWeightSum = 0;
        trialWeightCount = 0;

        trialSpeedSum = 0;
        trialSpeedCount = 0;

        trialStartDist = distance_ft;
        trialEndDist   = distance_ft;

        Serial.println("=== Trial START ===");
    }

    if (req.indexOf("GET /stop") >= 0) {
        trialRunning = false;
        Serial.println("=== Trial STOP ===");

        // ---- AVERAGE WEIGHT
        if (trialWeightCount > 0) {
            float avgWeight = trialWeightSum / trialWeightCount;
            Serial.print("Trial Average Weight (lbs): ");
            Serial.println(avgWeight, 2);
        }

        // ---- NEW: AVERAGE SPEED
        if (trialSpeedCount > 0) {
            float avgSpeed = trialSpeedSum / trialSpeedCount;
            Serial.print("Trial Average Speed (ft/s): ");
            Serial.println(avgSpeed, 2);
        }

        // ---- NEW: ABSOLUTE ΔDISTANCE
        if (!isnan(trialStartDist) && !isnan(trialEndDist)) {
            float deltaAbs = fabs(trialEndDist - trialStartDist);
            Serial.print("Absolute ΔDistance (ft): ");
            Serial.println(deltaAbs, 2);
        }
    }
```

```
      sendWeb(client);
      client.stop();
    }
}
```

Conclusions/action items:

- Tweak the webpage so it looks cleaner

- Solder all wires into the perf board

- Construct the final prototype onto the walker

Materials and Expenses 12/9/25

Aidan BURICH - Dec 09, 2025, 8:45 PM CST

Title: Materials and Expenses

Date: 12/9/25

Content by: Group

Present: Group

Goals: Complete Expenses for group compensation

Content:

Item	Description	Manufacturer	Part Number	QTY	Cost Each	Total	Link
Walker	2-wheel walker, **gifted** by client	Performance Health Supply, Inc.	081561703	1	$136.73	$0	Link
Load Cell initial 3D print	3D print of End-Cap 2.0 design **gifted** by friend with printer.	bambu lab a1 mini	N/A	1	$1.60	$0	N/A
Load Cells + HX711	4 50 kg load cells with HX711	Nextion	702795764555	1	$16.85	$16.85	Link
LiDar	Sensor Optical 3-200CM 12C	DigiKey	DigiKey part number : 1568-14032-ND	1	145.93	145.93	Link
Load Cell initial 3D print	3D print of End-Cap 2.0 design for show and tell	Bambu lab	NA	1	$1.04	$1.04	Link
Arduino Uno Rev 4	Arduino with wifi abilities for our code and electronics.	Arduino	Sku: ABX00087	1	29.21	29.21	Link
Additional HX711 Purchase	Extra HX711 Load Cell Amplifier because we were struggling to get the amazon one to function correctly	SparkFun	SKU: SEN-13879		11.50	11.50	Link
Electrical Component Prints	PLA print of electrical component box	Bambu lab	NA	1	4.56	4.56	Link
Battery Housing	9v Battery Holder with ON/Off Switch for Arduino	Gikfun	EK2107	1	19.28	19.28	Link
Velcro Straps	1.5ft of velcro to securely attach the wires along the walker leg	Wendt Commons	NA	1	5.19	5.19	NA
BME Design Account	This is a combination of shrink wrap for our prints, batteries, and a series of trial and final prints for the load	Wendt Commons	BME Design	NA	43.58	43.58	NA

	cell and electrical box housing.						
TOTAL:							**$277.06**

Conclusions/action items:

- Insert into report

- Finish Report

Fabrication Overview 12/8/25

Aidan BURICH - Dec 09, 2025, 8:41 PM CST

Title: Fabrication Overview

Date: 12/8/25

Content by: Group

Present: Group

Goals: Write Fabrication Overview

Content:

Overview

The Smart Walker consists of two main categories of components and fabrication types. The first being the circuitry components and circuitry design. The circuitry components include two sensor systems, one for the load cells to detect weight bearing and one for the LiDAR system for distance and speed. The second aspect is the 3D printed components to house those sensor systems, one being the End Caps, which hold the load cells, and the other the electrical housing box, which has the LiDAR, Arduino microcontroller, and perfboard.

Materials

For the weight tracking part of the design, two load cells will be used. The load cells work by tracking the displacement of the center region with the outside lip of the load cell, which changes the electrical resistance measured by the Wheatstone bridge circuit, producing a voltage proportional to the force. Figure 7 shows where the load cells get compressed and displaced. These load cells were chosen because they are very accurate for the price and can withstand up to 75kgs (165lbs) each for a total of 150kgs (330lbs) for two load cells, which meet the required weight of 140kgs. The load cells will be placed in the endcap design, which will be printed in Thermoplastic Polyurethane (TPU) with 50% infill. This material is flexible enough to fit the walker leg insert and the leg itself, but also durable enough to withstand the weight of the patient and walker. This material closely resembles the material of the end caps that a base walker comes with. So the load cell can be compressed properly, a walker leg insert will be made out of Polyvinyl Alcohol (PLA) with 50% infill. This is a hard, rigid material that is needed so the load cell is properly depressed by this piece. It is also a very durable material that can withstand constant pressure. To ensure the load cells send a strong enough signal, a load cell amplifier HX711 will be used. The amplifier takes in the weak or small voltage output from the load cells and amplifies the signal to a higher voltage. It also gets rid of electrostatic noise for a cleaner signal output. Because this design includes two load cells instead of four, a half-bridge configuration, seen in Figure 8, will connect them to the amplifier.

Figure 7 *Geekstory 50 kg Capacity Load Cells*

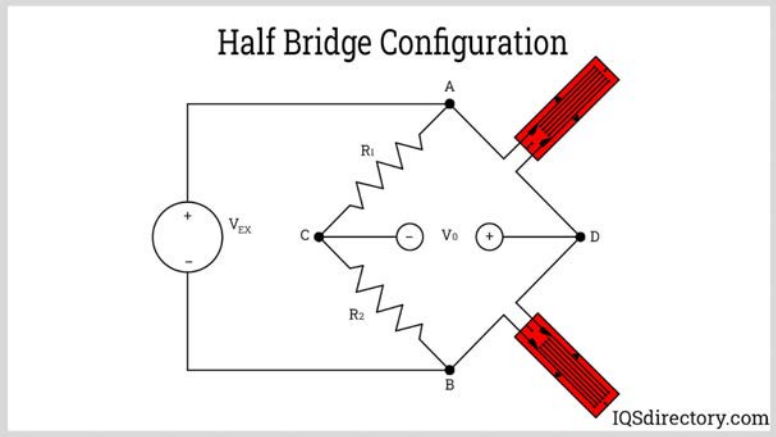


Figure 8: Half wheatstone bridge configuration showing strain gauges in red [11].

For the speed and distance portion of the design, the Garmin LIDAR-Lite Optical Distance Sensor - V3m, seen in Figure 9, will be used. The LiDAR emits a 905nm single-stripe laser that bounces off the wall/obstacle in front of it and back to the LiDAR. The time it takes for the laser to come back to the LiDAR is how it tracks distance, which can be used to compute speed. The LiDAR will be placed in the electrical component box. The component box will also be made out of PLA (Need infill here). This rigid nature of PLA will help protect the LiDAR and all the electrical components inside the component box. The box will also hold the perforated(perf) board and ARDUINO UNO WiFi REV2 microprocessor. See Appendix __ for detailed blueprints of all 3D prints. All 3D printed materials were designed in OnShape.

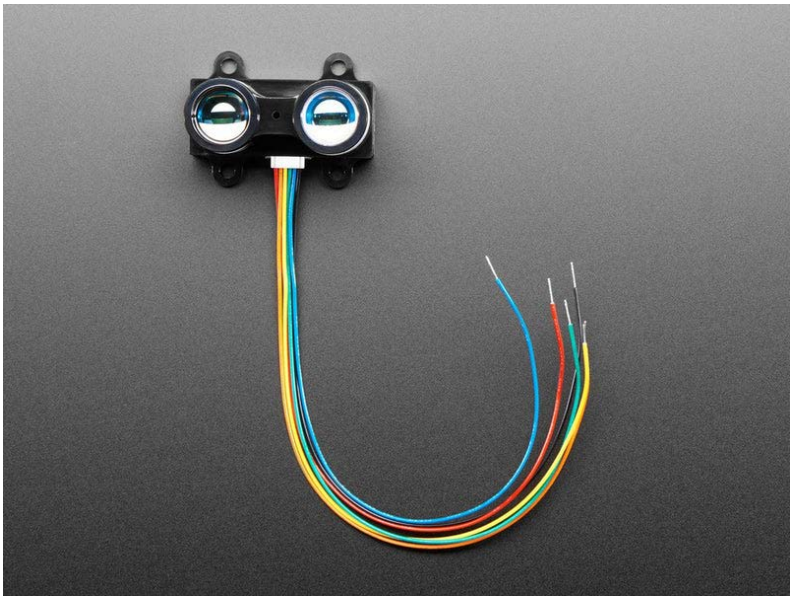


Figure 9 *LiDAR sensor*

A Duracell Procell 9V Alkaline Battery will serve as the power source for the device and be held in a Gikfun 9V Battery Holder with ON/Off Switch for Arduino. The battery housing has a barrel jack that plugs directly into the barrel jack on the Arduino. Figure 10 below shows a schematic of the circuit and components of the design.

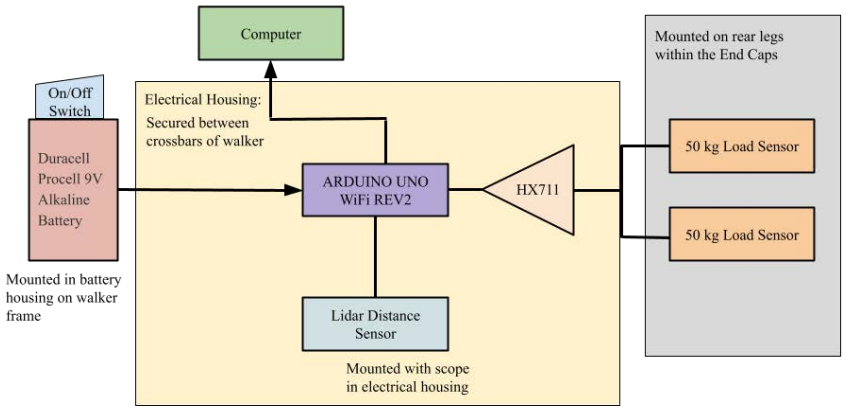


Figure 10 *Circuit block diagram of design and components.*

Methods

For the weight tracking circuit, the load cells will be connected directly to the HX711 load cell amplifier. The load cells have three wires coming from them: black, red, and white. The black wire is the negative wire, the white is the positive wire, and the red is the signalling wire. The HX711 amplifier board has two sides: one side that connects wires to the load cells and the other side that connects wires to the Arduino. The side that connects to the load cells has connection points E+, E-, A+, A-, B+, and B-. The side that connects to the Arduino has connection points GND, DT, SCK, and VCC. One load cell is connected to the HX711 amplifier by connecting the positive wire to the E+ connection, the negative wire to the E- connection, and the signalling wire to the A+ connection. The other load cell has the positive wire connected to the E- connection, the negative wire connected to the E+ connection, and the signalling wire connected to the A- connection. For the connection from the HX711 amplifier to the Arduino, the VCC connection is connected to the 5V port on the Arduino, the GND connection is connected to the GND port, the DT connection is connected to the 3 Digital port, and the SCK connection is connected to the 2 Digital port. See Figure 11 for a visual representation of the circuit. The load cells were calibrated using the code "SparkFun_HX711_Calibration.ino" from Sparkfun's HX711 Breakout Hookup Guide [12] found in Appendix G. Seeing as the load cell provides output based on the deformation of the center square of the load cell from the outer rim, while calibrating, they were attached to wooden boards with 3D printed mounting pieces from Thingiverse [13] that provide a spacer between the outer rim and the board. This way, the center piece was free to deform [14].

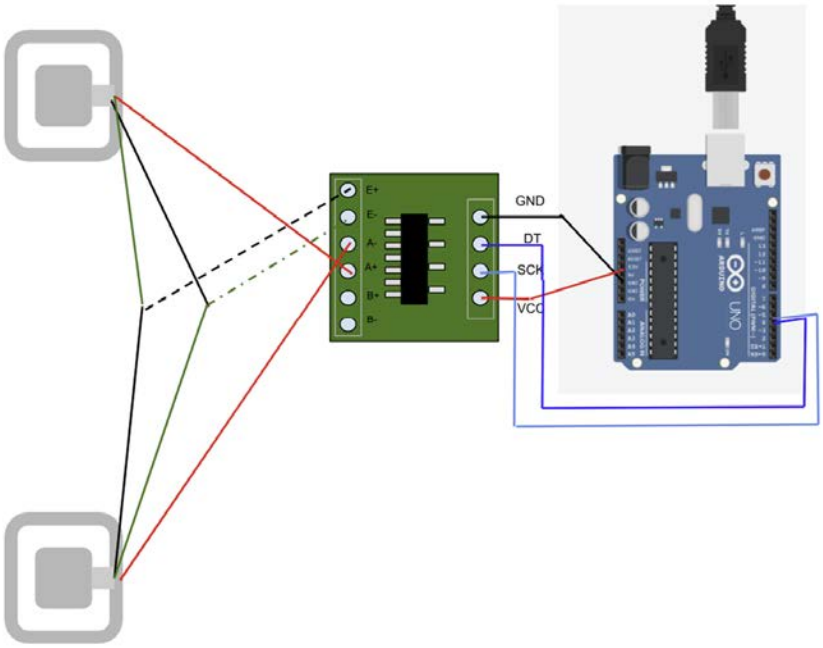


Figure 11 *Load cell circuit to Arduino [15]. The green wire is the white wire.*

For the speed and distance tracking circuit, the LiDAR wires are connected directly to the Arduino. The LiDAR has a power wire (red), a power enable wire (orange), a mode control wire (yellow), a clock power wire (green), a data power wire (blue), and a ground wire (black). The orange and yellow wires are not connected to any part of the circuit. A 1000 µF capacitor and two 4.7 kΩ resistors are needed in the circuit. The hookup guide for the LiDAR circuit was found on Sparkfun's LIDAR-Lite v3 Hookup Guide [16]. See Figure 12 for the full speed and distance tracking circuit.

Figure 12 *LiDAR circuit to Arduino [16]*

The combined circuit is soldered together on a perf board and then connected to the Arduino. The two circuits are completely separate on the perf board except for each circuit's power wire that connects to the 5V port on the Arduino board. Each circuit's power wire connects to a single wire that is connected to the 5V Arduino port. The complete circuits on the perf board connected to the Arduino can be seen in Figure 13.

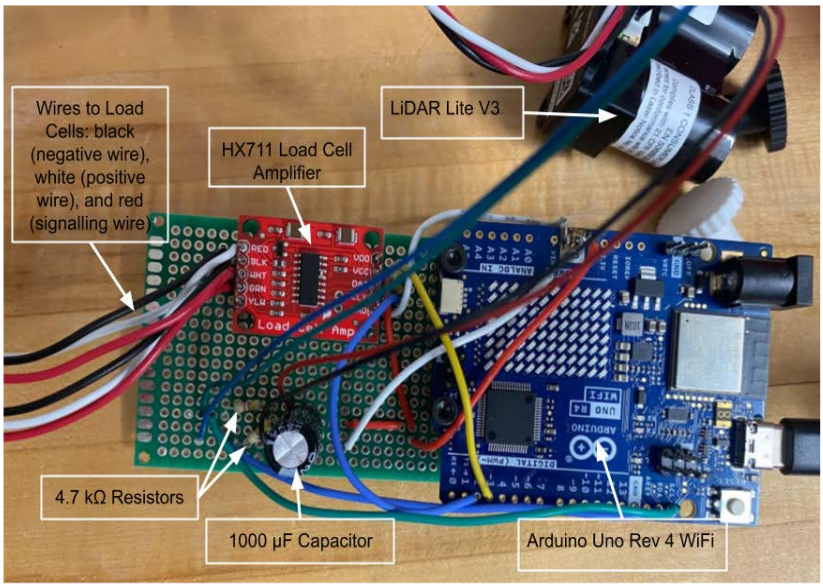


Figure 13 *Complete combined circuit on perfboard*

Software

The team first considered using MIT's App Inventor, but upon further research discovered that Arduino Uno R4 WiFi transmits Bluetooth Low Energy as opposed to classic Bluetooth (HC-05/06); therefore, the two are not compatible without additional hardware. The team then pivoted to a simple WiFi-based web browser. Code for the web page can be found in Appendix C. The webpage includes outputs of pressure/weight placed on the walker in pounds, the distance from the nearest surface in feet, and the speed at which the walker is moving in feet per second. Due to the large volume of data coming from the serial output of the Arduino, the webpage automatically refreshes every second.

The code for the load cells was also found on Sparkfun's HX711 Breakout Hookup Guide [12]. See Appendix H for the full code. This code was used to test the load cells and confirm that they functioned properly. The code for the LiDAR was found on the Garmin LIDARLite_Arduino_Library GitHub [17]. See Appendix I for the entire code. This code was also used for testing and to confirm the LiDAR worked correctly. Both of these codes were later adapted and combined along with the code for the webpage to make the final code that was uploaded to the Arduino. This code can be found in Appendix C.

Conclusions/action items:

- Write fabrication and assembly protocol

- Finish Report

Fabrication and Assembly Protocol 12/10/25

Aidan BURICH - Dec 09, 2025, 8:43 PM CST

Title: Fabrication and Assembly Protocol

Date: 12/10/25

Content by: Group

Present: Group

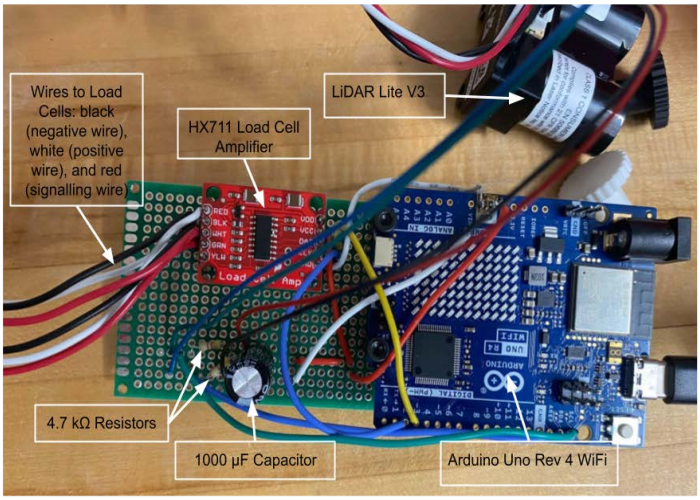
Goals: Write Fabrication and Assembly Protocol

Content:

Appendix G: Fabrication and Assembly Protocol

Soldering of Electrical Components

1. Take a perfboard and line up in parallel with an Arduino uno using the predrilled holes in the Arduino as a guide for the connection point.
2. Drill two 0.125 inch in diameter holes into the perfboard and connect with appropriate bolts and nuts.
3. Based on a breadboard or diagram of a breadboard place larger components first such as the HX711 load cell amplifier and the capacitor for the LiDAR leaving enough room open holes to make connections to wires.
4. Once layout is confirmed, solder pins to the perfboard.
5. From there solder connection wires directly to the Arduino
6. For reference to specific connections see figure below.



Endcaps and Loadcells

1. The wiring to the load cells is first wrapped in electrical tape
2. The load cells must then be clicked into place at the bottom of the endcaps
3. The direction can be ascertained by the wires as there are small grooves to indicate the direction of the wires out of the end caps.
4. Next, with a good amount of force, the cork pieces which push down on the load cells should be inserted into the end caps.
5. Once they are in the end caps they can be twisted until they click into place if they are not already properly aligned with the anatomy of the load cell.

6. After removing the current end caps on the walker, now both the 3D printed end cap-load cell systems are ready to be slid onto the ends of the back two legs.
7. Then the hook side of adhesive velcro was placed at several intervals on the walker frame to prevent the wires from drooping in the way of the walker user's path.
8. The loop side is attached to the wires in corresponding locations along their path to the electrical housing.

Attachment and Positioning of Electrical Housing

a. A clamp of 1” diameter and 2”length was placed around the top crossbar with a ¼” diameter bolt through a hole in the top of the housing unit with a nut on top was used to secure it to the walker frame

b. For the bottom cross bar the bottom half of the electrical housing was secured using two 1” long, ¼” diameter bolts and nuts.

Conclusions/action items:

- Finish Report

- Do Feedback Fruits

Load Cell Testing Procedure

Nial Donohoo - Dec 03, 2025, 6:52 PM CST

Title: Load Cell Testing Procedure

Date: 11/24/25

Content by: Group

Present: Group

Goals: Test the Load Cells to Ensure Accuracy Throughout Operating Range

Content:

To verify the accuracy of our calibrated load-cell system, we will compare its measurements with standard weights of a known accuracy. The load cells will be tested together placed flat on the ground on a hard level surface to minimize variation due to uneven loading. Accuracy will be assessed using linear weight increments of 5kgs (11.2 pounds), resulting in the following test loads: 22.05 lb, 33.07 lb, 44.09 lb, 55.12 lb, 66.14 lb, 77.16 lb, 88.18 lb, 99.21 lb, 110.23 lb, 121.25 lb, 132.28 lb, 143.3 lb, 154.32 lb, 165.35 lb, 176.37 lb, 187.39 lb, 198.42 lb, 209.44 lb, and 220.46 lb. For each load level, the appropriate combination of weight plates will be placed carefully and centrally on the two sensors so that the applied force is evenly distributed across both. After allowing several seconds for the load-cell reading to stabilize, we will record the load cells measurement. The paired load cell and reference readings from each trial will be used to calculate absolute error, percent error, and variability across the full operating range, allowing us to determine how well the load-cell system performs under controlled loading conditions.

Once all measurements have been collected, we will analyze the accuracy of the load-cell system by directly comparing the walker's recorded values to the corresponding known values. For every load level, we will calculate the absolute error (walker reading minus reference reading) and the percent error relative to the true load. To visualize performance across the full range, we will generate a plot comparing the walker's measured load to the reference values. If the mean percent error remains low and consistent across the 0–220.46 lb range, we will conclude that the load-cell system maintains reliable accuracy throughout its operating range.

Conclusions/action items: Record and analyze load cell data!

Lidar Sensor Testing Procedure

Nial Donohoo - Dec 10, 2025, 10:19 PM CST

Title: Lidar Sensor Testing Procedure

Date: 12/1/2025

Content by: Group

Present: Group

Goals: Create a Procedure to ensure the accuracy of the Lidar Sensor

Content:

LiDAR Testing:
To evaluate the accuracy and reliability of the LiDAR distance and speed measurements, we performed a series of walking trials in a long hallway inside the UW–Madison Engineering Centers Building. This environment was not fully controlled, as students occasionally walked past or crossed the testing path, which reflects realistic clinical conditions in which the device may also be used. The LiDAR sensor remained mounted in its permanent configuration inside the electronic housing box, ensuring that all testing reflected its true operational setup rather than an idealized bench-test configuration.

Before testing, a long tape measure was used to mark reference distances on the hallway floor. Starting at 15 ft (4.57 m) from a flat wall, we placed tape marks at increments of 15 ft up to a maximum distance of 120 ft (36.6 m). These tape marks served as fixed starting positions for each trial. One team member pushed the walker while another monitored the Arduino data stream and managed timing. The walker was kept level, and the LiDAR remained pointed directly at the wall throughout each trial.
For each trial, the walker's front legs were placed exactly on the tape mark corresponding to the starting distance. The operator then pushed the walker normally toward the wall, without attempting to control or standardize walking speed. This approach allowed us to test the LiDAR under realistic variations in gait and movement. While the walker moved, the LiDAR continuously recorded the distance to the wall and calculated speed using the Arduino's internal clock.

At the end of each trial, we compared the final distance measured by the LiDAR to the known starting distance measured manually. This allowed us to compute absolute error and percent error for each of the eight trials. To evaluate speed accuracy, we compared the LiDAR-calculated speed with the manually calculated speed obtained by dividing the known travel distance by the stopwatch time. We then averaged the percent errors across all trials to determine the overall accuracy of the LiDAR system under typical operating conditions. These comparisons allowed us to assess whether the LiDAR performance met the PDS requirements for both distance- and speed-tracking accuracy.
Across all eight trials, the LiDAR distance measurements showed an average percent error of 1.24%, with the majority of trials remaining below 1% error. The two largest errors (2.64% at 105 ft and 2.97% at 120 ft) occurred at the longest distances, suggesting that accuracy decreases slightly as the LiDAR approaches the upper end of its effective range. Overall our average percentage error over 120ft is well within our guidelines for accuracy.

Conclusions/action items: Record and Analyze Data!

Load Cell Test Results

Carolyn Randolph - Dec 10, 2025, 1:34 PM CST

Title: Load Cell Testing Results

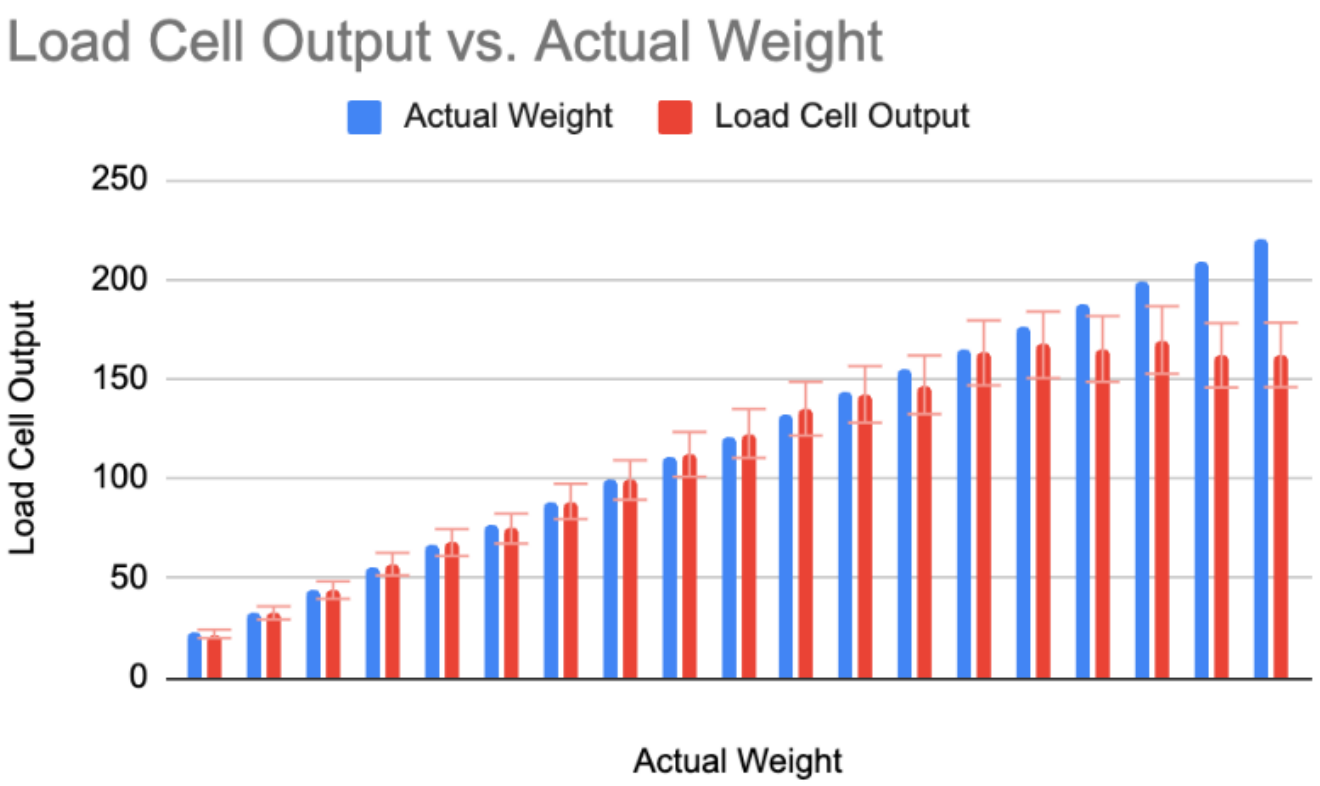
Date: December 23, 2025

Content by: All

Present: All

Goals: Demonstrate the results of load cell testing

Content: see attachments for values



Conclusions/action items: Integrate into report and consider implications for future work.

Carolyn Randolph - Dec 10, 2025, 1:32 PM CST

Actual Weight	Load Cell Output	callibration factor	
22.05	22	-18670	0.2267573696
33.07	32.5	-18670	1.723616571
44.09	43.9	-18670	0.4309367203
55.12	57	-18670	3.410740203
66.14	67.8	-18670	2.509827638
77.16	74.8	-18670	3.058579575
88.18	88.5	-18670	0.3628940803
99.21	99.2	-18670	0.01007962907
110.23	112.1	-18670	1.696452871
121.25	122.6	-18670	1.113402062
132.28	135	-18670	2.05624433

143.3	142.2	-18670	0.7676203768
154.32	147	-18670	4.743390358
165.35	163	-18670	1.421227699
176.37	167	-18670	5.312694903
187.39	165	-18670	11.94834303
198.42	169.5	-18670	14.57514363
209.44	161.8	-18670	22.74637128
220.46	162	-18670	26.51728205

Download

Screenshot_2025-12-10_at_1.32.07_PM.png (139 kB)

Lidar Sensor Test Results

Carolyn Randolph - Dec 10, 2025, 1:31 PM CST

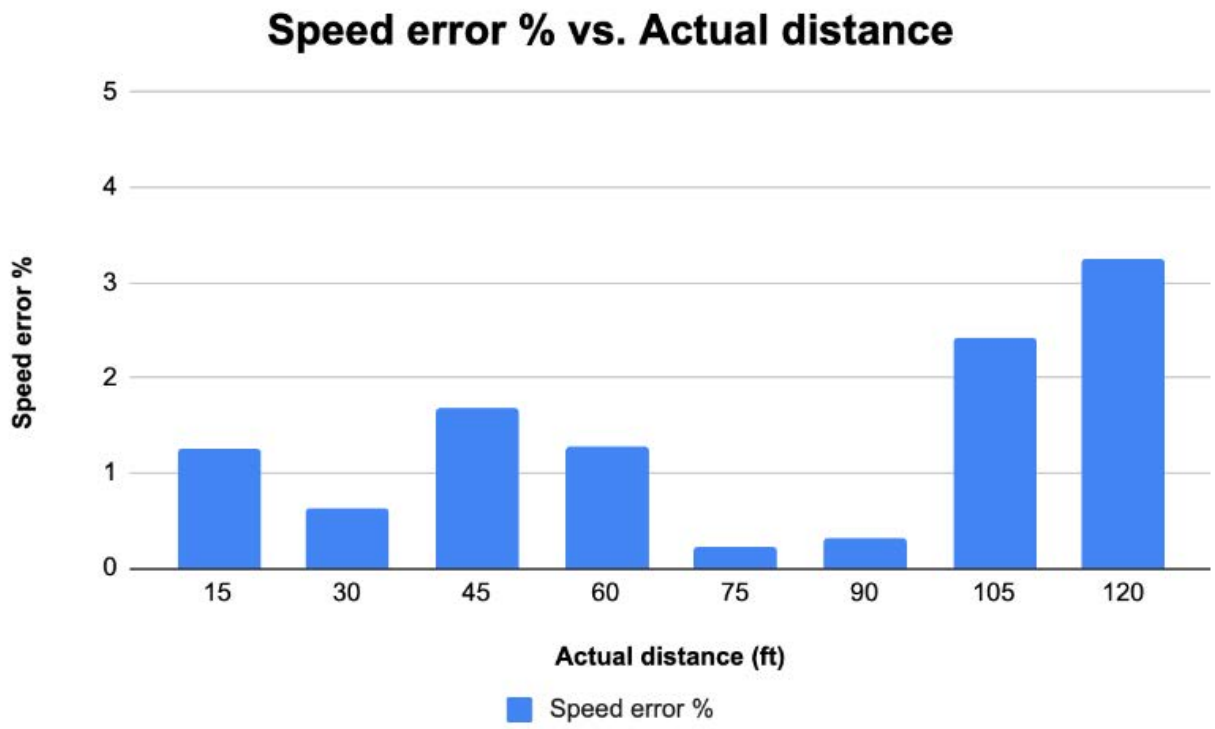
Title: LiDAR Testing Results

Date:

Content by: All

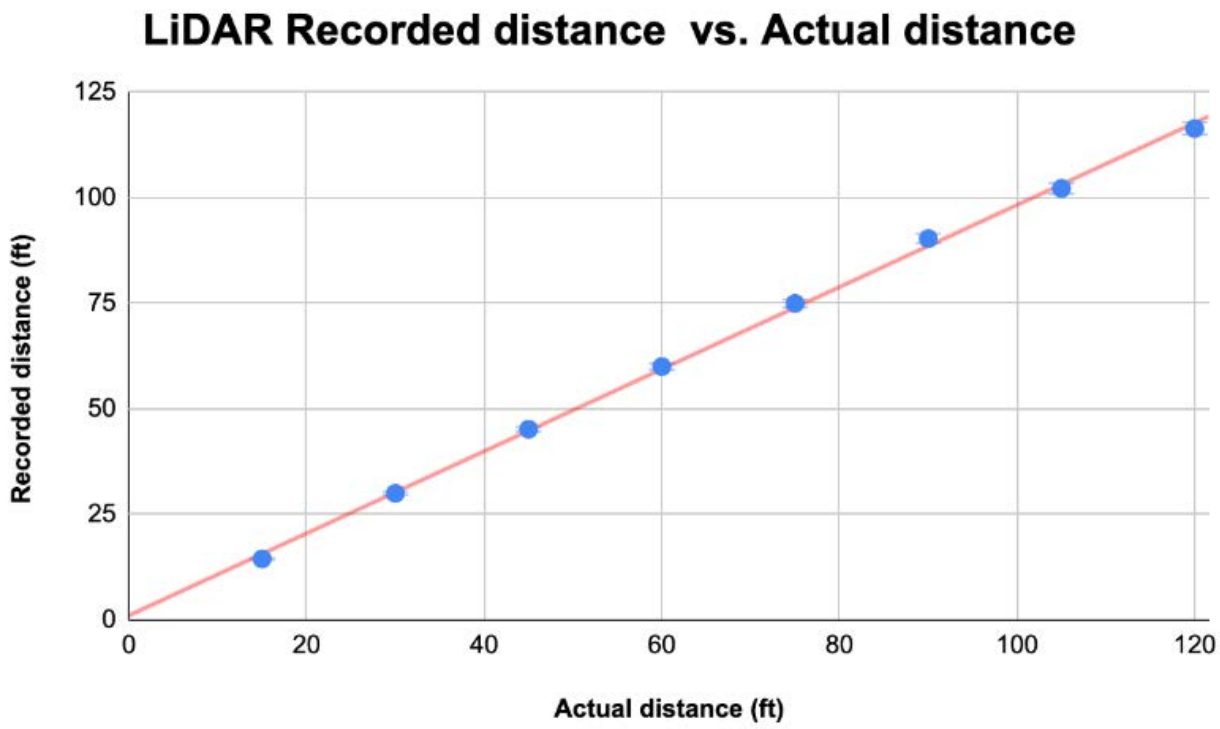
Present: All

Goals: Demonstrate the results of testing.


Speed error % vs. Actual distance
Speed error %
5
4
3
2
1
0
15
30
45
60
75
90
105
120
Actual distance (ft)
Speed error %

Content:


Recorded Distance vs. Actual Distance
Actual distance
Recorded distance
150
100
50
0
Distance in (ft)



A	B	C	D	E	F	G
Actual distance	Recorded distance	Distance error %	Time	Actual Speed	Recorded Speed	Speed error %
15	14.5	3.333333333	7.8	1.923076923	1.899	1.252
30	30.02	0.06666666667	12.51	2.398081535	2.383	0.6289
45	45.21	0.4666666667	17.88	2.516778523	2.559	1.6776
60	60.039	0.065	23.13	2.594033722	2.561	1.27345
75	75	0	32.76	2.289377289	2.284	0.23488
90	90.354	0.3933333333	37.63	2.391708743	2.399	0.3048555556
105	102.231	2.637142857	44.37	2.366463827	2.309	2.428257143
120	116.437	2.969166667	47.74	2.513615417	2.432	3.246933333
		1.24141369				1.380859504

Conclusions/action items: Integrate into final report

PDS 9/18/25

Aidan BURICH - Dec 09, 2025, 8:31 PM CST

Title: PDS

Date: 9/18/25

Content by: Group

Present: Group

Goals: COmplete PDS

Content:

See attachment

Conclusions/action items:

- Start ordering materials

- Start printing of the first endcap design

Aidan BURICH - Dec 09, 2025, 8:32 PM CST

BME Design: Product Design Specification

Date: September 18, 2025

Project title: Smart Walker

Group members
Team Lead: Nicolas Maldonado
Communicator: Aidan Burich
BSAC: Carolyn Randolph
BWIG: Nial Donohoo
BPAG: Henry Salita

Client: Dan Kutschera
Advisor: Duc-Huy Nguyen

Function/Problem Statement:

Patients with TBI often undergo traumatic events followed by intense rehabilitation to help them walk and return to everyday life as soon as possible. During rehabilitation, doctors struggle to measure progress as patients are gaining strength, making it hard for physicians to give patients tangible data of their improvement. The insurance companies also often do not feel that there is enough evidence of improvement, making it harder for the clinic to be paid for the services they provide. The smart walker will measure the pressure applied, speed, and distance walked of patients with neuro-rehabilitation needs. This data will be reported and displayed in real-time to help clinicians monitor progress and motivate patients. Ultimately, the device will reduce the time required to meet Medicare's documentation needs and increase objective markers of patient readiness for discharge.

Client requirements:

The device must provide real-time data on user pressure, speed, and distance. It must be compatible with the walkers currently being used without compromising the structural integrity of the walker. Data provided by the smart walker should be presented in a metrics report that is comprehensible to insurance companies. Furthermore, the client requested a compact design that is easy to use, accurate, and reliable. The budget for this project is ~$500.

Design requirements

1. Physical and Operational Characteristics
    a. *Performance requirements*

Download

PDS_Smart_Walker_2_.pdf (213 kB)

Preliminary Report 10/8/25

Aidan BURICH - Dec 03, 2025, 6:25 PM CST

Title: Preliminary Report

Date: 10/8/25

Content by: Group

Present: Group

Goals: Complete Preliminary Report

Content:

See attachment

Conclusions/action items:

- Start working on the endcap design and lidar design as they were the designs that won the design matrix, and we decided to proceed with

Aidan BURICH - Dec 03, 2025, 6:25 PM CST

Smart Walker: Biometric Neurorehabilitation and Mobility Assessment System

Preliminary Report, October 8, 2025

BME 200/300

Client: Dan Kutschera, PT
Advisor: Dr. Duc-Huy Nguyen

Group members
Nicolas Maldonado (Team Lead)
Aidan Burich (Communicator)
Carolyn Randolph (BSAC)
Niall Donohoo (BWIG)
Henry Salvo (BPAG)

Download

Smart_Walker_Preliminary_Design_Report_2_.pdf (5.39 MB)

Poster 10/5/25

Aidan BURICH - Dec 09, 2025, 8:29 PM CST

Title: Poster

Date: 10/5/25

Content by: Group

Present: Group

Goals: Complete poster

Content:

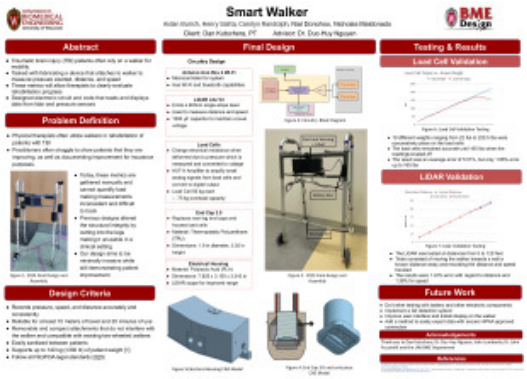
See Attachment

Conclusions/action items:

- Finish Report

- Complete Feedback Fruits

Aidan BURICH - Dec 09, 2025, 8:29 PM CST



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Smart_Walker_Poster.pptx_1_.pdf (833 kB)

Final Report 12/10/25

Aidan BURICH - Dec 09, 2025, 8:35 PM CST

Title: Final Report

Date: 12/10/25

Content by: Group

Present: Group

Goals: Finish Final Report

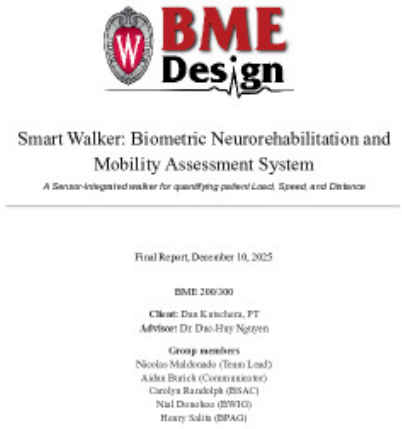
Content:

See Attachment

Conclusions/action items:

- Done!

Aidan BURICH - Dec 10, 2025, 10:30 PM CST



BME Design

Smart Walker: Biometric Neurorehabilitation and Mobility Assessment System

A Sensor-Integrated walker for quantifying patient Load, Speed, and Distance

Final Report, December 10, 2025

BME 200/300

Client: Dan Kanchera, PT
Advisor: Dr. Duc-Huy Nguyen

Group members
Nicolas Maldonado (Team Lead)
Aidan Burich (Communicator)
Carolyn Randolph (BSAC)
Niel Donahoo (BWIG)
Henry Saltu (BPAG)

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Final_Smart_Walker_Design_Report.pdf (7.84 MB)

2025/10/31 Show and Tell

Carolyn Randolph - Oct 31, 2025, 1:44 PM CDT

Title: Show and Tell

Date: October 31, 2025

Content by: Carolyn Randolph

Present: All

Goals: Take feedback on prototype and design challenges

Content:

-Contact biomechanics lab

-Data filtration to reduce the noise

-Rubber cuff to secure walker leg

-Silicone roll

Conclusions/action items: Apply design changes.

How to use a walker properly 9/10/25

Aidan BURICH - Sep 10, 2025, 4:41 PM CDT

Title: How to use a Walker Properly

Date: 9/10/25

Content by: Aidan

Present: Aidan

Goals: Learn how a walker should be used to we can properly design the add-ons for the smart walker.

Content:

- The article briefly explained the differences between walker

- It talked about different numbers of wheels, grips, and lengths. All ways to adjust a walker to fit personal needs

- It also talked about how to properly use a walker

- The article emphasized that there should be little to no bending of the back

- When using the walker, you should first move it forward, then step into it.

- The height of the walker is also very important and should cause your arms to bend at about a 15-degree angle

- Tips for choosing and using walkers - Mayo Clinic

Conclusions/action items:

- Knowing how to properly use a walker is very important for our design. If we design something that promotes bad walker use, the product will be ineffective.

- How to properly use the walker should also be kept in mind when looking at data. For example, the walker should be somewhat stationary while walking, which should be accounted for when processing data

- The next steps are to talk to our client and start diving into the project

- The first part of the designing process should be finding where on the walker the accessories should be placed

How do Scale Technology Work? 9/17/25

Aidan BURICH - Sep 17, 2025, 5:56 PM CDT

Title: Research on Scale Technology

Date: 9/17/25

Content by: Aidan

Present: Aidan

Goals: Understand more fully how scale technology works and see if it could be used in this project

Content:

- After doing research, I found out that a load cell is the main working component in scales

- Load cells are very small, which is what we need for our device

- Load cells are expensive, however.

- The load cell can then send the weight it receives to a digital display

- https://www.marsden-weighing.co.uk/blog/how-weighing-scales-work?srsltid=AfmBOoqm_kGQkxw6KsWBEGeG8cVJ2hYR9F9-_nDNbaApc8rYqybZMezU

Conclusions/action items:

- Next step is to present this to the group

- Also, more indepth brainstorming is needed to ensure this will work

- We also need to pick up the walker from Dan

Research on types of walkers 9/10/25

Aidan BURICH - Sep 10, 2025, 3:59 PM CDT

Title: Research on types of walkers

Date: 9/10/25

Content by: Aidan

Present: Aidan

Goals: To figure out the best type of walker to use for the project, or if creating our own design would be best

Content:

- This study/article took multiple types of walkers and tested metrics like average speed, ease of setup, and ability to walk without assistance

- The walkers used were a classic folding walker, a four-wheeled walker, a power-assisted walker, and another folding walker with a slightly different shape and grips.

- After their tests, they concluded that the classic folding walker was best for fast movement, as the average speed using that walker was the highest.

- The power-assisted walker was deemed best for patients who struggled the most with walking.

- T. Tamura, M. Sekine, H. Kuno, M. Fujie, A. Mori and K. Andoh, "Evaluation of walkers for elderly people," *2001 Conference Proceedings of the 23rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, Istanbul, Turkey, 2001, pp. 1391-1392 vol.2, doi: 10.1109/IEMBS.2001.1020460.

Conclusions/action items:

- After reading this article, it seems the traditional walker might be the best option; however, a walker with a basket might be necessary because of the add-on needed and the potential extra space we might need.

- Next steps will be asking the client what his expectations are so we can narrow down the type of walker that will suit us best.

Grip Strength Reader 9/10/25

Aidan BURICH - Sep 10, 2025, 4:56 PM CDT

Title: Grip Strength Reader

Date: 9/10/25

Content by: Aidan

Present: Aidan

Goals: Understand how a grip strength reader works to determine if it could be useful for our project

Content:

- In the article, it talks about how a grip strength reader works
    - It can be squeezed by a hand and then give a force reading
    - I think that this can be put on the grips of a walker, and the force could be measured when the patient pushes down on the walker.
- The device is relatively small but does have to be calibrated regularly for accurate results
- There are multiple kinds that give digital readings or analog readings
- Hand Dynamometer: How it works and Why it’s important - prohealthcareproducts.com

Conclusions/action items:

- I think that these devices could be retrofitted and work really well for this project
- The most difficult part will be finding something that falls in the price range and fits well with the walker
- The next steps will be starting to brainstorm design ideas with the rest of the group

9/20/24 Preliminary Design, On Shape -

Aidan BURICH - Oct 01, 2025, 3:03 PM CDT

Title: Primary Design Idea

Date: 9/20/24

Content by: Aidan

Present: Aidan

Goals: Create a preliminary Design for the design matrix and presentation

Content:

Onshape design link:

Smart walker on handles | Part Studio 1

- This design would be placed on the handles of the walker

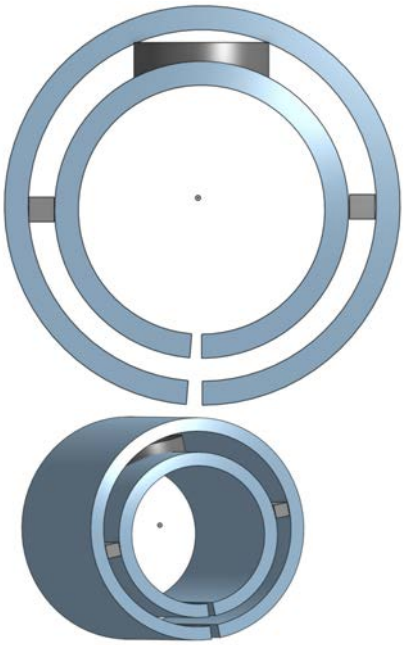
- The sensor would go between the 2 cylinders and would track the weight put on the sensor

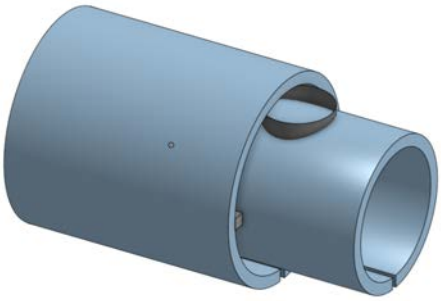
- The outside would be made of a soft, bendable plastic or even a foam

- The inside supports to attach the 2 cylinders will have to be a slightly stronger plastic

- There would need to be a harder plastic over the load cell to ensure the user does not feel the presence of the load cell, to ensure comfort

- The design could also be entirely 3D printed with a bendable plastic





Conclusions/action items:

I believe this design can be very useful for this project. One of the issues with putting the load cell on the legs is we can only get 2 legs to have the load cell because of the wheels which would not give us the full weight put on the walker. This design solves that issue and will read the entirety of the weight placed on the walker.

Next steps:

- Present this idea to the group

- Maybe get some help with refining the design, I am not the best with Onshape.

- I also need to sign up for shop classes

- On Thursday, we have to pick up our example walker from our client.

9/21/25 Rotary Encoder For Speed Tracking -

Aidan BURICH - Oct 01, 2025, 6:37 PM CDT

Title: Rotary Encoder On Walker Wheel

Date: 9/21/25

Content by: Aidan

Present: Aidan

Goals: How to implement a rotary encoder to track speed

Content:

- Along with tracking the weight put on the walker, we need to track speed

- I think that this can be done by a rotary encoder

- Rotary encoders at a basic level track rotation of an axel

Absolute Encoders

- Provide the current position at any time, even after power loss. No need to “home” or reference.
- Can be single-turn or multi-turn. Multi-turn encode both the angle in the current revolution plus counted revolutions. There are battery-powered, geared, or energy-harvesting types.
- Multiple sensing technologies: optical, magnetic, mechanical (brush contacts), capacitive.

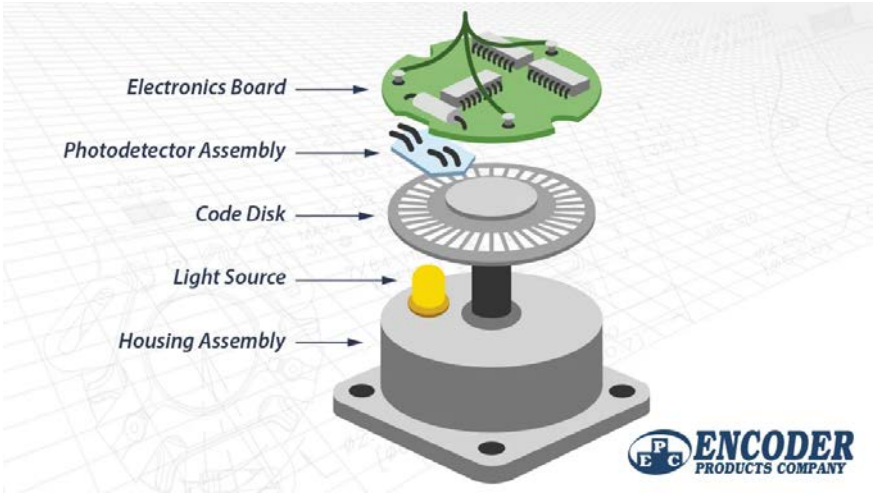
Incremental Encoders

- Report changes in position — motion, direction, speed — rather than the absolute position. To know absolute position, system must start at known reference (“homing”).
- Usually output two signals, A and B (quadrature), which are 90° out of phase. The direction can be deduced from which leads the other. The number of pulses gives travel/distance; frequency gives speed.

- After looking at both types it seems that the incremental encoders would be the best choice

- They are less expensive and can track the speed which is what we need

The inside of the encoder is shown below



- We should be able to buy an encoder like shown above and below. I am not great with electronics so I am not sure if we would be able to transmit the data to an attached screen or Bluetooth to a wireless device. The goal is to have as few wires as possible.

As seen in the picture below, the metal shaft can be connected to the wheel of the walker to track rotations

Research links:

https://en.wikipedia.org/wiki/Rotary_encoder

https://www.heidenhain.us/addl-materials/enews/pdf/Heidenhain_Automation_Newsletter_July2011.pdf

https://www.youtube.com/watch?time_continue=130&v=N5EMTY70PX8&embeds_referring_euri=https%3A%2F%2Fwww.encoder.com%2Farticle-what-is-an-optical-encoder&source_ve_path=Mjg2NjMsMjM4NTE

Conclusions/action items:

When looking at the encoder and now the wheel of the walker look, there will most likely need to be a gear attached to the wheel to move the rotary encoder. This should not be too hard to do, however, we must make sure to not edit the walker in a way that could hurt the stability of it. Also the client did say he didn't want to many wires hanging around which might happen if this is used. The device is under $20 on Amazon, so if it did not work, it wouldn't destroy our budget just set us back a week or two.

Next Steps

- We now need to see pick up the walker and inspect the wheel to see how to connect this device to track speed and if it will work at all

- We also need to share our ideas as a group to narrow down what we plan to do for our three preliminary designs.

9/25/25 Possible Material for 3D Printing for on Handle Design -

Aidan BURICH - Sep 25, 2025, 6:01 PM CDT

Title: Materials for 3D printing for on handle weight sensor

Date: 9/25/25

Content by: Aidan

Present: Aidan

Goals: Narrow down possible materials for the on handle weight tracker design

Content:

- First, here are the notes taken on the different types of 3D printers and materials at Wendt Commons (Most information came from the Innovation Lab website)

- I focused on bendability specifically because we will need the design to be bendable so it can go on the walker

1. Ultimaker (FDM/FFF)

Printer type: FDM/FFF (Fused Deposition Modeling / Fused Filament Fabrication).
Materials supported:

- PLA (Polylactic Acid): Easy to print, rigid, brittle, not very bendable. Will snap under stress.
- ABS (Acrylonitrile Butadiene Styrene)**:** Tougher than PLA, slightly more flexible, but still relatively rigid.
- PETG (Polyethylene Terephthalate Glycol)**:** Strong, impact resistant, slightly bendable compared to PLA/ABS.
- Nylon: Very bendable, strong, resistant to impact and wear, can flex without breaking.
- TPU/TPE (Thermoplastic Polyurethane/Elastomer): Highly flexible and bendable, rubber-like elasticity.
- CPE, PC (Polycarbonate), PP, composites: Wide range of stiffness/flexibility depending on blend.

Bendability summary:

- Broad spectrum depending on filament.
- PLA = rigid, Nylon = flexible, TPU = very bendable (like rubber).
- Ultimaker has excellent material compatibility for flexible prototyping.

2. Bambu Lab (FDM/FFF)

Printer type: FDM/FFF, known for high speed and automation.
Materials supported:

- PLA & PLA-CF (carbon fiber blends): Rigid, brittle, little bendability.
- PETG & PETG-CF: More impact resistance, moderate flexibility.
- ABS & ASA: Tough, slightly bendable, ASA is also UV resistant.

- PA (Nylon, including PA-CF and PA-GF blends): High strength, more bendable than PLA/ABS, good toughness. Fiber-filled versions (CF/GF) reduce flexibility, increase rigidity.

Bendability summary:

- Similar to Ultimaker's FDM range but optimized for speed.
- Carbon fiber/glass-filled filaments are stiffer and less bendable.
- TPU is bendable, but more challenging at Bambu's high speeds.

3. Formlabs Form 2, 3, + 4 (SLA)

Printer type: SLA (Stereolithography), uses liquid resin cured by laser.
Materials (resins) supported:

- Standard Resin: Rigid, brittle, little bendability.
- Tough 2000 / Tough 1500 Resin: Designed to mimic ABS/PET properties. Tough 1500 bends and rebounds, giving limited flexibility.
- Durable Resin: More ductile, low friction, better bendability (like polypropylene).
- Flexible 80A Resin: Rubber-like, bendable, simulates flexible plastics.
- Elastic 50A Resin: Highly flexible, stretchy, very bendable (like silicone rubber).
- Rigid Resins (10K/4000): Reinforced with glass, very stiff, essentially no bend.
- High Temp Resin: Heat-resistant, rigid, not bendable.

Bendability summary:

- Standard SLA resins = brittle.
- Flexible/Elastic resins = extremely bendable compared to FDM plastics.
- Tough/Durable resins = limited bendability, somewhat similar to PETG/Nylon.

- I did not include some of the machines that were more expensive and didn't have very bendable material capability

Conclusions/action items:

After researching all the types of machines and materials, it seems like the Ultimaker and the Formlabs seem to be the best options for this design. The nice part about the Ultimaker is that it is the cheapest and fastest. The material we would most likely use is TPU or PP because they are the most bendable. For the formlabs, we would use Flexable 80A or Elastic 50A for their bendability. It will also be useful to talk the design through with the workers at Wendt to get their opinion.

Next Steps

- Finish preliminary design

- Talk to wendt commons workers about suggestions

- Print!

10/1/25 Ideas for the design of the endcap of walker -

Aidan BURICH - Oct 01, 2025, 3:20 PM CDT

Title: Design Ideas for endcap of Walker

Date: 10/1/25

Content by: Aidan

Present: Aidan

Goals: Find the best shape for the endcap of the walker leg

Content:

After doing some research, the best and most common endcaps are detailed below, and the best and worst parts of each are discussed.

1. The Standard Round Ferrule (Most Common)

- This is the default tip that comes on most walkers.

- Best For: General indoor use on smooth, hard surfaces (linoleum, hardwood, low-pile carpet).

Pros:

- Provides good, stable contact with the floor.

- Allows the walker to pivot easily for maneuvering.

- Absorbs shock and reduces noise.

Cons:

- Can be unstable on uneven surfaces.

- The flat profile offers little grip on outdoor surfaces.

Verdict: Good all around.

2. The "Guitar Tip" / Contoured Ferrule

- This tip is angled, resembling the tip of a cello or guitar peg.

- Best For: Users who need to navigate tight spaces and make sharp turns.

Pros:

- The angled design allows the walker to be tilted back and moved without lifting the entire frame, making it easier to turn in small areas like bathrooms

Cons:

- The smaller contact point can be less stable than a flat, round ferrule on smooth floors.

- Not ideal for outdoor use.

Verdict: Excellent for indoor maneuverability, especially for users with limited arm strength.

3. The "Wheels-Up" Glide / Rocker Tip

- This is a specialized tip with a curved bottom.

- Best For: Users who have a "step-to" gait pattern (lifting the walker and setting it down with each step) but struggle with the "pick-up and set-down" motion.

Pros:

- Allows the user to rock the walker forward smoothly without having to fully lift it, reducing strain on the arms and back.

Cons:

- Can be very dangerous if used incorrectly. The rocking motion can lead to instability and a higher risk of the walker sliding out from under the user if they put too much weight on it while it's moving.

- Requires more coordination then patients will most likely have.

Verdict: A useful tool for a specific gait pattern, but patients might not have the proper balance to use.

Conclusions/action items:

After looking at the 3 most common tips, the standard and guitar tip are definitely the better options. The rocker tip would be way too unsafe for the client's patients because they might not have the proper balance to use it properly. However, I believe that a combination between the guitar and standard tips could be the best optoin. This is because we already have to 3D print our own endcaps so making a slight curve on the bottom with the shape of a standard endcap will give the most maneuverability with the most stability and safety

Next Steps:

- We now need to finalize the design we want

- Order the proper load cells

- Then design it in Onshape to ensure the load cells will fit

- Print design and test with load cells

10/6/25 Type of Load Cell to use -

Aidan BURICH - Oct 08, 2025, 8:29 PM CDT

Title: Type of Load Cells

Date: 10/6/25

Content by: Aidan

Present: Aidan

Goals: Figure out the best economical load cell for this project

Content:

Button Load Cell (A Type of "Compression-Only" Load Cell)

- Imagine a small, robust, cylindrical device with a prominent "button" on top.

- Design: Compact, cylindrical, with a central loading button or a raised platform.

- Primary Load Type: Compression Only. They are designed to measure forces pushing down directly on the button. They cannot measure tension (pulling forces).

- How it Works: The force is applied to the central button, which causes a slight deformation in the internal strain gauges. This deformation is measured and converted into an electrical signal proportional to the force.

Typical Use Cases:

- Small Platform Scales: Bench scales, kitchen scales, postal scales.

- Industrial Machinery: Level monitoring in silos, force monitoring in presses.

- Medical Devices: Patient weighing systems, force feedback in surgical tools.

- Vending Machines: To detect coin weight.

Key Advantages:

- Compact Size: Very small and low-profile.

- Robust: Often hermetically sealed, making them suitable for harsh environments.

- Easy to Install: Typically require simple mounting with a single central bolt.

"Regular" Load Cell (e.g., S-Type, Shear Beam, Bending Beam)

- This category includes the most common general-purpose load cells.

- Design: Comes in various shapes, but the S-Type is a very common "regular" load cell for comparison.

- Primary Load Type: Both Compression and Tension. An S-Type load cell has threaded holes on both ends and can be pulled apart or squeezed together.

- How it Works: The force (either tension or compression) is applied along the primary axis of the cell, causing the "S" shaped body to deform, which is measured by the strain gauges.

Typical Use Cases:

- Hanging Scales: Crane scales, hopper weighing.

- Tension Measurement: Testing the strength of cables, ropes, and fabrics.

- Industrial Weighing: Tank and silo weighing (using multiple cells).

- Force Testers: Material testing machines.

Key Advantages:

- Dual Functionality: Can measure both push and pull forces.

- High Accuracy: Often used in high-precision applications.

- Versatility: Available in a wide range of capacities and sizes.

Key Takeaways

- If you are only pushing down on something (like a scale platform), a Button Load Cell is often the simplest, most compact, and cost-effective choice.

    - This is what we will most likely go with

- If you need to both push and pull, or are specifically measuring a tensile force (like a hanging weight), a "Regular" S-Type load cell is the correct tool for the job.

Sources:

High quality load cells from trusted manufacturer Flintec

Load Cell | Load Sensor | Load Measurement | HBM

Conclusions/action items:

After looking at the different types of load cells, it's pretty obvious button cells are the way to go. They are much cheaper and are simple which will make the device work more smoothly. I then looked at some ones available online that we can buy.

This load cell is only $10 on amazon - [Wishiot 4PCS 50KG Load Cell Weighing Sensor Half-Bridge Strain Gauge Human Body Scale Pressure Sensors + HX711 Amplifier AD Module (4sensor 1module): Amazon.com: Industrial & Scientific]

This one is $20 and can hold slightly more weight - [Micro Load Cell 5Kg 10Kg 20Kg 30Kg 50Kg 100Kg 200Kg 300Kg 500Kg Small Button Compression Force Sensor Adapts HX711 - AliExpress 1420]

Next steps:

Choose what load cell we want to use

Get client to order materials

give premilinary presentation

10/9/25 Ideas for Possible Lidar Detectors -

Aidan BURICH - Oct 09, 2025, 6:19 PM CDT

Title: Types of Lidar Sensors

Date: 10/9/25

Content by: Aidan

Present: Aidan

Goals: Find the best lidar sensor

Content:

There are many different types of lidar sensors. I wanted to find the best ones for this project. Below are the different types I found and the most important things about each

Category A: High-Performance for Automotive & Robotics

These sensors offer long range and high resolution, suitable for demanding navigation tasks.

- Valeo SCALA 3 (MEMS)

- Tech: MEMS
- Specs: Range up to 150m+, 75° x 16° FOV. Designed for automotive-grade performance.
- Key Differentiator: The only LiDAR in series production on consumer vehicles today (e.g., Mercedes-Benz S-Class). It's a proven, automotive-qualified sensor.
- Primary Application: L2+/L3 Autonomous Driving, Adaptive Cruise Control.

- InnovizOne & InnovizTwo (MEMS)

- Tech: MEMS
- Specs: InnovizTwo: Range > 300m @ 10% reflectivity, 120° x 40° FOV, high resolution.
- Key Differentiator: Designed to meet the stringent performance and cost targets for high-volume automotive L3 programs (e.g., selected by BMW). Offers robust perception software.
- Primary Application: Automotive.

- Aeva Aeries (FMCW + 4D)

- Tech: FMCW (Frequency-Modulated Continuous Wave) co-developed with MEMS. This is a different approach from the standard ToF (Time-of-Flight) used by most others.
- Specs: "4D Perception" - Provides instantaneous velocity for each point (Doppler effect), > 500m range, immune to interference from other LiDARs and sunlight.
- Key Differentiator: FMCW technology. Offers unique data (velocity) and performance advantages, though it's more complex.
- Primary Application: Automotive, Trucking.

Category B: Mid-Range for Robotics, Drones, and Mapping

This is a highly competitive segment with many excellent options.

- Ouster OS Series (Solid-State Rotating)

- Tech: Digital Flash LiDAR on a rotating base (they call it "Lidar-on-a-Chip").
- Specs: Multiple models (e.g., OS0-128, OS1-32). Ranges from ~50m to 240m. Configurable resolution (e.g., 128 channels vs 32 channels).
- Key Differentiator: Flexibility and cost. Offers a wide range of performance profiles in a similar form factor. Built-in cameras for sensor fusion.

- Primary Application: Robotics, Industrial Automation, Drones, Research.

- Velodyne Velarray M1600 (MEMS)

- Tech: MEMS
- Specs: Range of 200m+, 120° x 30° FOV. Compact, embeddable form factor.
- Key Differentiator: From a pioneer in the industry, designed for automotive and industrial integration.
- Primary Application: Automotive, Last-Mile Delivery, Robotics.

- Livox MID-70 & Avia (Solid-State Rotating)

- Tech: Unique non-repetitive scanning pattern via a rotating prism.
- Specs: MID-70 has a 70° circular FOV. Range up to 245m. Scan pattern creates a "flower-like" shape, increasing point cloud density over time.
- Key Differentiator: Extremely low cost for the performance. The unique scan pattern is excellent for static mapping but can be challenging for dynamic object tracking.
- Primary Application: UAV Mapping, Surveying, Research.

Category C: Low-Cost & Short-Range for Consumer & Logistics

These sensors prioritize cost and size over long-range performance.

- Sony DepthSense IMX459 (Flash)

- Tech: Stacked SPAD (Single-Photon Avalanche Diode) ToF Sensor.
- Specs: 1/2.9-type format, 15m range, high accuracy.
- Key Differentiator: Mass-market potential. Sony's manufacturing scale could make this a de-facto standard for consumer and mobile applications.
- Primary Application: Robotics, Drones, AR/VR, Mobile Devices.

- TIOPTICS TioMini (MEMS)

- Tech: MEMS
- Specs: Very small form factor (~50mm cube), weight ~120g, range up to 30m.
- Key Differentiator: One of the smallest and lightest performance MEMS LiDARs. Ideal for size, weight, and power (SWaP) constrained applications.
- Primary Application: Micro-drones, Small Robots, Wearable devices.

Summary Table:

Sensor	Technology	Max Range*	Field of View (FOV)
Valeo SCALA 3	MEMS	150m+	75° x 16°
InnovizTwo	MEMS	300m+	120° x 40°
Ouster OS1-32	Solid-State (Rotating)	120m	90° x 30°
Livox MID-70	Solid-State (Rotating)	245m	70° (Circular)
Sony IMX459	Flash (SPAD)	15m	N/A (Sensor)
TIOPTICS TioMini	MEMS	30m	75° x 30°

Sources:

LiDAR sensor | Autonomous vehicle sensors | Valeo

https://www.aeva.com/technology

https://www.sony-semicon.com/en/news/2020/2020111901.html

Digital Lidar Sensors for Automation, Drones & Robotics | Ouster | Ouster

Conclusions/action items:

After looking at the many types of lidars, the Ouster OS Series sensor seemed the best. It fits the range needed and it is very compact. It is also not too expensive for the quality of data it gives (at least according to online).

The next steps are to order the lidar and load cells to begin testing

10/15/25 Wire Holder

Aidan BURICH - Nov 02, 2025, 8:57 PM CST

Title: CAD Design for Wire Holder

Date: 10/15/25

Content by: Aidan

Present: Aidan

Goals: Create a CAD design for the wire holder needed to make the wires discrete on the walker

Content:

- One of the things that our client asked for was that if any wires needed would be consolidated so they would not become a hazard or visibly unappealing

- To do this, I think we should have small housings attached to the legs that the wires could run through, so they stay out of the way

- This will also look visually appealing because they will be consolidated on the side and won't have a bunch of different wires dangling everywhere, making them almost out of sight

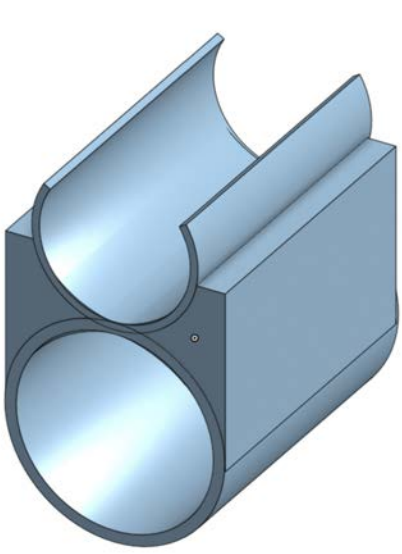
- This design could easily be 3D printed.

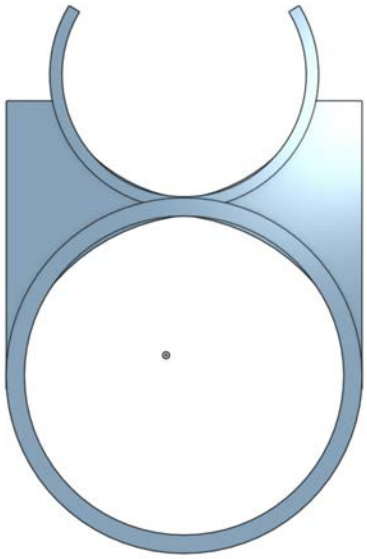
- What it would do is the side with the semicircle would simply snap on the leg, and the wires would be threaded through the full circle up to the component housing

- 3 or 4 can be printed and placed up the entire leg

- It can be printed out of pretty much any flexible plastic

- Pics are attached below





Conclusions/action items:

- Next steps are to continue working with the load cells code and the lidar code

- I also need to present this idea to the group and get their input.

10/20/25 Wire Holder V2

Aidan BURICH - Dec 08, 2025, 3:29 PM CST

Title: Wire Holder V2

Date: 10/20/25

Content by: Aidan

Present: Aidan

Goals: Revise Wire Holder

Content:

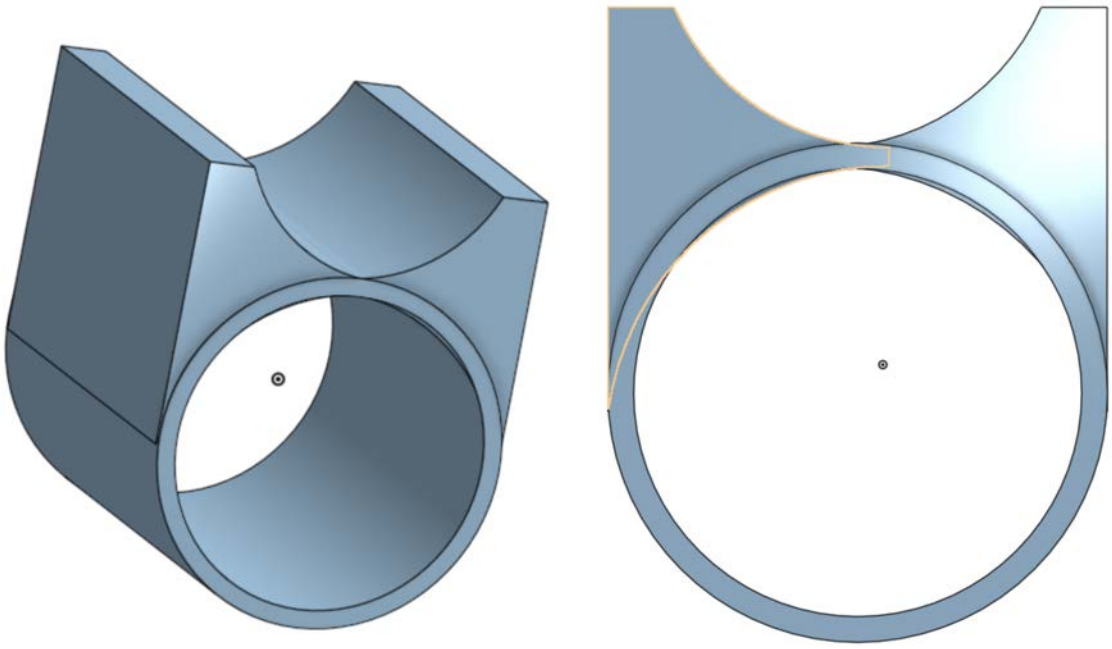
- In the previous design, there were higher edges on the open side that would clip directly on the walker

- The clips would have been very thin because of how small we needed them

- Because of how thin they needed to be and the nature of 3D print materials, they would be prone to breaking

- To fix this problem, I removed the high edges and will instead place a velcro back on the wire holder, and the attaching end will be stuck on the walker leg

- This new design should be more durable and should still not affect the walker in any way or affect the user of the walker



Conclusions/action items:

Conclusion: This new design should be more durable and should still not affect the walker in any way or affect the user of the walker

Action items:

- Consult group on changes

- Print the design

- Keep working on load cell issues

11/25/25 Wire Holder Update

Aidan BURICH - Dec 08, 2025, 4:24 PM CST

Title: Wire Holder Update

Date: 11/25/25

Content by: Aidan

Present: Aidan

Goals: Update on Wire Holder

Content:

- We decided to scrap the wire holder idea

- There were a few reasons

    - We have still so much to do with very little time. The wire holders are a luxury, not a necessity

    - We still haven't finished all our other prints, and to make sure we stay in our wendt budget, it makes sense not to move forward with it

    - There is little time to test them to make sure they work and are sturdy enough. This time should be spent elsewhere

- Because of these reasons, we decided not to use the wire holders

Conclusions/action items:

Conclusion: We decided not to go with the wire holders for this rendition. If this project is continued, it would be valuable to make some sort of wire holder for aesthetic and practical reasons. We will just use tape or Velcro to attach the wires directly to the walker frame. This still does not edit the walker in anyway so there is no problem going in this direction

Action items:

- Solder everything on perf board

- Find battery housing and battery

- Assemble prototype

All Required Trainings for BME 200 - 9/30/25

Aidan BURICH - Oct 02, 2025, 11:57 AM CDT

Title: Required Course Trainings

Date: 10/1/25

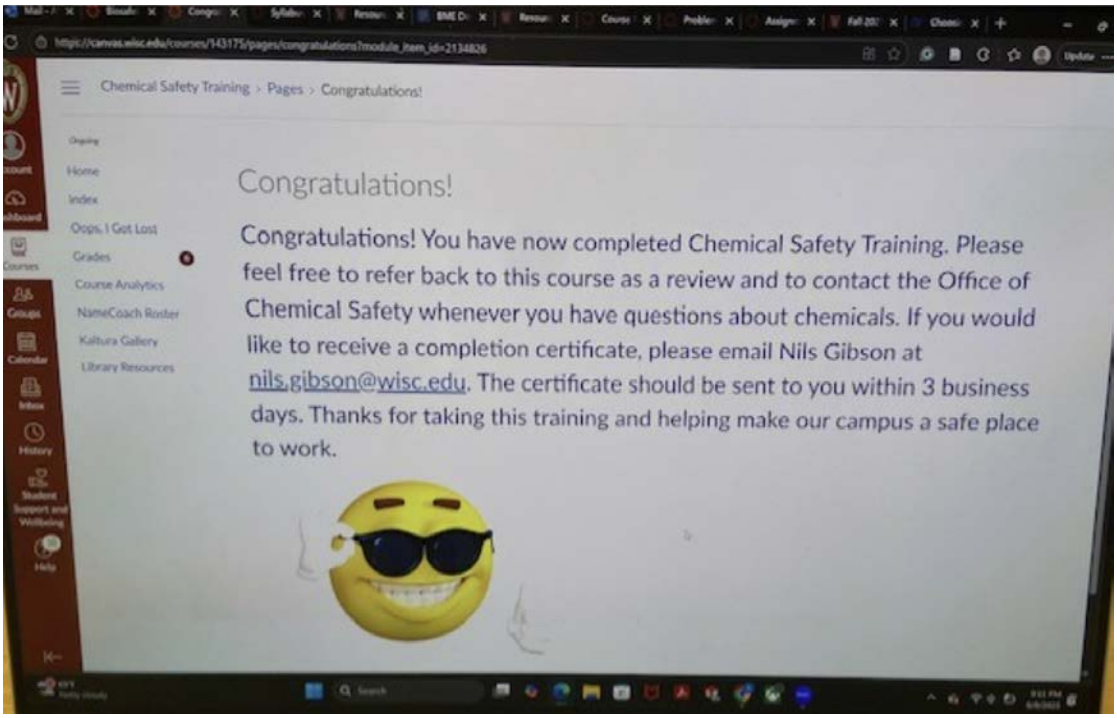
Content by: Aidan

Present: Aidan

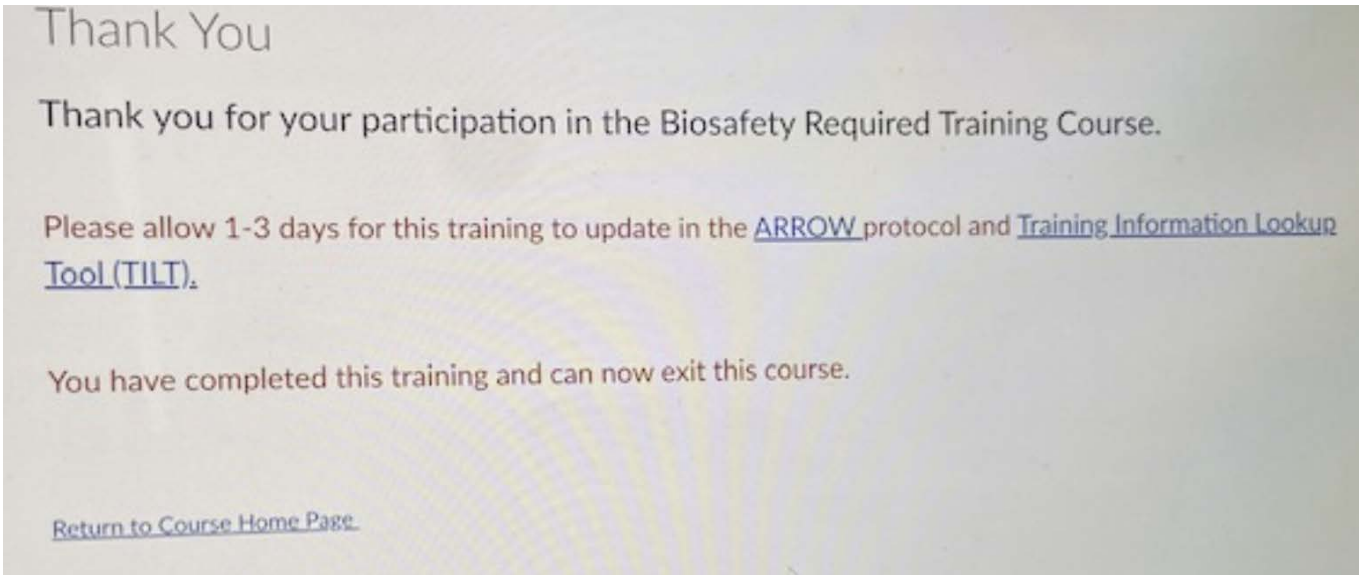
Goals: Complete all Required Course Trainings

Content: Below is picture proof that all required trainings were completed

Chemical Saftey Training:



Biosafety Training:



Lath and Mill Training:

Conclusions/action items:

Next steps are to utilize these trainings to make our current project and any other projects in the future.

9/8/25 Questions for client -

Aidan BURICH - Sep 10, 2025, 4:14 PM CDT

Title: Questions for Client

Date: 9/10/25

Content by: Aidan

Present: Aidan

Goals: Create questions for our client

Content:

- Is there a specific type of walker that you want us to use?

- What are all the stats you want us to track

- Is this for s specific person or for anyone to use and benefit?

Conclusions/action items:

- These questions are very surface-level and preliminary. We most likely will have more questions as we dive deeper into this project.

- The next steps are to meet with our client and ask these clarification questions.

9/25/25 Meeting with Client -

Aidan BURICH - Sep 25, 2025, 5:19 PM CDT

Title: Client Meeting

Date: 9/25/23

Content by: Aidan

Present: Aidan

Goals: Pick up walkers from the client

Content:

- Had a quick meeting with the client to pick up the past walker

- He gave me a walker we can test our designs on, and the old working smart walker

- He showed me how to use the smart walker and how it displayed its readings

Conclusions/action items:

Now that we have the old walker and the trial walker, we can get better measurements for our preliminary designs. We also have a place to test our designs. The old walker can also be used as a guide or example on how to implement the speed and weight trackers and how to display the data. With these our project can progress much more efficiently

Next Steps,

- Take any and all measurements needed for the CAD designs

- Start our preliminary presentation and decide on the designs we want to present

- Show designs to the client and get his input

10/29/25 Lidar Coding

Aidan BURICH - Nov 01, 2025, 5:44 PM CDT

Title: Lidar Coding

Date: 10/29/30

Content by: Aidan

Present: Group

Goals: Code the Working Lidar

Content:

- We just recently got the lidar, and we now want to code it

- We didn't have access to an Arduino today, so we instead used a speeedino

- The code we have is posted below

- The code didn't actually give us the data we wanted, but that is the lidar was not compatible with the speeedino. Once it's attached to an Arduino, it will work fine.

- Code:

```
#include <Wire.h>
#include <LIDARLite.h>

LIDARLite myLidarLite;

// ----- Rate limit -----
unsigned long lastRead = 0;
const unsigned long interval = 50; // ~20 Hz

// ----- Speed state -----
float prev_ft = NAN;
unsigned long prev_ms = 0;
bool ema_initialized = false;
float speed_ema_ft_s = NAN; // start as NAN so first line shows only distance

// ----- Toggle between text vs plot output -----
#define PLOT_OUTPUT 1   // set to 0 if you want the old text prints

inline float cmToFeet(int cm) { return cm * 0.0328084f; }

void printReading(bool bias)
{
  unsigned long now = millis();
  int dist_cm = myLidarLite.distance(bias);
  if (dist_cm <= 0) return;

  float dist_ft = cmToFeet(dist_cm);

  // Speed calc
  float inst_speed_ft_s = NAN;
  if (prev_ms != 0) {
    float dt_s = (now - prev_ms) / 1000.0f;
    if (dt_s > 0) {
      inst_speed_ft_s = (prev_ft - dist_ft) / dt_s; // + if approaching
```

```
      const float alpha = 0.25f;
      if (!ema_initialized) {
        speed_ema_ft_s = inst_speed_ft_s;
        ema_initialized = true;
      } else {
        speed_ema_ft_s = alpha * inst_speed_ft_s + (1 - alpha) * speed_ema_ft_s;
      }
    }
  }

  // ----- Output -----
#if PLOT_OUTPUT
  // Arduino Serial Plotter likes: label:value [tab] label:value ...
  Serial.print("distance_ft:");
  Serial.print(dist_ft, 2);
  Serial.print("\tspeed_ft_s:");
  if (isnan(speed_ema_ft_s)) {
    Serial.println(0);     // first sample has no speed yet; plot zero
  } else {
    Serial.println(speed_ema_ft_s, 2);
  }
#else
  Serial.print("Distance: ");
  Serial.print(dist_ft, 2);
  Serial.print(" ft");

  if (!isnan(speed_ema_ft_s)) {
    float mph = speed_ema_ft_s * 0.681818f;
    Serial.print(" | Speed: ");
    Serial.print(speed_ema_ft_s, 2);
    Serial.print(" ft/s (");
    Serial.print(mph, 2);
    Serial.print(" mph)");
  }
  Serial.println();
#endif

  prev_ft = dist_ft;
  prev_ms = now;
}

void setup() {
  Serial.begin(115200);
  myLidarLite.begin(0, true);
  myLidarLite.configure(0);
}

void loop() {
  unsigned long now = millis();
  if (now - lastRead >= interval) {
    lastRead = now;
    printReading(true);
  }
}
```

Conclusions/action items:

- Try code with Arduino

- Troubleshoot load cell code

11/2/25 Revision of Report

Aidan BURICH - Nov 02, 2025, 9:24 PM CST

Title: Revision of preliminary designs in the report

Date: 11/2/25

Content by: Aidan

Present: Aidan

Goals: Fix mistakes in the report

Content:

- The following is what was added to the report:

Distance/Speed Sensors

Design 1: Infrared Sensor

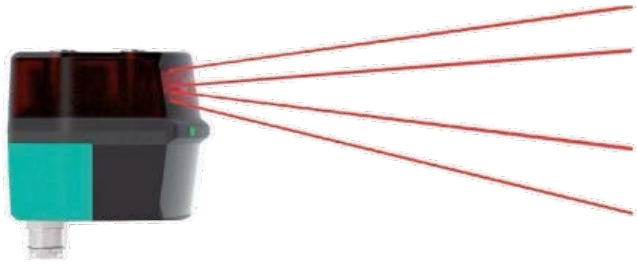
The infared sensor would be mounted at the bottom of one of the legs of the walker and track the rotations of the walker wheel. The wheel will have a white strip of tape on it and every time the white strip passes the sensor it will track the rotation and use this to calculate the average speed of the walker.

Design 2: Rotary Encoder

The rotary encoder sensor tracks the rotations of the wheel. The encoder will be mounted on the wheel of the walker and track the rotations of the axel of the wheel. The number The number of rotations can be used to calculate the distance and speed of the walker.

Design 3: Lidar Sensor

The lidar sensor will be placed in a box the will be mounted on the front of the walker. The lidar will measure the distance between the walker and the wall at a frequency of 2 MHz. It can track the speed of the change in distance which can be used to calculate speed and distance traveled.



- Multiple other formating issues were fixed as well

Conclusions/action items:

Next Steps:

- Keep Editing Report

- Figure out issues with load cell code

11/8/25 Revision of Report - Background

Aidan BURICH - Dec 08, 2025, 4:35 PM CST

Title: Background Report Revision

Date: 11/8/25

Content by: Aidan

Present: Aidan

Goals: Make Revisions to the background section of the report

Content:

- One of the motives for our design was to show insurance companies that the physical therapists deserve to be paid for their work

- I didn't understand what that really meant, so I did some research

- I found out that insurance companies do medical credentialing that investigates facilities and sees if their services should be covered by their insurance

- This process is very long and looks closely into the therapists

- It is hard to show insurance companies to cover their work, so trust processes and tools must be used to showcase their abilities

- This is why our product is so important: it has to show companies that their services are worth paying for

- I also organized our sources so they appear in order in the text

Revisions Made:

Patients with traumatic brain injuries often undergo traumatic events followed by intense rehabilitation to help them walk and return to everyday life as soon as possible. Acute stroke care clinics provide specialized care to initiate recovery following hospitalization [1]. During rehabilitation, doctors struggle to measure progress as patients gain strength, making it difficult for physicians to provide patients with tangible data of their improvement. The insurance companies also require evidence of improvement. Insurance companies use a process called “Medical Insurance Credentialing” to verify that medical providers are qualified to receive reimbursement for their services [2]. This necessitates that clinics document progress to be compensated for their hard work. Currently, the documentation process is time-consuming and lacks the equipment needed to measure the pressure put on the walker. The smart walker will measure the pressure applied, speed, and distance walked of patients with neuro-rehabilitation needs. This data will be reported and displayed in real-time to help clinicians monitor progress and motivate patients. Ultimately, the device will reduce the time required to meet Medicare's documentation needs and increase objective markers of patient readiness for discharge [3].

Following a traumatic brain injury (TBI), walking speed is often referred to as the “sixth vital sign” because it provides an objective measure of functional recovery [5]. Gait speed encompasses the combined performance of multiple physiological systems, including balance, coordination, and muscle strength. Along with speed, the pressure applied to a walker is an essential indicator of patient stability, confidence, and weight-bearing ability, all of which are used to assess readiness for discharge from inpatient care [6]. Clinicians need to know how much weight patients put on a walker, especially if the patient is trying to gain the ability to walk without a walker. When patients want to stop using the assistance of a walker, clinicians need to know if it is safe to do so. If patients stop using a walker before they are ready, it could lead to walking less throughout the day, which causes serious risks like decreased blood flow, backed-up bowel movements, and stiffness [7].

Conclusions/action items:

- Keep working on load cell code

11/18/25 Load Cell Code and hook up

Aidan BURICH - Dec 08, 2025, 5:00 PM CST

Title: Load Cell Code and hook up

Date: 11/18/25

Content by: Aidan

Present: Aidan

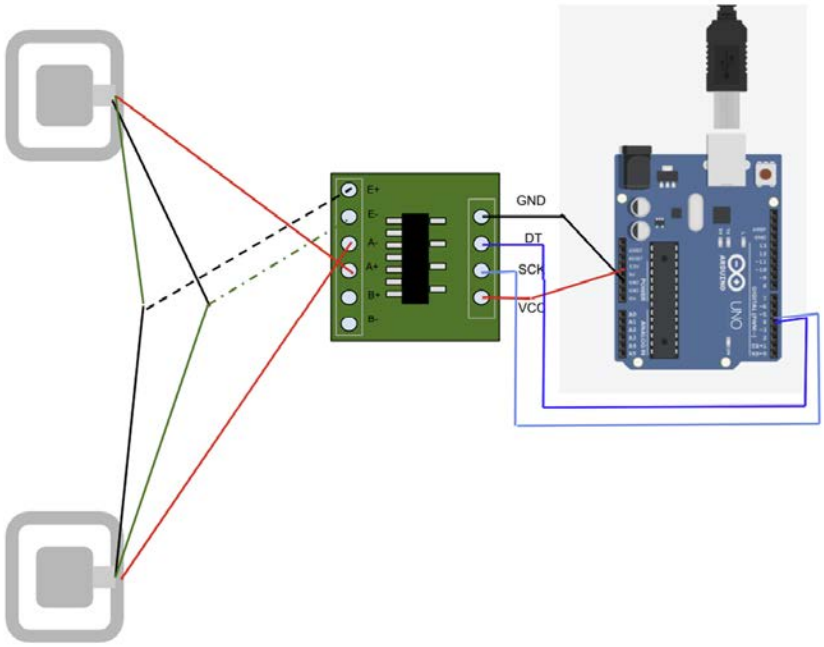
Goals: Get load cells working

Content:

- We finally figured out the load cells and they are reading accurately

- We figured out that the white wire was the positive not the red which fixed the problem

Here is the new hook up diagram:



Here is the code:

```
/*
  ----------------------------------------------------------------------------
  HX711_ADC
  Arduino library for HX711 24-Bit Analog-to-Digital Converter for Weight Scales
  Olav Kallhovd sept2017
  ----------------------------------------------------------------------------
*/

/*
  Settling time (number of samples) and data filtering can be adjusted in the config.h file
  For calibration and storing the calibration value in eeprom, see example file "Calibration.ino"

  The update() function checks for new data and starts the next conversion. In order to acheive maximum effective
  sample rate, update() should be called at least as often as the HX711 sample rate; >10Hz@10SPS, >80Hz@80SPS.
  If you have other time consuming code running (i.e. a graphical LCD), consider calling update() from an interrupt routine,
  see example file "Read_1x_load_cell_interrupt_driven.ino".

  This is an example sketch on how to use this library
```

```
*/

#include <HX711_ADC.h>
#include <EEPROM.h>

//pins:
const int HX711_dout = 4; //mcu > HX711 dout pin
const int HX711_sck = 5; //mcu > HX711 sck pin

//HX711 constructor:
HX711_ADC LoadCell(HX711_dout, HX711_sck);

const int calVal_eepromAdress = 0;
unsigned long t = 0;

void setup() {
  Serial.begin(57600); delay(10);
  Serial.println();
  Serial.println("Starting...");

  LoadCell.begin();
  //LoadCell.setReverseOutput(); //uncomment to turn a negative output value to positive
  float calibrationValue; // calibration value (see example file "Calibration.ino")
  calibrationValue = -0.46; // uncomment this if you want to set the calibration value in the sketch
#if defined(ESP8266)|| defined(ESP32)
  //EEPROM.begin(512); // uncomment this if you use ESP8266/ESP32 and want to fetch the calibration value from eeprom
#endif
  //EEPROM.get(calVal_eepromAdress, calibrationValue); // uncomment this if you want to fetch the calibration value from eeprom

  unsigned long stabilizingtime = 2000; // preciscion right after power-up can be improved by adding a few seconds of stabilizing time
  boolean _tare = true; //set this to false if you don't want tare to be performed in the next step
  LoadCell.start(stabilizingtime, _tare);
  if (LoadCell.getTareTimeoutFlag()) {
    Serial.println("Timeout, check MCU>HX711 wiring and pin designations");
    while (1);
  }
  else {
    LoadCell.setCalFactor(calibrationValue); // set calibration value (float)
    Serial.println("Startup is complete");
  }
}

void loop() {
  static boolean newDataReady = 0;
  const int serialPrintInterval = 0; //increase value to slow down serial print activity

  // check for new data/start next conversion:
  if (LoadCell.update()) newDataReady = true;

  // get smoothed value from the dataset:
  if (newDataReady) {
    if (millis() > t + serialPrintInterval) {
      float i = LoadCell.getData();
      Serial.print("Load_cell output val: ");
      Serial.println(i);
      newDataReady = 0;
      t = millis();
    }
  }

  // receive command from serial terminal, send 't' to initiate tare operation:
  if (Serial.available() > 0) {
    char inByte = Serial.read();
    if (inByte == 't') LoadCell.tareNoDelay();
```

```
  }

  // check if last tare operation is complete:
  if (LoadCell.getTareStatus() == true) {
    Serial.println("Tare complete");
  }


}
```

Conclusions/action items:

- Figure out bluetooth code

- expand the wires of load cells

- connect load cell and lidar circuit and code

11/20/25 Purchased Battery Pack

Aidan BURICH - Dec 08, 2025, 4:43 PM CST

Title: Purchased Battery Pack

Date: 11/20/25

Content by: Aidan

Present: Aidan

Goals: Purchase Battery Pack

Content:

- The picture below is the product

- It holds a 9V battery

- It has an on/off button

- it has a barrel jack so it can be plugged in directly to the Arduino to give it power

Conclusions/action items:

- Finish perf board

- Start constructing the final prototype

12/4/25 Revision of Fabrication of Report

Aidan BURICH - Dec 06, 2025, 5:41 PM CST

Title: Fabrication Revision

Date: 12/6/25

Content by: Aidan

Present: Aidan

Goals: Edit the fabrication of the report, specifically the materials used

Content:

- In our previous rendition of the report, we had one big, confusing paragraph for the materials of the project. It jumped around and was not concise

- I want to fix that, so I made multiple paragraph groupings together with different components that are related to each other

- I talked about the importance of different materials, which was not discussed before

- I explained how the sensors (lidar and load cell) actually work structurally and how they report data

- I also fixed lots of grammatical errors

- I The only thing needed to add is the infill for the prints, which I do not know as of this moment

Below is the revised section:

For the weight tracking part of the design, two load cells will be used. The load cells work by tracking the displacement of the center region with the outside lip of the load cell, which changes the electrical resistance measured by the Wheatstone bridge circuit, producing a voltage proportional to the force. The load cells will be placed in the endcap design, which will be printed in Thermoplastic Polyurethane (TPU) (Need infill value here). This material is flexible enough to fit the walker leg insert and the leg itself, but also durable enough to withstand the weight of the patient and walker. This material closely resembles the material of the end caps that a base walker comes with. So the load cell can be compressed properly a walker leg insert will be made out of Polyvinyl Alcohol (PVA) (Need infill value here). This is a hard, rigid material that is needed so the load cell is properly depressed by this piece. It is also a very durable material that will withstand constant pressure. To ensure the load cells send a strong enough signal, a load cell amplifier HX711 will be used. The amplifier takes in the weak or small voltage output from the load cells and amplifies the signal to a higher voltage. It also gets rid of noise for a cleaner signal output. Because this design includes two load cells instead of four, a half-bridge configuration, seen in Figure 7, will connect them to the amplifier.

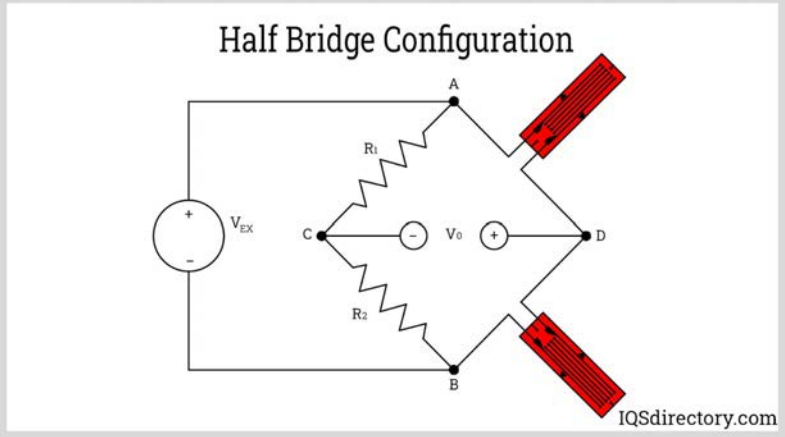


Figure 7: Half wheatstone bridge configuration showing strain gauges in red [9].

For the speed and distance portion of the design, the Garmin LIDAR-Lite Optical Distance Sensor - V3 will be used. The lidar emits a 905nm single-stripe laser that bounces off the wall/obstacle in front of it and back to the lidar. The time it takes for the laser to come back to the lidar is how it tracks distance, which can be used to compute speed. The liadr will be placed in the electrical component box. The component box will also be made out of PVA (Need infill here). This rigid nature of PVA will help protect the lidar and all the electrical components inside the component box. The box will also hold the perforated(perf) board and ARDUINO UNO WiFi REV2 microprocesser. See Appendix __ for detailed blueprints of all 3D prints. All 3D printed materials were designed in OnShape.

A Duracell Procell 9V Alkaline Battery will serve as the power source for the device and be held in a Gikfun 9V Battery Holder with ON/Off Switch for Arduino. Figure 8 below shows a schematic of the circuit and components of the design.

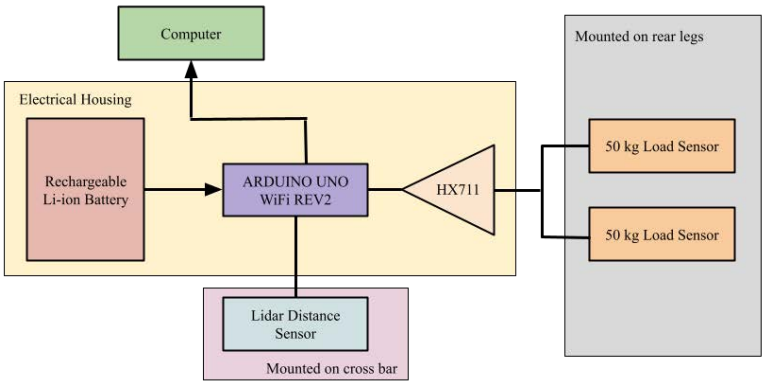


Figure 8 *Circuit block diagram of design and components.*

Conclusions/action items:

- Obtain in fill values to add to text

- Finish the rest of the fabrication section, especially explaining the electrical component

- Make edits to the results and conclusion section

12/9/25 Methods Revision

Aidan BURICH - Dec 10, 2025, 10:33 PM CST

Title: Methods Revision

Date: 12/9/25

Content by: Aidan

Present: Aidan

Goals: Change Methods section

Content:

- We had changed our method of fabrication from when we originally wrote the report. I fixed it

Revised Report:

Methods

For the weight tracking circuit, the load cells will be connected directly to the HX711 load cell amplifier. The load cells have three wires coming from them: black, red, and white. The black wire is the negative wire, the white is the positive wire, and the red is the signalling wire. The HX711 amplifier board has two sides: one side that connects wires to the load cells and the other side that connects wires to the Arduino. The side that connects to the load cells has connection points E+, E-, A+, A-, B+, and B-. The side that connects to the Arduino has connection points GND, DT, SCK, and VCC. One load cell is connected to the HX711 amplifier by connecting the positive wire to the E+ connection, the negative wire to the E- connection, and the signalling wire to the A+ connection. The other load cell has the positive wire connected to the E- connection, the negative wire connected to the E+ connection, and the signalling wire connected to the A- connection. For the connection from the HX711 amplifier to the Arduino, the VCC connection is connected to the 5V port on the Arduino, the GND connection is connected to the GND port, the DT connection is connected to the 3 Digital port, and the SCK connection is connected to the 2 Digital port. See Figure 13 for a visual representation of the circuit. The load cells were calibrated using the code "SparkFun_HX711_Calibration.ino" from Sparkfun's HX711 Breakout Hookup Guide [12] found in Appendix G. Seeing as the load cell provides output based on the deformation of the center square of the load cell from the outer rim, while calibrating, they were attached to wooden boards with 3D printed mounting pieces from Thingiverse [13] that provide a spacer between the outer rim and the board. This way, the center piece was free to deform [14].

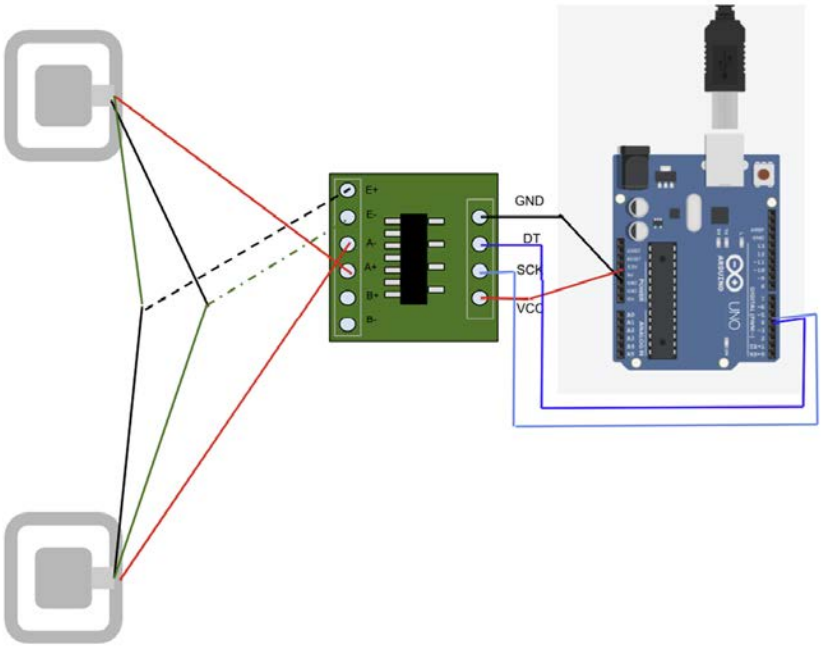


Figure 13: *Load cell circuit to Arduino [15]. The green wire is the white wire.*

For the speed and distance tracking circuit, the LiDAR wires are connected directly to the Arduino. The LiDAR has a power wire (red), a power enable wire (orange), a mode control wire (yellow), a clock power wire (green), a data power wire (blue), and a ground wire (black). The orange and yellow wires are not connected to any part of the circuit. A 1000 µF capacitor and two 4.7 kΩ resistors are needed in the circuit. The hookup guide for the LiDAR circuit was found on Sparkfun's LIDAR-Lite v3 Hookup Guide [16]. See Figure 14 for the full speed and distance tracking circuit.

Figure 14: *LiDAR circuit to Arduino [16]*

The combined circuit is soldered together on a perf board and then connected to the Arduino. The two circuits are completely separate on the perf board except for each circuit's power wire that connects to the 5V port on the Arduino board. Each circuit's power wire connects to a single wire that is connected to the 5V Arduino port. The complete circuits on the perf board connected to the Arduino can be seen in Figure 15.

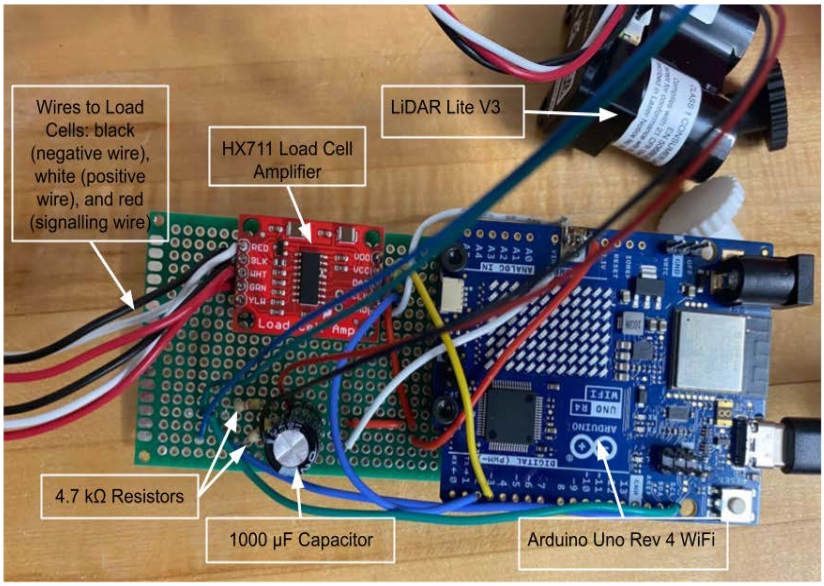


Figure 15: *Complete combined circuit on perfboard*

Software

The team first considered using MIT's App Inventor, but upon further research discovered that Arduino Uno R4 WiFi transmits Bluetooth Low Energy as opposed to classic Bluetooth (HC-05/06); therefore, the two are not compatible without additional hardware. The team then pivoted to a simple WiFi-based web browser. Code for the web page can be found in Appendix C. The webpage url is http://192.168.4.1/ and the device being used must be connected to the Smart_Walker wifi. See Appendix G for a more detailed connection guide. The webpage includes outputs of pressure/weight placed on the walker in pounds, the distance from the nearest surface in feet, and the speed at which the walker is moving in feet per second. The visual display can be seen in Figure 16Due to the large volume of data coming from the serial output of the Arduino, the webpage automatically refreshes every second.

The code for the load cells was also found on Sparkfun's HX711 Breakout Hookup Guide [12]. See Appendix H for the full code. This code was used to test the load cells and confirm that they functioned properly. The code for the LiDAR was found on the Garmin LIDARLite_Arduino_Library GitHub [17]. See Appendix I for the entire code. This code was also used for testing and to confirm the LiDAR worked correctly. Both of these codes were later adapted and combined along with the code for the webpage to make the final code that was uploaded to the Arduino. This code can be found in Appendix C.

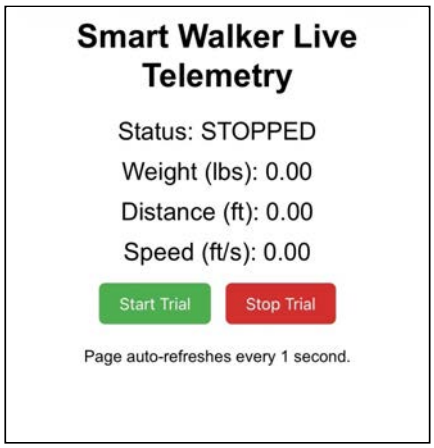


Figure 16: *Webpage for data collection*

Conclusions/action items:

- FInish report

- Do feedback fruits

9/11/2025 Notes on Benefits of using a Walker

Nial Donohoo - Sep 11, 2025, 4:26 PM CDT

Title: Notes on Benefits of using a Walker

Date: 9/11/2025

Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Examine the benefits of using a walker to ensure we are maximizing them within our design.

Content:

I read the article "Postural and Metabolic Benefits of Using a Forearm Support Walker in Older Adults With Impairments" by Chandrasekaran Jayaraman, Chaithanya Krishna Mummidisetty, Alexandra Loesch, Sandi Kaur, Shenan Hoppe-Ludwig, Manfred Staat, and Arun Jayaraman

https://www.sciencedirect.com/science/article/pii/S0003999318313844

Key takeaways:

- 30-50% of people who own a walker stop using them soon after receiving them because its necessary to lean forward to use them and because of the effort it takes to either pick them up or wheel them around.

- Adjustable forearm supports is a good way to try to solve this.

- Using adjustable forearm supports and making an effort to have the user remain upright while walking had a positive impact on gait and stability.

Conclusions/action items:

This study gave me insight into design elements that are important to include in a walker design.

10/10/2025 Gait Rehabilitation After a Stroke

Nial Donohoo - Oct 10, 2025, 3:33 PM CDT

Title: Gait Rehabilitation After a Stroke

Date: 10/10/2025

Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Examine the way existing research measures the progress of people in stroke rehabilitation

Content:

Notes on the article - Mobility After Stroke: Relearning to Walk

Mobility Impact:
- Around two-thirds of stroke patients experience impaired mobility initially. Early, targeted rehabilitation greatly influences long-term independence and quality of life.
- Most functional recovery occurs within the first few months post-stroke, making early intervention critical for maximizing outcomes.
- Balance is a fundamental requirement for all gait rehabilitation; improving postural control supports success in more complex motor and walking activities.

Study Basis:
- Clinical pathways developed from a systematic review of RCTs (Randomized Controlled Trials) and systematic reviews focused on walking ability, balance, gait speed, and endurance.
- This study was based on the German ReMoS guideline, developed by the German Society for Neurorehabilitation (DGNR): forms the evidence base for gait rehabilitation.

Assessment Methods:
- Speed: 10-meter walk test
- Endurance: 6-minute walk test
- Balance: Berg Balance Scale (Consists of 14 tasks, each designed to test a different aspect of balance), Timed Up and Go (TUG) test (time it takes them to stand up and walk 3m)

Research Gaps:
Few high-quality studies address everyday walking tasks (e.g., navigating slippery floors or carrying items), limiting real-world application data.

Conclusions/action items:

We can apply these findings to the design of our walker as it would be good if our walker could address the needs of more than just our client and potentially be sued in other testing.

9/19/2025 Notes on A review of the functionalities of smart walkers

Nial Donohoo - Sep 19, 2025, 9:26 AM CDT

Title: Notes on A review of the functionalities of smart walkers

Date: 9/19/2025

Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Understand more of what metrics are on existing smart walkers.

Content:

https://www.sciencedirect.com/science/article/pii/S1350453315001782

Conclusions/action items:

9/19/2025 Possible pressure sensors

Nial Donohoo - Sep 19, 2025, 9:49 AM CDT

Title: Possible pressure sensors

Date: 9/19/2025

Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Research and look for possible options of pressure sensors that we could use on our walker.

Content:

Wireless Load Cell
Our wireless load cells are customizable solutions that pair any resistive bridge type load cell (four-wire or six-wire) to a wireless signal conditioner. This setup allows wireless communication with a PC, Mac, or Linux machine using Xbee (DI-1000ZP), BLE (DI-1000BLE), or WiFi (DI-1000WiFi) protocols.

https://www.loadstarsensors.com/technology/wireless-load-cell.html?srsltid=AfmBOorZUmci8TEbuKfqU9ke79dO0bMkM8XwNlDTKREvRp2r3dLmCNde

4PCS 50KG Load Cell Weighing Sensor Half-Bridge Strain Gauge Human Body Scale with Bracket + HX711 Amplifier AD Module

https://www.amazon.com/Wishiot-Weighing-Half-Bridge-Bracket-Amplifier/dp/B0DCK48BSK/ref=sr_1_4?dib=eyJ2IjoiMSJ9.crG5Gc54t3stjtfk3VpZLSnoUaDWYjG1z80eEWhOiyQDjg8rukbXC4-ZT82MqKy9M-KU54xb2_b70Qkw-sTyLAUcazXvkAjeVJbixqN70SldlDQz2eX_DpKYdnVn8AAToXZvSNvUK0IXLYyYq4NfIRBQzbBUz0WqI3yCIvAd93la4pcOq-vJB5No4ZzsV-Wji_3AZqaqF3RU-HHHP-hcnYASlusHpvZD5Ey3S0uTZX0.8nRBl2enrtWHKfRRD_ZF5b89wxUWVAPvFesAXMP5cG0&dib_tag=se&keywords=Weight+Sensor&qid=1758292111&sr=8-4

Load Cell Sensor,Micro Bellows Type Test Tension and Compression Force Weight Pressure Sensor,Accuracy 0.2% Stainless Steel with 2m Cable Range (0-30KG)

https://www.amazon.com/dp/B0DFWHKSXR/ref=sspa_dk_detail_0?pf_rd_p=7446a9d1-25fe-4460-b135-a60336bad2c9&pf_rd_r=ZTTKP2KBRKD9RJZ6GRD9&pd_rd_wg=9g4qh&pd_rd_w=sjlae&content-id=amzn1.sym.7446a9d1-25fe-4460-b135-a60336bad2c9&pd_rd_r=c254e59a-8c3a-4986-814c-2e3bd76916f8&sp_csd=d2lkZ2V0TmFtZT1zcF9kZXRhaWw&th=1

Conclusions/action items:

There are multiple options for the types of pressure sensors we could use

9/25/2025 Notes on Load Cell Wiring

Nial

Title: Notes on Load Cell Wiring

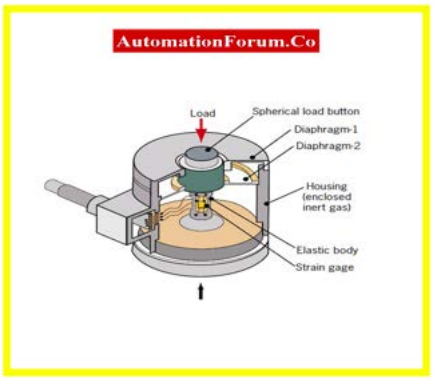
Date: 9/25/25

Content by: Nial Donohoo

Present: Nial Donohoo

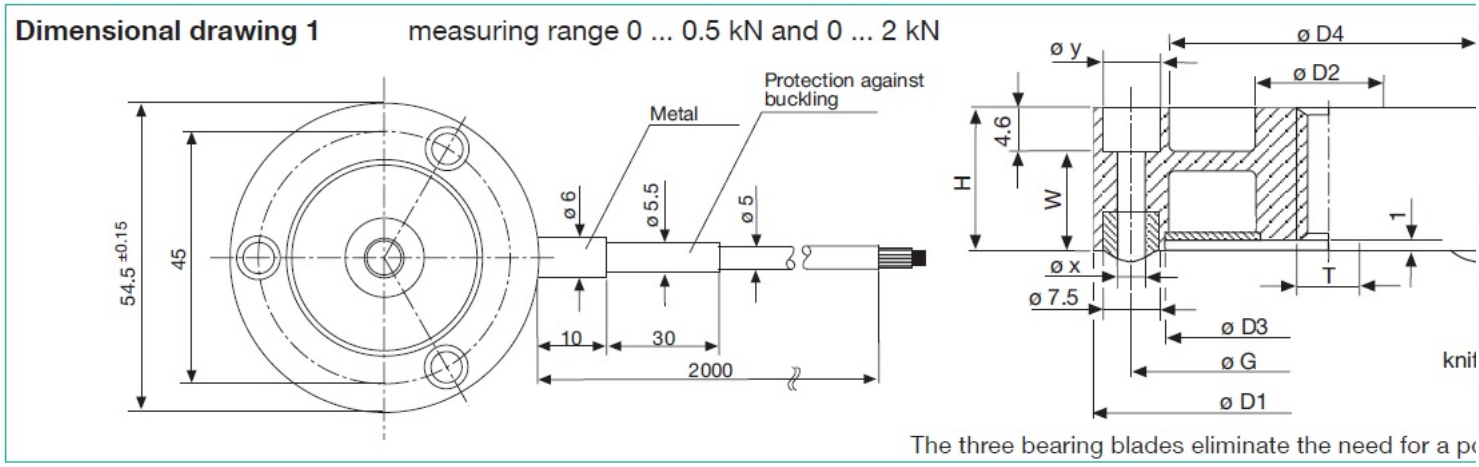
Goals: Understand more of how pancake compression load cells work and how to wire them.

Content:



https://automationforum.co/load-cell-working-principle/

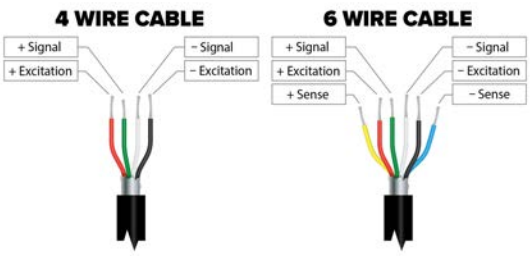
A strain gauge in a pancake load cell works by changing its electrical resistance as the cell's metal body deforms under compressive force, and this tiny resistance changeis converted into a volt load.



https://www.a-tech.ca/Product/Series/43/8524_Burster_Load_Cell_Miniature_Pancake/?tab=1

When a compressive force is applied: The central loading surface pushes down, causing minute elastic deformation of the cell's structure. This then deformation strains the bonded strain gauge circuit of four resistors or strain gauges usually arranged in a diamond that outputs a small voltage when the resistances change, allowing precise measurement of tiny resistance changes) conv signal proportional to the force that was applied.

Pancake load cells handle high weights with good accuracy, minimal error.



https://www.ricelake.com/resources/articles/the-basics-of-load-cell-wiring-and-trimming/

4-Wire Load Cell: Two wires for excitation (E+ / E–) and two for signal (S+ / S–). Simple, but cable resistance and temperature changes can cause small errors.

6-Wire Load Cell: Same four wires plus two “sense” wires that measure the actual excitation voltage at the cell. This lets the cell compensate for voltage drop, giving higher accuracy, especially

Conclusions/action items: Use this knowledge to make informed decisions when purchasing and wiring load cells to the walker.

10/17/25 Possible Lidar Sensors

Nial Donohoo - Oct 26, 2025, 7:59 PM CDT

Title: Possible Lidar Sensors

Date: 10/17/25

Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Find the best possible lidar sensor to use to measure distance accurately

Content:

50 m Laser Distance Measuring Sensor Module (Cheap/Entry Option)
- Price range: around US $40–90.
- Range & accuracy: Up to ~50 m (~164 ft). Accuracy spec is weak or minimally published (e.g., ±1 mm claimed in one listing for a related sensor)

Garmin LIDAR-Lite v3 (Mid Option)
- Price range: around US $130 (some ~$129.99) for the unit.
- Range & accuracy: Up to ~40 m (~131 ft) per specs. Accuracy ±2.5 cm at distances >1 m.

Benewake TF03 100 m (Mid Option)
- Price range: Around US $178–270.
- Range & accuracy: Up to ~100 m (~328 ft) in one variant. Repeatability ~<3 cm 1σ for TF03-100 version.

Benewake TF350 (Long-Range Option)
- Price range: Around US $500–900 depending on variant.
- Range & accuracy: Up to ~350 m (some spec sheets list ~180 m for certain config) with good accuracy (about ±0.1 m for some specs)

Conclusions/action items: Decide on a lidar sensor with my team and order it!

10/26/2025 Battery

Nial Donohoo

Title: What Battery Should We Use?

Date: 10/26/2025

Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Figure out what type of battery we should use to power our project

Content:

Below is the link of the type of battery last eyars group used to power their smart walker project. They used a KBT lithium-ion battery (12V, 2400mAh)

https://www.amazon.com/KBT-2400mAh-Rechargeable-Replacement-Compatible/dp/B0C241NS29/ref=sr_1_1_sspa?
crid=3SWXC1CP6E2IP&dib=eyJ2IjoiMSJ9.npOz96XuTBZqkAx6xYKRfyzIfDv0xkrtPMhz_2W4vOXGjHj071QN20LucGBJIEps.12uF0WJPev6GTK6igs5mvzmRkt6g1gFcIYyLfQRNUq4&dib_tag=
ion%2Bbattery%2B(12V%2C%2B2400mAh)&qid=1761527634&sprefix=kbt%2Blithium-ion%2Bbattery%2B12v%2C%2B2400mah%2B%2Caps%2C112&sr=8-1-spons&sp_csd=d2lkZ2V0TmFtZ

After doing additional research it is important that we find a battery that is rechargeable to sustain long term use of our project with out having to replace components. We also want a battery tha
least 30 minutes at a time.

Conclusions/action items:

11/25/25 How a Lidar Sensor Works

Nial Donohoo - Dec 10, 2025, 10:21 PM CST

Title: How a Lidar Sensor Works

Date: 11/25/25

Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Figure out how our lidar sensor works that way we can modify our housing.

Content:

A LiDAR sensor measures distances by using pulses of laser light:

1. **Emit Laser Pulses**
   The LiDAR unit sends out very fast, precise pulses of infrared or visible laser light into the surrounding environment.

2. **Detect Reflected Light**
   These pulses hit objects (walls, people, ground, etc.) and reflect back to the sensor's receiver.

3. **Calculate Distance**
   The sensor measures the **time of flight**—how long it takes each pulse to return.
   Since the speed of light is known, it calculates distance using:
   distance = (speed of light × time of flight) / 2

By repeating this thousands to millions of times per second while rotating or scanning, the LiDAR builds a **3D point cloud** representing the shape, position, and distance of objects in the environment.

Conclusions/action items: Modify our Electronics housing design with this knowledge in mind

9/25/25 Walker Pressure Sensor Design Idea

Nial Donohoo - Sep 25, 2025, 4:32 PM CDT

Title: Walker Pressure Sensor Design Idea

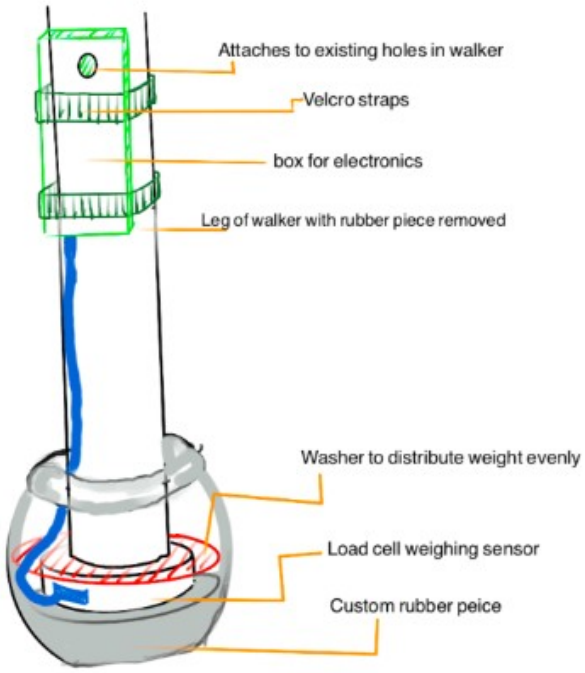
Date: 9/25/25

Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Design a leg for a walker that includes a load cell weighing sensor

Content:



Conclusions/action items: Talk about this design with my group and compare ideas

10/3/2025 CAD Drawing Tennis Baller

Nial Donohoo - Oct 03, 2025, 3:09 AM CDT

Title: CAD Drawing Tennis Baller Design

Date: 10/3/2025

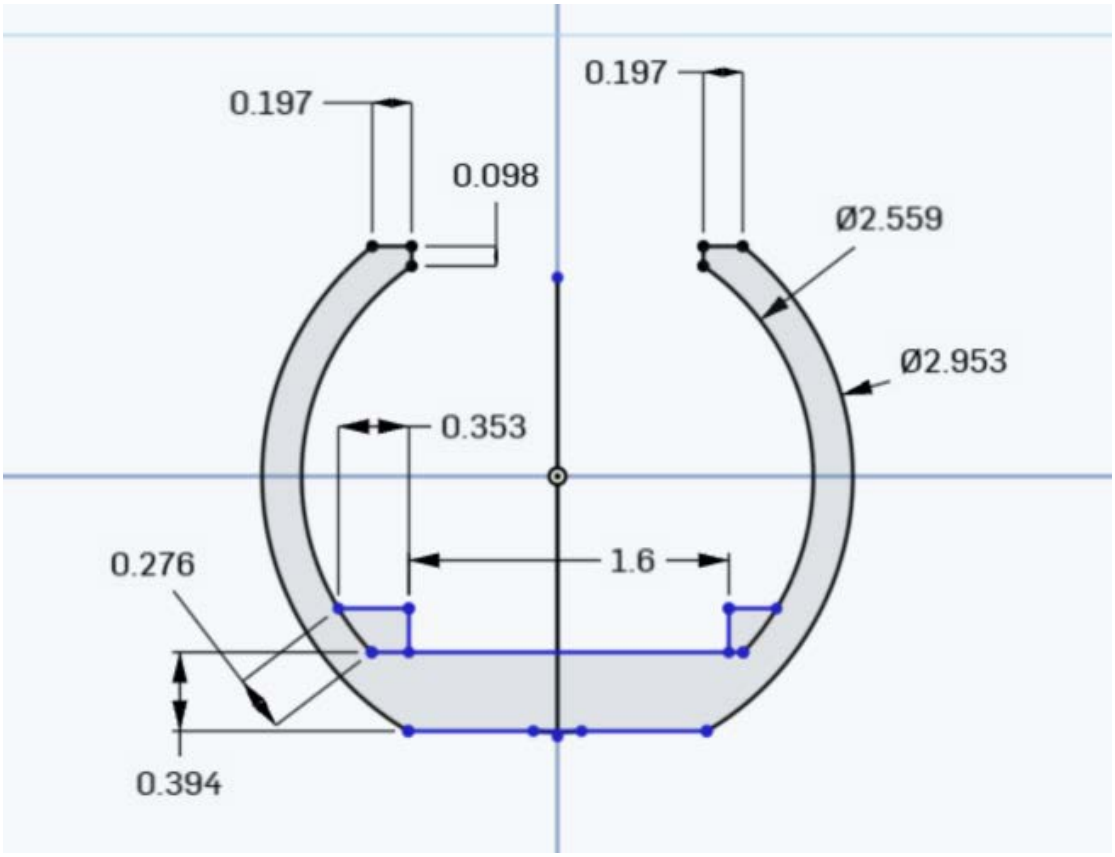
Content by: Nial Donohoo

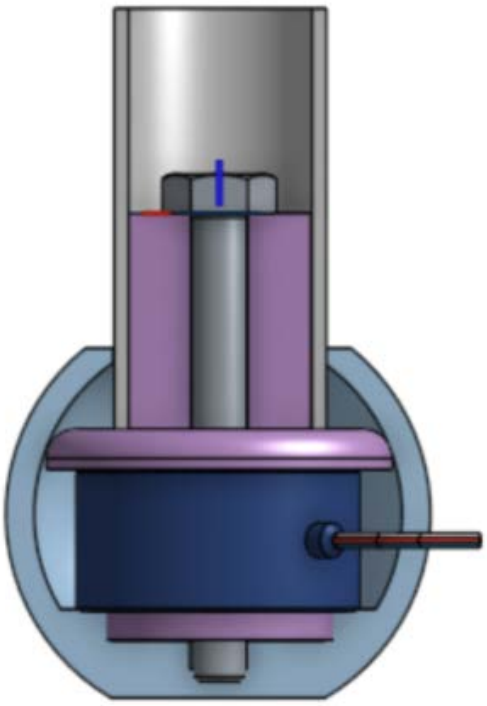
Present: Nial Donohoo

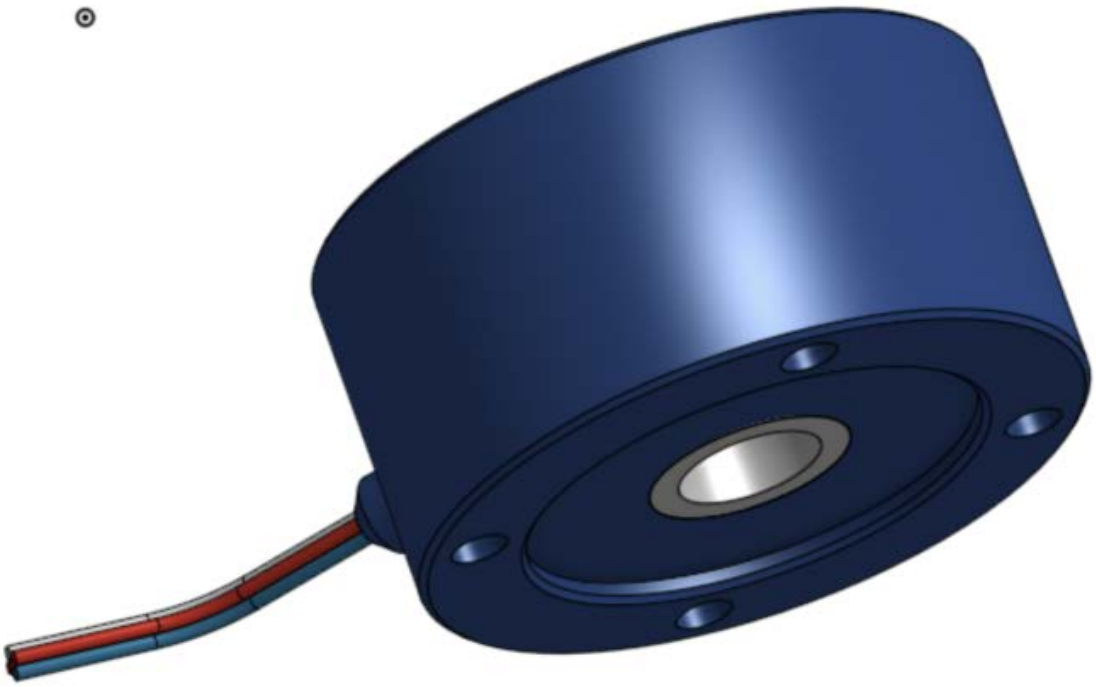
Goals: Create Cad Design to help visualize a potential design idea

Content:

https://cad.onshape.com/documents/a0b69a13ed12a048f9ee0d2b/w/a317e61d26d04eb17ca5e8a1/e/cb30ccc5e63cb38f49de7a9c?renderMode=0&uiState=68df840838f6aa72f8fb4867







Conclusions/action items: Work as a team to discuss best design ideas and make decisions on what might go into our final design and what we need to order

10/19/25 Load Cell Wiring

Nial Donohoo - Oct 26, 2025, 7:13 PM CDT

Title: Load Cell Wiring

Date: 10/19/2025

Content by: Nial Donohoo

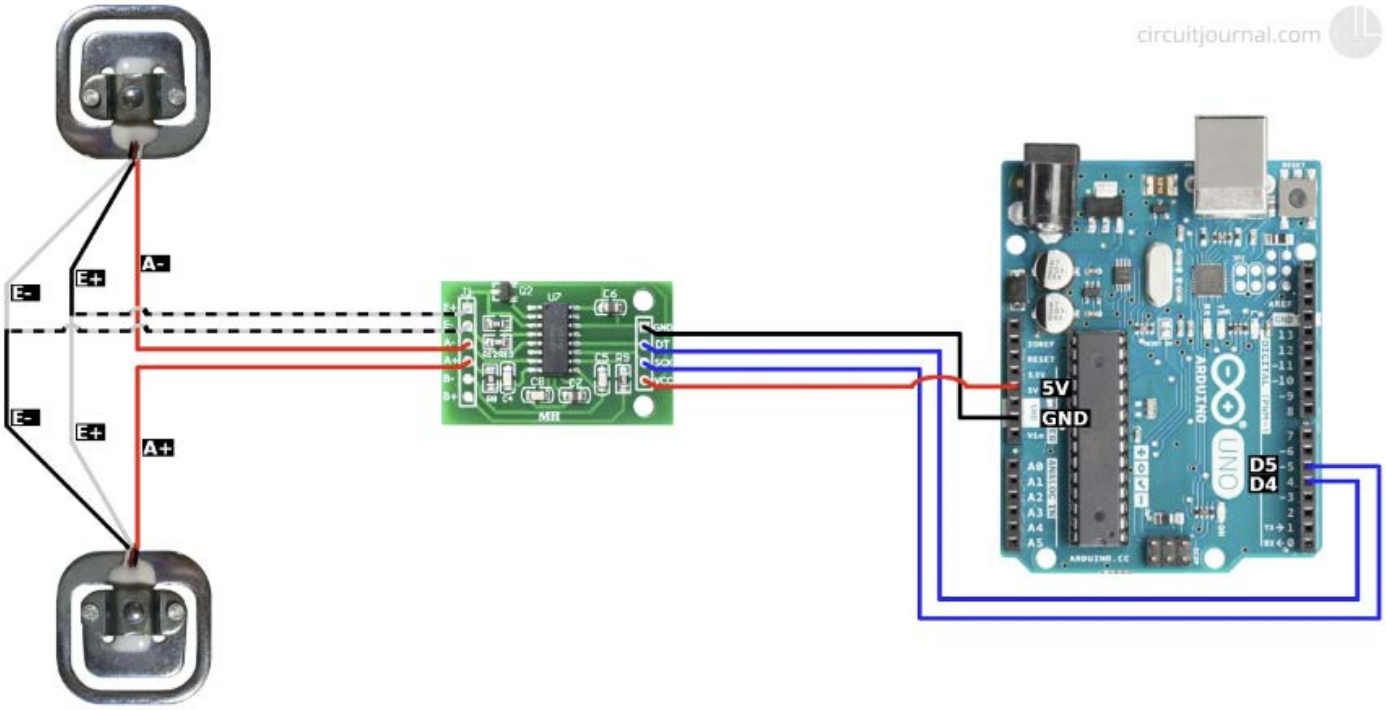
Present: Nial Donohoo

Goals: Figure out how to wire the load cells we bought to act in tandem and report accurate weights back to the code

Content:

https://circuitjournal.com/50kg-load-cells-with-HX711

This is the link to a website that has the information on how to connect 2 50kg load cells to act in tandem with an HX711 and connect to an Arduino Uno



This is the image of the wiring plan that we had. We set up our circuit according to this when we met as a group to try to hook up the pressure sensor to a computer and upload code however we had issues with getting the calibration value to be correct.

"

1. Connect the opposite sides of the outer wires (white and black) of the two load cells.

- Validate your wiring by measuring the resistance between the two connection points of the white-back wires pairs. It should be about 1k ohm.

- Then measure the resistance between the two red wires. It should also be about 1k ohm

2. Connect the outer wire pairs to E+ and E- output of the HX711 module.

- One white-black pair goes to the E+ and the other black-white pair to the E-.

- E+ and E- are the power wires for the cells. The polarity doesn't matter. Switching will only invert the calibration parameter in the software.

3. Connect the middle wires (red) of the load cells to the A+ and A- inputs of the HX711 module.

- A+ and A- are the measurement inputs from the cells. Like with the power wires, the polarity is not important.

4. Connect the GND of the HX711 module to the Arduino GND and VCC to the Arduino 5V pin.

- HX711 also works with 3.3V. So if you have some other microcontroller that runs on 3.3V, then you can use 3.3V instead of 5V.

6. Connect the DT and SCK of the HX711 module to any of the Arduino digital IO pins.

- In the schematic, I used pins 4 and 5, since those are the default pins for the examples of the "HX711_ADC" library.

- If you want to use interrupts to update scale data, then you should connect the DT output to an interrupt enabled pin of the Arduino. For Uno/Nano, those are pins 2 and 3.

"

Conclusions/action items: Figure out the issues with the code to make our pressure sensors work!

10/23/25 Lidar Wiring

Nial Donohoo - Oct 26, 2025, 8:09 PM CDT

Title: Lidar Wiring

Date: 10/23/25

Content by: Nial Donohoo

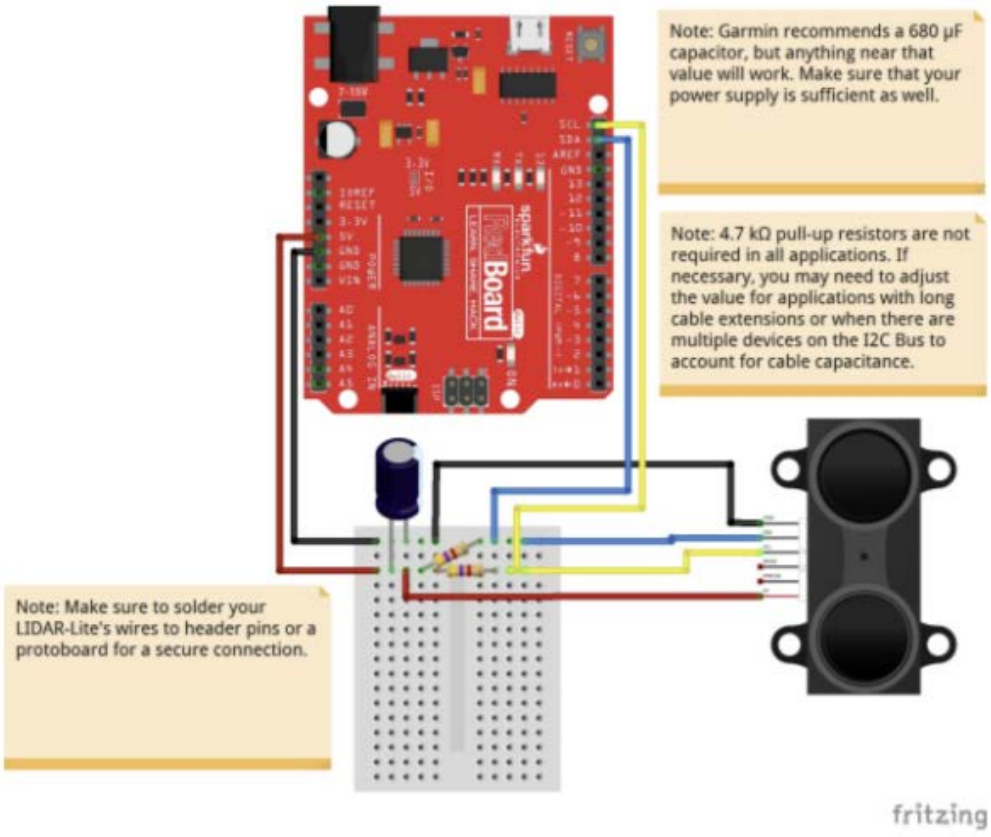
Present: Nial Donohoo

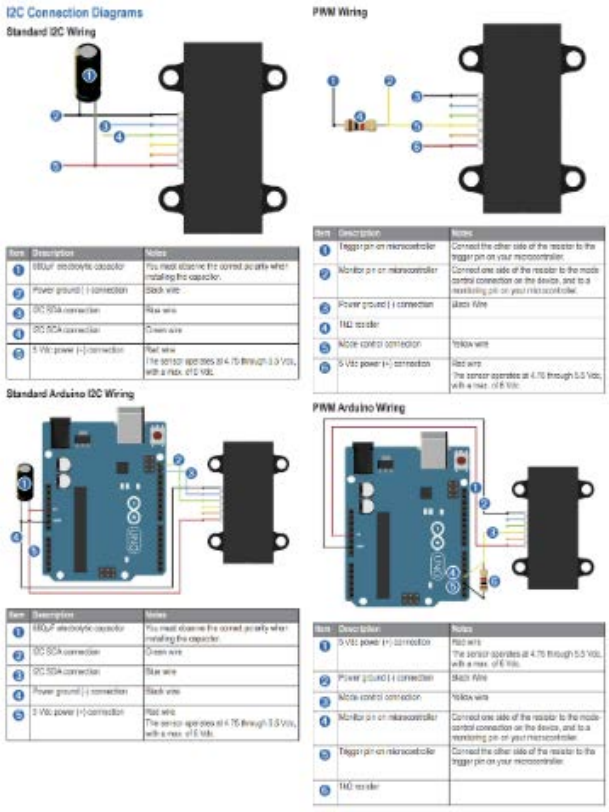
Goals: Learn how to wire the lidar sensor so that once it gets here we will be able to hook it up to the Arduino uno!

Content:

https://learn.sparkfun.com/tutorials/lidar-lite-v3-hookup-guide

This link is the hookup guide for the Lidar Lite V3





Lidar Lite V3 Operation Manuel: https://static.garmin.com/pumac/LIDAR_Lite_v3_Operation_Manual_and_Technical_Specifications.pdf

This is the wiring guide for different types of Arduino's however I couldn't find an example where someone hooked the lidar up to an Arduino uno.

Conclusions/action items: Use these as guides to help us wire the Lidar Sensor when it gets here!

10/23/25 Lidar Lite V3 Code

Nial Donohoo - Oct 26, 2025, 7:32 PM CDT

Title: Lidar Lite V3 Code

Date: 10/23/25

Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Find the code needed for the lidar sensor we ordered

Content:

Github library for the Arduino code: https://github.com/garmin/LIDARLite_Arduino_Library

Hookup guide for Lidar Lite V3: https://learn.sparkfun.com/tutorials/lidar-lite-v3-hookup-guide

Below is the code needed to connect the lidar to our Arduino, we need to paste this into an Arduino sketch:

```
/**
 * LIDARLite I2C Example
 * Author: Garmin
 * Modified by: Shawn Hymel (SparkFun Electronics)
 * Date: June 29, 2017
 *
 * Read distance from LIDAR-Lite v3 over I2C
 *
 * See the Operation Manual for wiring diagrams and more information:
 * http://static.garmin.com/pumac/LIDAR_Lite_v3_Operation_Manual_and_Technical_Specifications.pdf
 */

#include <Wire.h>
#include <LIDARLite.h>

// Globals
LIDARLite lidarLite;
int cal_cnt = 0;

void setup()
{
  Serial.begin(9600); // Initialize serial connection to display distance readings

  lidarLite.begin(0, true); // Set configuration to default and I2C to 400 kHz
  lidarLite.configure(0); // Change this number to try out alternate configurations
}

void loop()
{
  int dist;

  // At the beginning of every 100 readings,
  // take a measurement with receiver bias correction
  if ( cal_cnt == 0 ) {
    dist = lidarLite.distance();      // With bias correction
  } else {
    dist = lidarLite.distance(false); // Without bias correction
  }

  // Increment reading counter
  cal_cnt++;
  cal_cnt = cal_cnt % 100;
```

```
  // Display distance
  Serial.print(dist);
  Serial.println(" cm");

  delay(10);
}
```

Conclusions/action items: Test the code with the lidar sensor and make any necessary modifications

10/26/25 Drawing of Where Wires Go

Nial Donohoo - Oct 26, 2025, 8:55 PM CDT

Title: Drawing of Where Wires Go

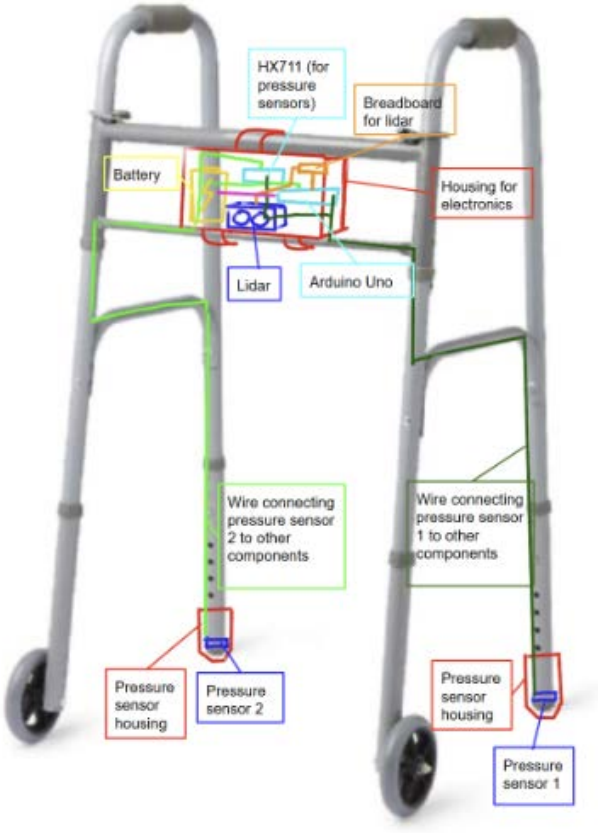
Date: 10/26/2025

Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Understand how different components of our walker will fit together

Content:



* This image does not include a component to hold a phone or connect to Bluetooth because we have not finalized the designs on how those pieces will work.

Conclusions/action items: Use this general idea to identify missing components and finalize cad model of component housing.

10/26/2025 Preliminary Onshape Drawing of Component Housing

Nial Donohoo - Oct 26, 2025, 9:19 PM CDT

Title: Preliminary Drawing of Onshape Component Housing

Date: 10/26/2025

Content by: Nial Donohoo

Present: Nial Donohoo

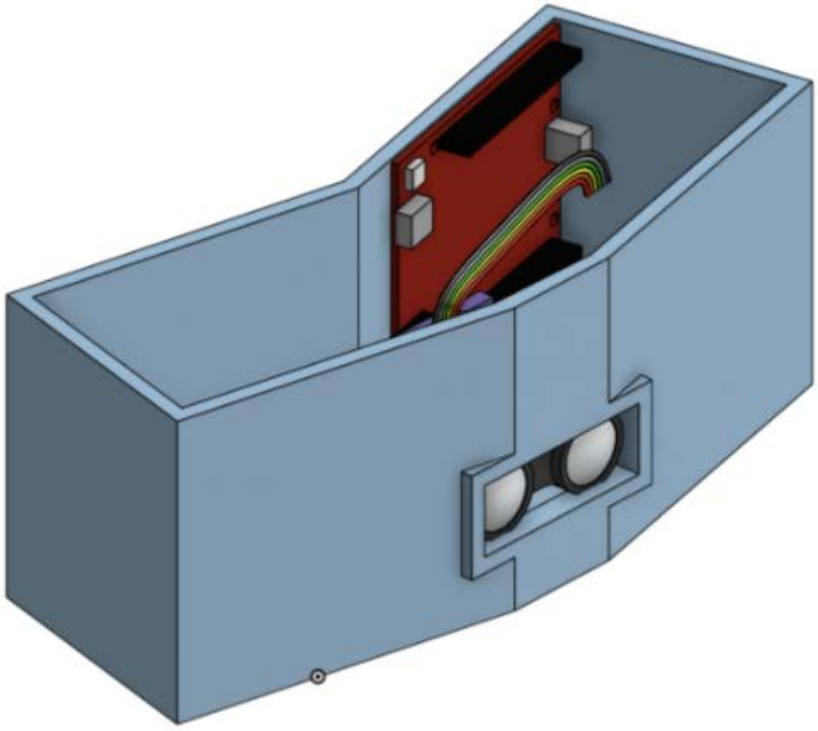
Goals: Get a basic idea of what component need to go in the component housing box on the walker

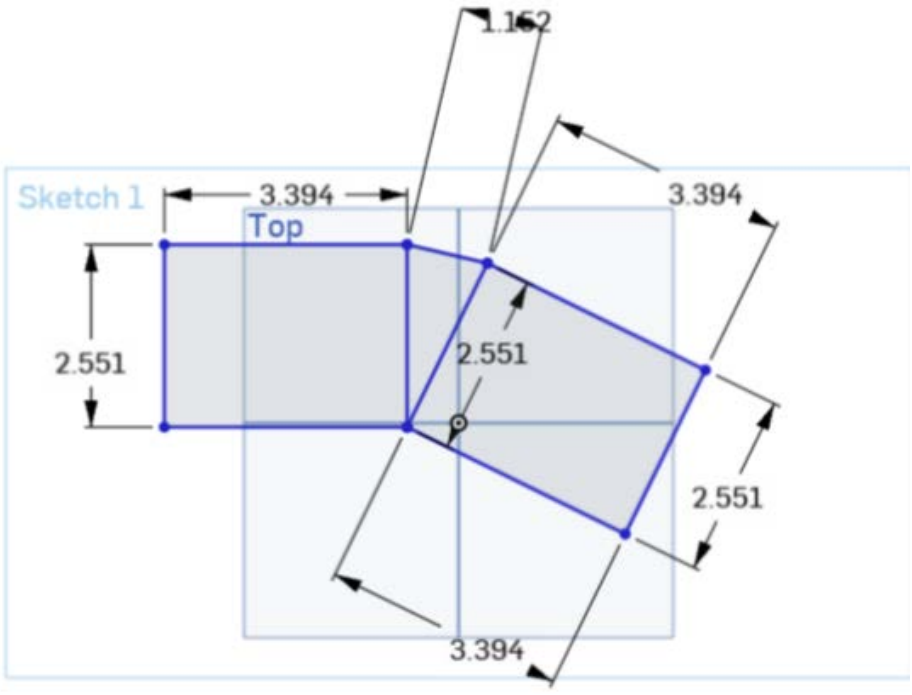
Content:

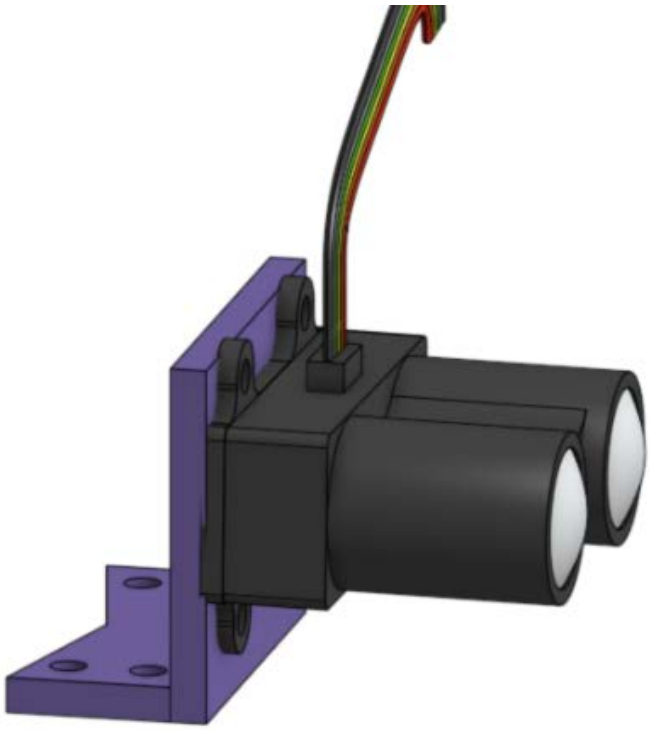
Limitations:

- We haven't decided on what kind of battery we will use

- We haven't decided how we will connect Bluetooth or what we need to do for that




1.162
Sketch 1
3.394
Top
3.394
2.551
2.551
2.551
3.394



https://cad.onshape.com/documents/85025c69c30cac776474dcad/w/d281f783a65ecb34513f842e/e/25c24b476cf60e006710967e?renderMode=0&uiState=68fed6883c0ce165ee661ba9

Conclusions/action items: Finalize the CAD drawing and add the other components

11/6/2025 Housing Attachment Clamp

Nial Donohoo - Nov 06, 2025, 5:56 PM CST

Title: Housing Attachment

Date: 11/6/2025

Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Find attachment options to attach the housing to the rest of the walker.

Content:

There are two widths of bars that the housing component will need to attach to. We have extra of the 1 in diameter attachments from last years project but will need to order more to attach to the 1/2 inch section of the bar

https://www.amazon.com/gp/aw/d/B01HPE185Y/?_encoding=UTF8&pd_rd_plhdr=t&aaxitk=e9bd44a1bbfeb3e53918a91904fa8e4b&hsa_cr_id=4626046920401&qid=1762472526&sr=1-1-9e67e56a-6f64-441f-a281-df67fc737124&ref_=sbx_be_s_sparkle_mcd_asin_0_img&pd_rd_w=PTelR&content-id=amzn1.sym.9f2b2b9e-47e9-4764-a4dc-2be2f6fca36d%3Aamzn1.sym.9f2b2b9e-47e9-4764-a4dc-2be2f6fca36d&pf_rd_p=9f2b2b9e-47e9-4764-a4dc-2be2f6fca36d&pf_rd_r=Y0ZCX7NTQGWSXG5TPZQQ&pd_rd_wg=WSq2z&pd_rd_r=200b12c4-4d76-45c1-94c2-5b4e4116486e&th=1

Conclusions/action items: Order the parts!!

11/16/25 Laser Pointer to buy

Nial Donohoo - Nov 06, 2025, 6:17 PM

Title: Laser pointer to buy

Date: 11/6/2025

Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Find a Laser pointer help us find where the lidar sensor is pointing

Content:

https://www.amazon.com/IVVTRYI-Rechargeable-Flashlight-Presentations-Construction/dp/B0DD74Y4LW/ref=sr_1_4?crid=HYKYF6C26M6Y&dib=eyJ2IjoiMSJ9.xNiM7Fp5nedfWPijMutjbttS2aOsSqyD-9ciQ_o6bjjz797zN60O-GEZoYxDDV1KzMkRZCflkB95b8WsjaZbu8z1AhJZcT5pHdySC8qcNeSzn4thY0ZQvt3soL01qjX7VV3XgTjxsGlQGa6xA3WwbfKy9sldm4mJ5jl9_vBqs6NyoGaA3n5vlM33Y7tdNa389xmFuZ9sZdjQQKDGa4bkqPuy4hA3WXhZKoI.AkLWhc-Kzg6sgDsxLdj-OD5ESQKrNpt1r4y6e6REVkY&dib_tag=se&keywords=lazer%2Bpointer%2B150%2Bfeet&qid=1762472073&sprefix=lazer%2Bpointer%2B150%2Bfeet%2Caps%2C104&sr=8-4&th=1

Conclusions/action items: Buy a laser pointer and incorporate it into the housing!

11/18/25 Housing Components for first 3D print

Nial Donohoo - Nov 18, 2025, 9:55 AM CST

Title:

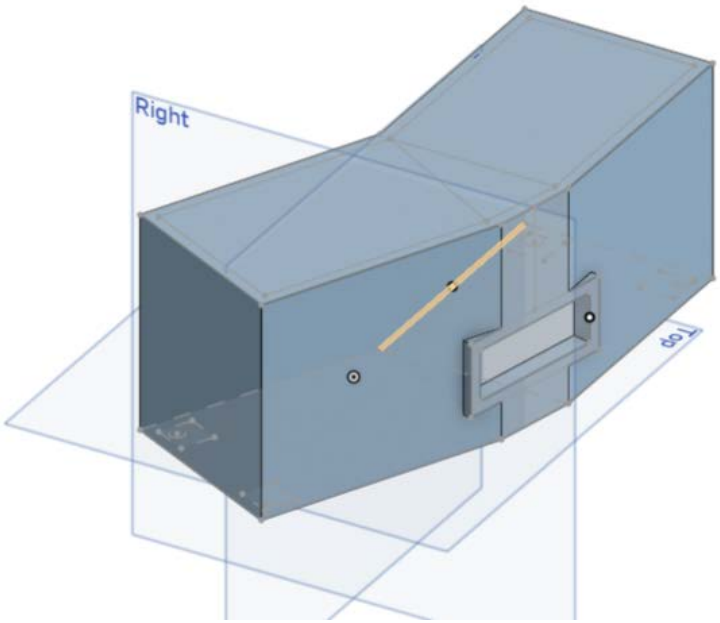
Date: 11/18/25

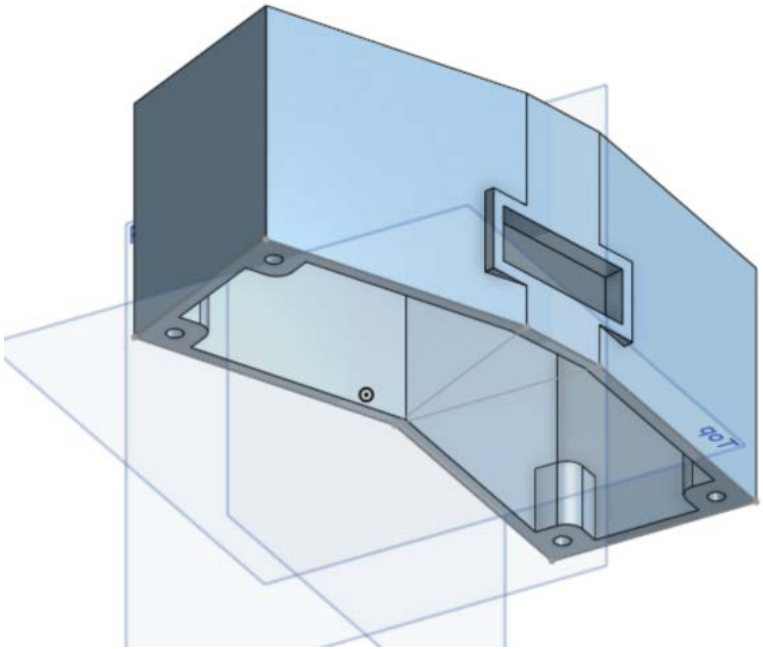
Content by: Nial Donohoo

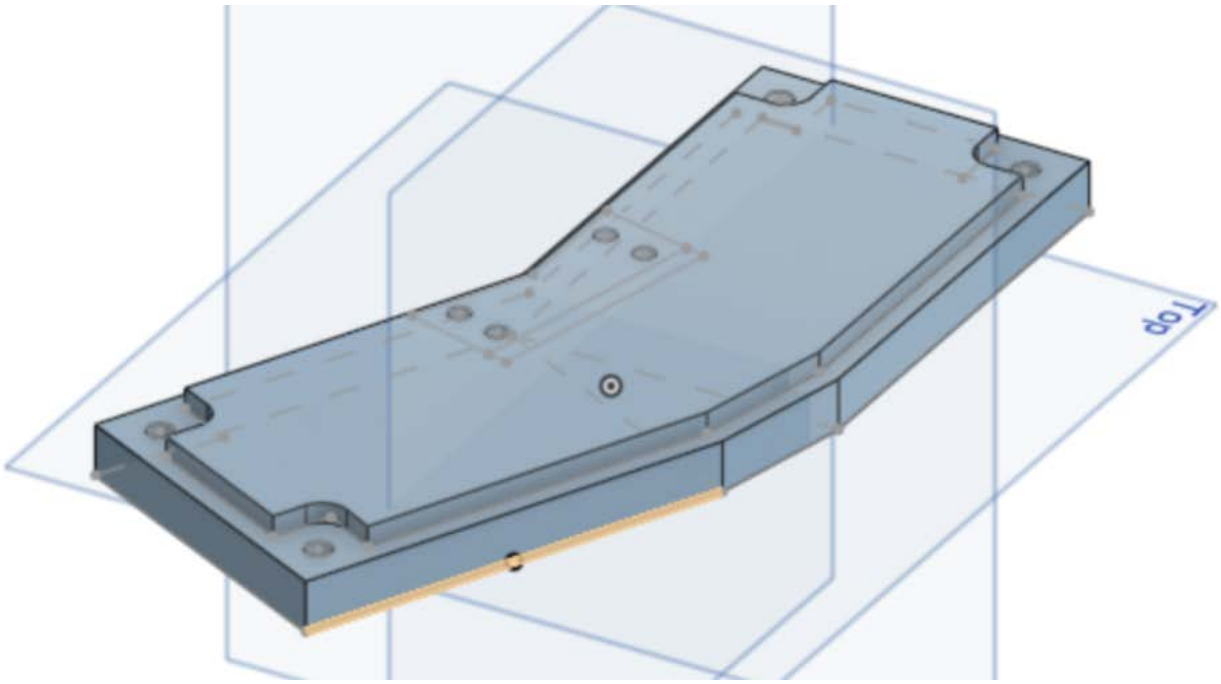
Present: Nial Donohoo

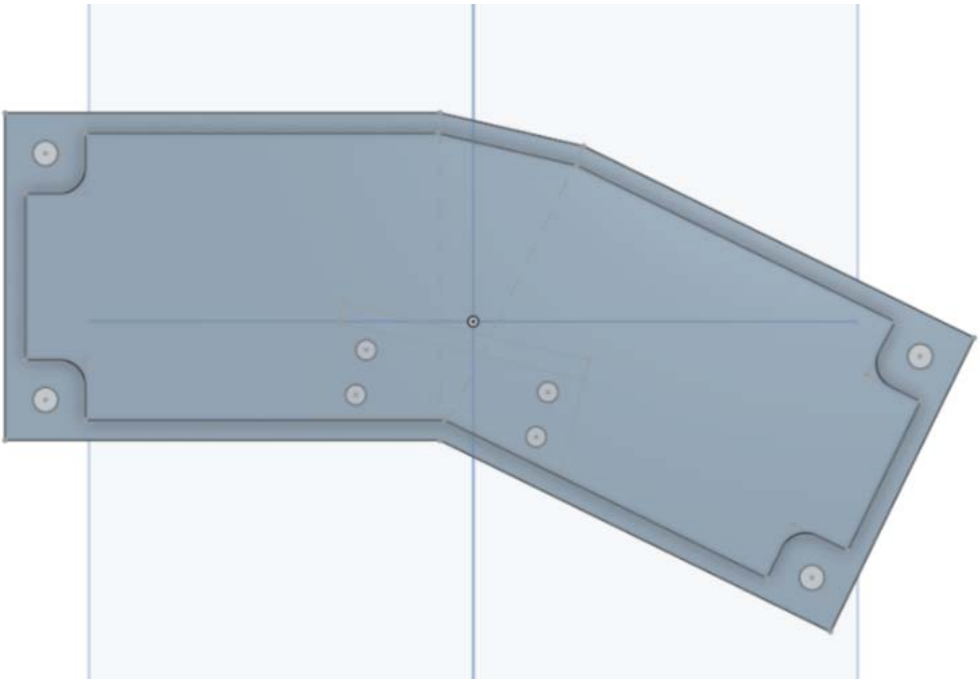
Goals: 3D print housing for electronics

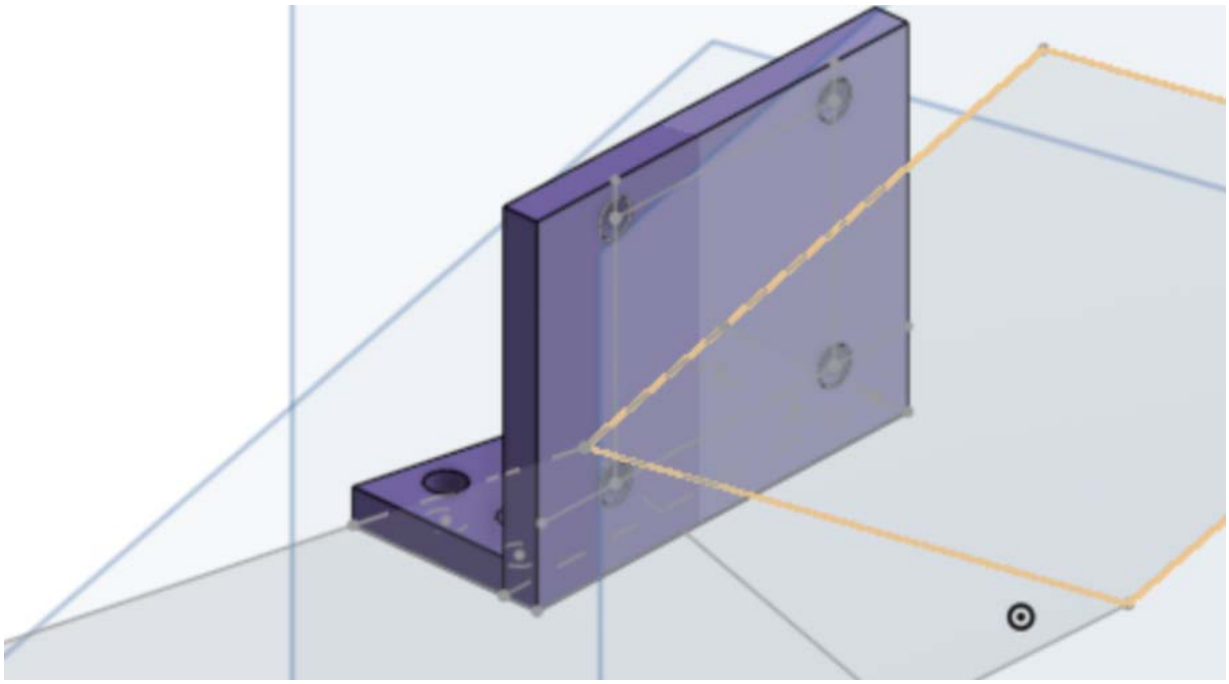
Content:

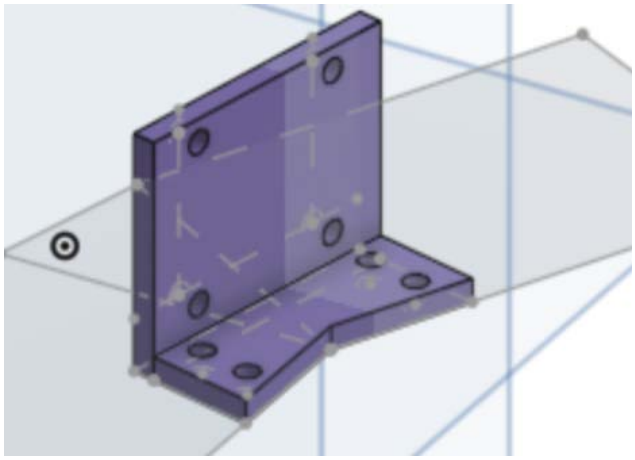





Top







Conclusions/action items: Need to try to fit all the electronics in it and add attachment points to add to the lidar

11/24/25 Lidar Print V2

Nial Donohoo - Dec 03, 2025, 6:08 PM CST

Title: Lidar Print V2

Date: 11/12/25

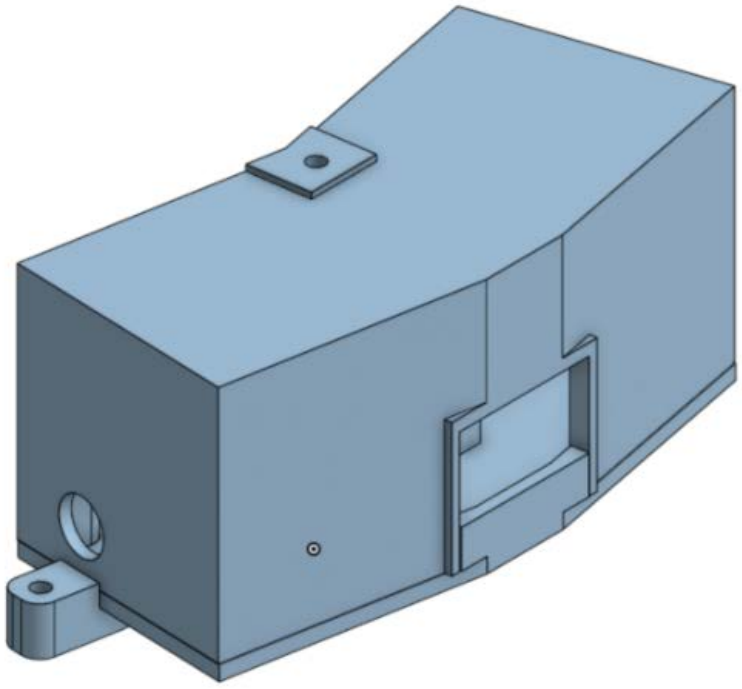
Content by: Nial Donohoo

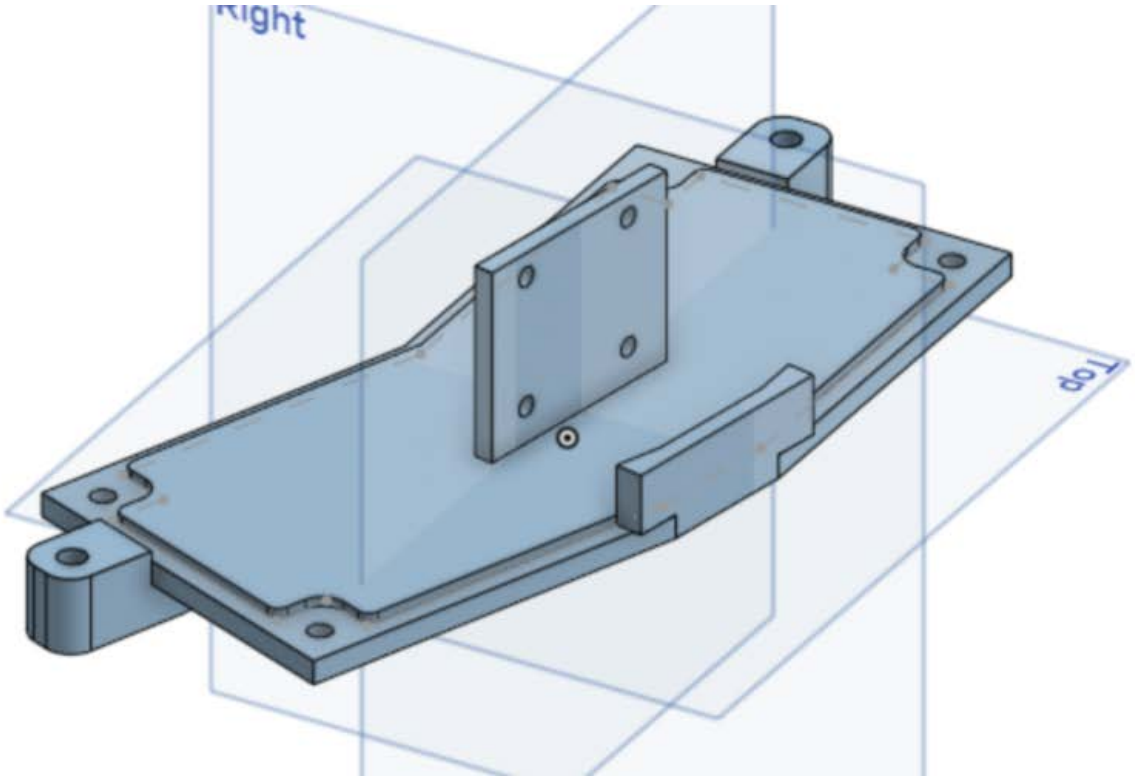
Present: Nial Donohoo

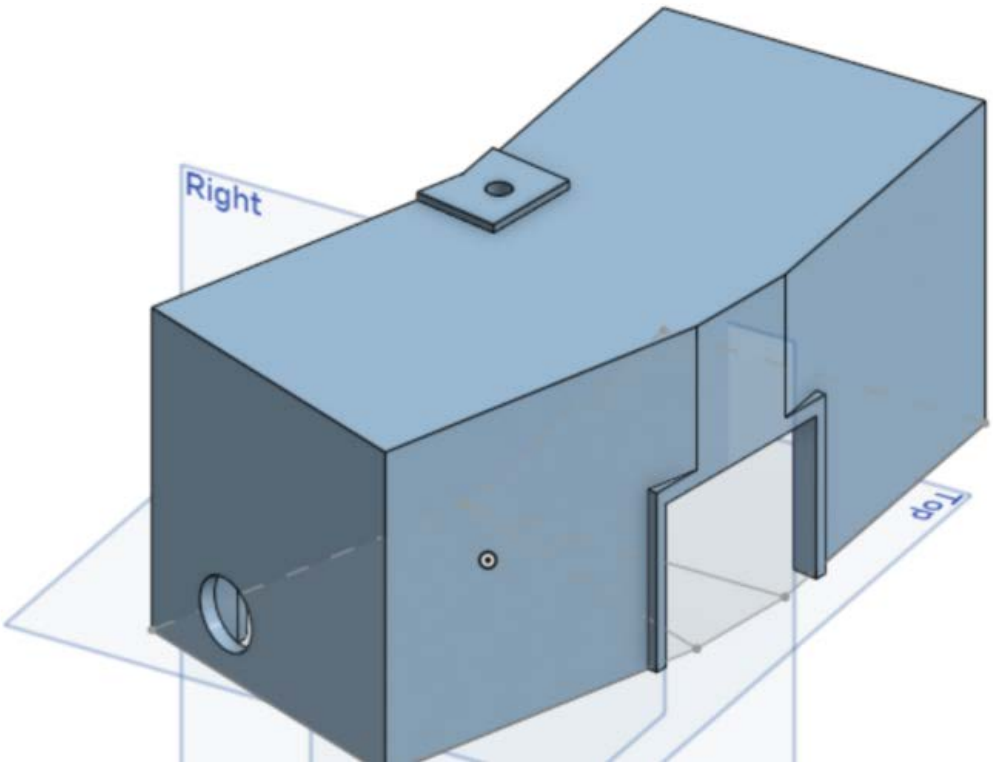
Goals: Print out the Lidar Housing!

Content:

https://cad.onshape.com/documents/ea38da0845fd917062dd39b7/w/e287286ae802fb27528f5fd4/e/36b1fcc7e2002916f11347db?renderMode=0&uiState=6930d098a308cf374b28138c







Conclusions/action items: Use the 3D print of the Lidar housing to make any necessary modifications to the design.

12/1/25 Lidar Print V3

Nial Donohoo - Dec 03, 2025, 6:13 PM CST

Title: Lidar Print V3

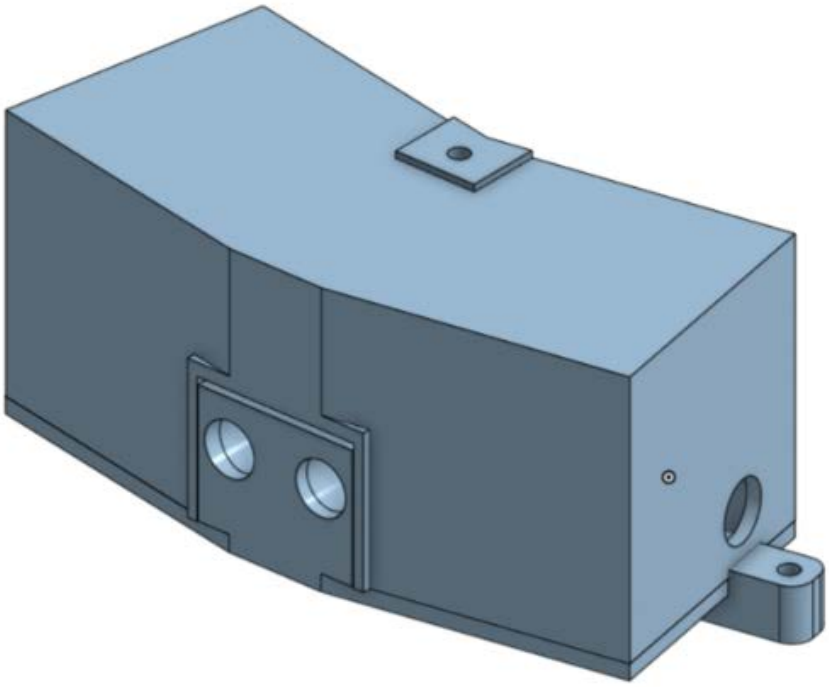
Date: 12/1/25

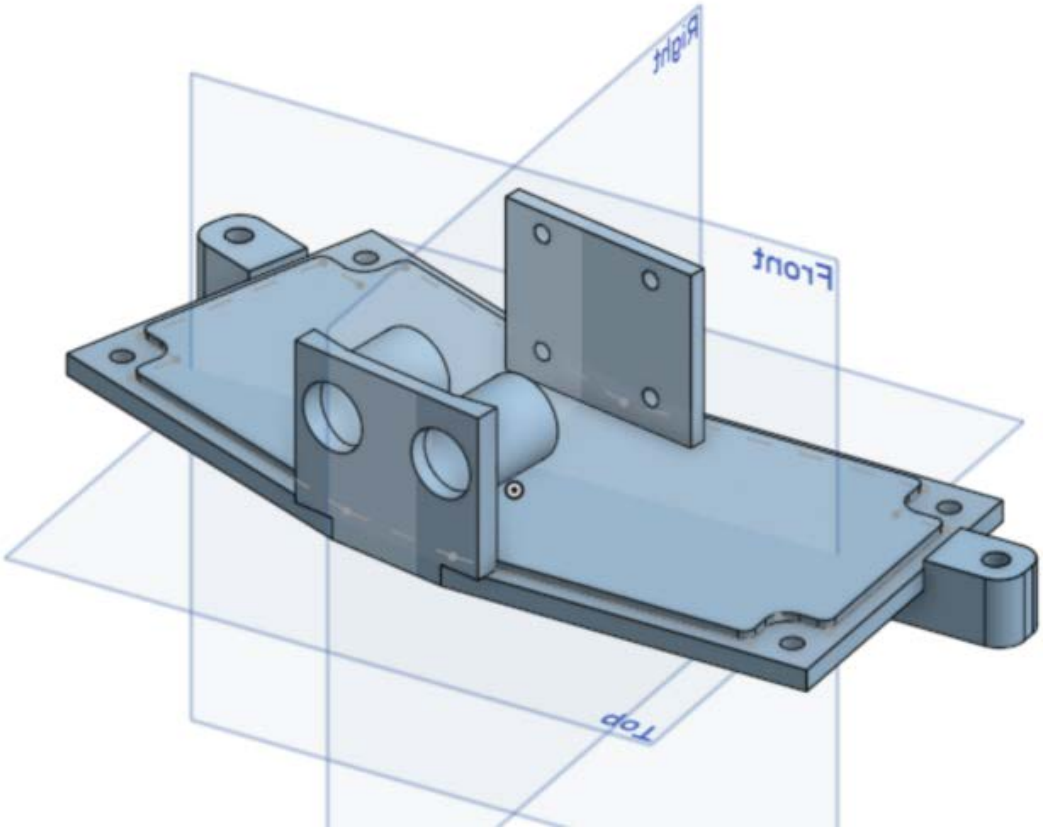
Content by: Nial Donohoo

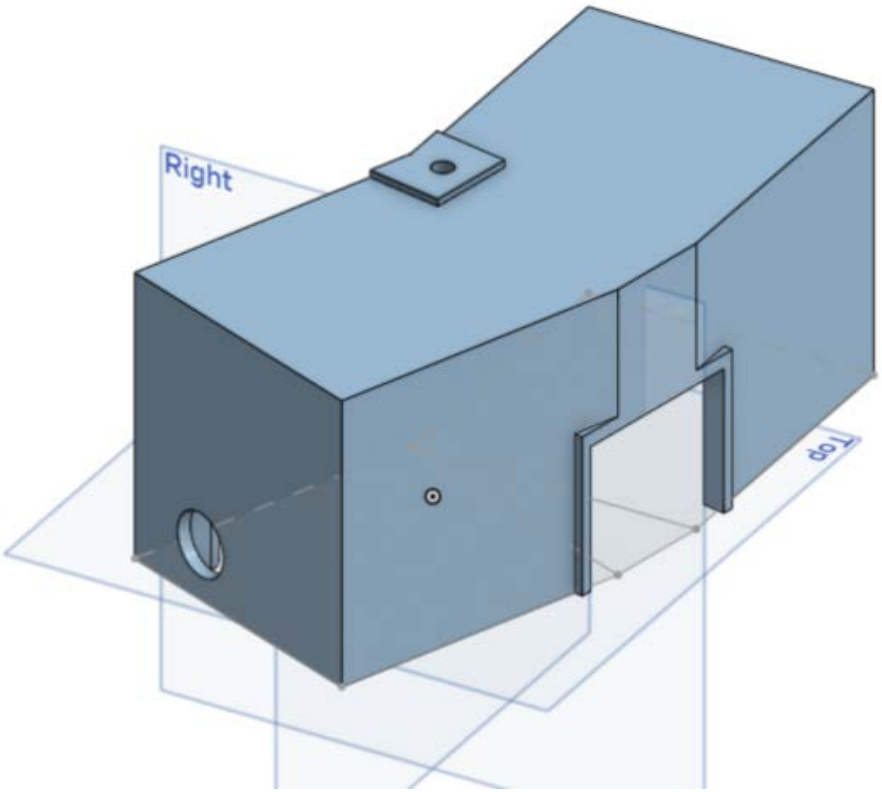
Present: Nial Donohoo

Goals: Add focus scopes to the lidar sensor that way it is able to look down narrow hallways with out hitting the walls.

Content:




Right
Front
Top



Conclusions/action items: Use this 3D print to test the Lidar sensor and then assemble the walker!

10/29/25 Training Documentation

Nial Donohoo - Oct 31, 2025, 4:13 PM CDT

Title: Training Documentation

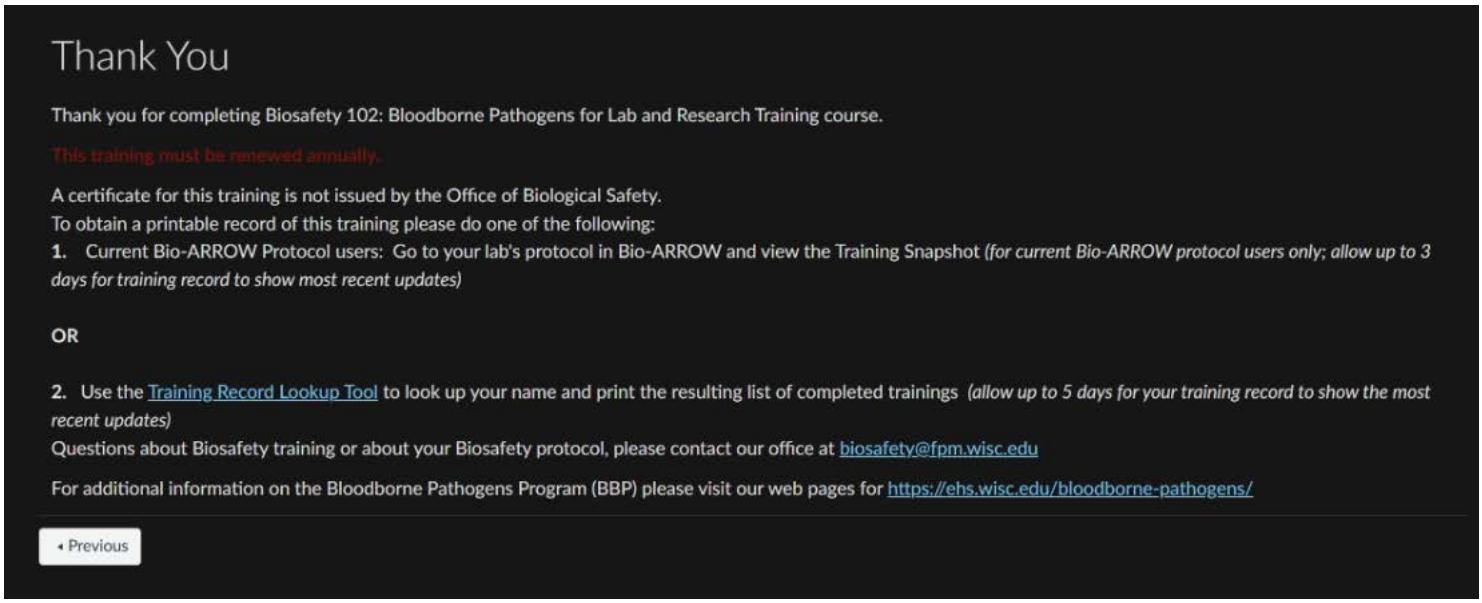
Date: 10/29/25

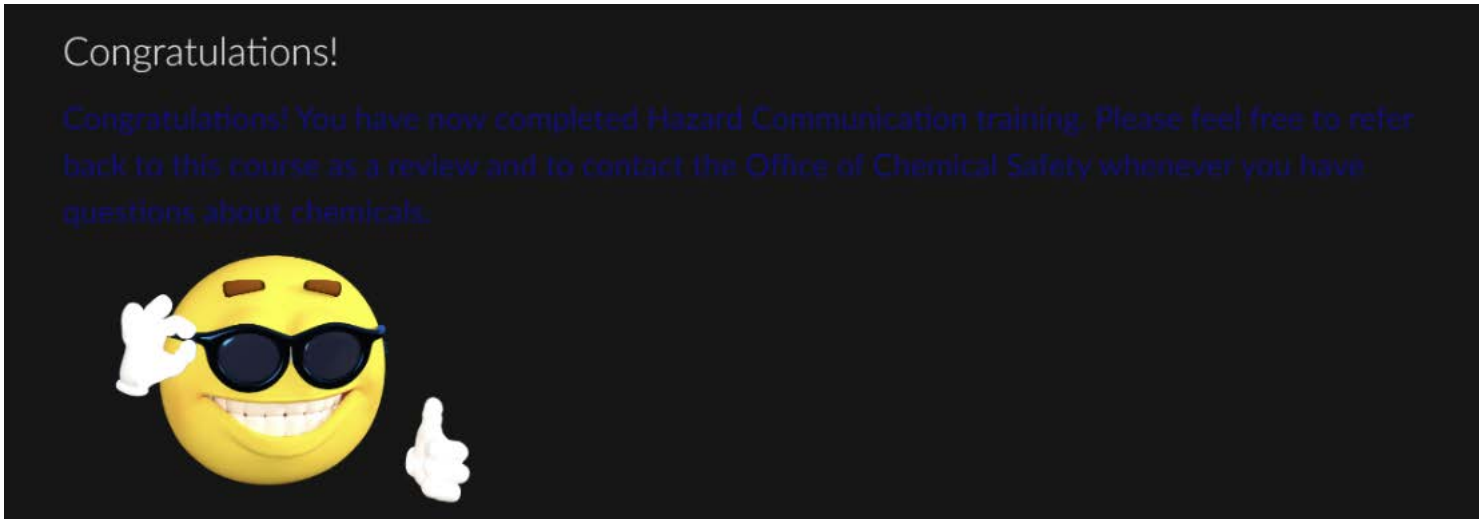
Content by: Nial Donohoo

Present: Nial Donohoo

Goals: Complete the required trainings for BME 200!

Content:





Conclusions/action items: I plan to use the information from these trainings as we work to complete our project.

9/11/25 Past Progress

NICOLAS MALDONADO - Sep 11, 2025, 12:52 PM CDT

Title: Handoff Plan

Date: 9/11/25

Content by: Nicolas Maldonado

Present: Nicolas Maldonado

Goals: Catch up with past work

Content:

Goal

Measure walking distance, average speed, and applied load using a standard walker for stroke rehab. Real-time display on the walker. Forward motion only, turns ignored. Target hallway trials up to about 100 ft.

User need

Therapists need quick, objective feedback on distance, speed, and loading during rehab sessions. A standard walker with embedded sensing simplifies setup in clinics and at home.

System overview

• Sensing: four load sensors integrated into the legs, one IR wheel sensor for distance and speed.

• Compute: Raspberry Pi Pico on perfboards.

• UI: OLED displays near the left handle plus a trial start switch.

• Wiring: routed inside tubing to avoid gait interference.

• Housing: printed enclosure mounted to front crossbars.

Hardware

1. Four load sensors mounted in the legs with printed holders and C-ring retention.
2. IR reflective wheel sensor aligned to a marked front wheel.

3. Raspberry Pi Pico on perfboards with op-amps, regulators, and screw terminals.
4. OLED near the left handle, start switch, and front housing clamped to crossbars.
5. Internal wiring pulls through tubing with a conduit near the housing.

Calibration and testing

1. Load calibration with incremental weights and quadratic fit per system.
2. Distance and average speed trials at 50, 100, 150 ft across three target speeds.
3. Instantaneous speed segment tests at 10, 20, 30 ft.
4. Load validation against in-ground force plates.

Performance reported

1. Distance error about 1.25 percent.
2. Average speed error about 1.20 percent.
3. Instantaneous speed error about 20.6 percent.
4. Load error about 2.4 percent vs force plates.
5. Noise present in dynamic load signals. One OLED failed during testing.

Immediate actions (week 1)

Bench verification

1. Inspect all solder joints, headers, and screw terminals. Reflow any dull or cracked joints.
2. Replace the failed OLED with the same model number. Confirm I2C address and pull-ups.
3. Confirm IR sensor alignment and standoff to the wheel. Target 1–3 mm gap, centered on strip.
4. Check all fasteners on load holders. Add threadlocker where metal meets metal.
5. Inspect internal wiring for insulation nicks and tight bends. Add heat-shrink at exits.

Firmware snapshot

1. Freeze current code and configuration in a versioned folder. Tag with date and device ID.
2. Log raw ADC for all load channels and raw IR transitions at full sampling for one hallway session. Save to CSV.
3. Confirm load calibration coefficients in code match the latest spreadsheet.

Expert recommendations to improve accuracy and robustness

Signal acquisition and filtering

1. Sampling rates
   • Load channels: 200–500 Hz. This covers gait dynamics while controlling CPU load.
   • Wheel sensor: interrupt on edges with microsecond timestamps.

2. Analog front end
   • Use an instrumentation amplifier per leg (e.g., INA333/INA826). Gain so peak loads map to 70–90 percent of ADC full-scale at 3.3 V.
   • Add an RC anti-alias filter per channel with fc near 50–75 Hz.

3. Digital filtering
   • Apply a 2nd-order low-pass IIR or a 9–15 sample moving average on load channels. Start with fc 6–8 Hz.
   • Add a median filter of size 3 on load for spike suppression.
   • Timestamp all samples. Avoid blocking delays.

4. ADC strategy on Pico
   • Average 8–16 oversamples per reading to reduce quantization noise.
   • Calibrate ADC reference by measuring an internal or external known source.

Distance and speed measurement

1. Wheel circumference
   • Measure effective circumference under typical user load. Roll 10 wheel turns under load over tape on the floor and compute average. Store in firmware.

2. Sensing approach
   • Increase events per revolution to reduce instantaneous error. Options:
   a) Add 8–16 evenly spaced reflective strips.
   b) Switch to a magnet + Hall sensor with 6–12 magnets on the wheel.
   c) Use a low-profile encoder ring (20–40 CPR) if space allows.

3. Instantaneous speed calculation
   • Compute speed from time over the last 5–10 edges. Use a sliding window of 150–300 ms.
   • Apply exponential smoothing with α between 0.2 and 0.4 for the display value.
   • Add hysteresis on the IR comparator or use digital Schmitt triggering to reduce chatter.

4. Motion logic
   • Forward-only logic stays. Ignore reversals and tight turns by gating on heading change or speed threshold <0.1 m/s for stop.

Load measurement

1. Zeroing and drift
   • Tare loads at trial start with the walker lifted. Record zero offset per leg.
   • Log temperature and check drift across a 10–15 minute warmup. Add a temperature term if drift exceeds 0.5 percent FS.

2. Combination logic
   • Report total applied load = sum of legs after tare.
   • Keep per-leg values available for diagnostics and asymmetry checks.

3. Calibration procedure upgrade
   • Use at least 7 weight points spanning 10–80 percent FS. Two repeats per point.
   • Fit linear and quadratic models. Select the lowest RMSE model. Store coefficients in nonvolatile memory with a version tag.

Firmware quality and safety

1. State machine
   • Implement explicit states: IDLE, READY, RUN, SUMMARY, FAULT.
   • Require a 1-second press to start RUN to avoid accidental starts.

2. Data integrity
   • Log raw and filtered streams at 50 Hz to CSV during validation runs.
   • Include firmware hash, calibration version, and test distance in headers.

3. Watchdog and brownout
   • Enable watchdog reset at 1–2 seconds.
   • Detect supply sag and pause sampling below 3.1 V to avoid corrupt reads.

User interface

1. Display layout
   • Top: Distance (in ft, 2-digit decimals).
   • Middle: Avg speed (m/s) and current speed (smoothed).
   • Bottom: Avg load and current load.
   • Update rates: distance 5 Hz, current speed 5 Hz, loads 10 Hz, averages each second.

2. Trial workflow
   • READY screen with battery and tare status.
   • RUN screen during trial.
   • SUMMARY screen with distance, avg speed, avg load, and trial time. Long-press to return to READY.

Mechanical and wiring

1. Strain relief
   • Add flexible grommets at all tube exits. Use silicone strain relief boots where wires meet the housing.
   • Route slack loops inside the housing, not inside moving tubes.

2. Holder stiffness
   • Check printer settings for 100 percent infill at fastener bosses. Increase wall count to 5+.
   • Add metal washers under bolts to distribute load.

3. Fastener torque map
   • Record torque values for each clamp and holder screw. Mark with torque paint for inspection.

Validation plan (weeks 2–3)

Distance and average speed

1. Distances 50, 100, 150 ft on level hallway. Three trials each at slow, comfortable, and brisk paces.

2. Targets: distance error ≤2 percent, average speed error ≤2 percent.

Instantaneous speed

1. Segment tests at 10, 20, 30 ft with reference timing gates or high-FPS video.
2. Target: instantaneous speed error ≤10 percent after sensing upgrade.

Load vs force plates

1. Five trials at three paces with synchronized timestamps. Compare average and peak loads.
2. Targets: average load error 2–3 percent, peak timing within 50 ms.

Reliability

1. Ten 100-ft runs with full UI use. Zero reboots, no data loss, no fastener loosening.
2. Battery test to low-voltage threshold. Log brownout behavior.

Documentation you need next

1. Latest calibration spreadsheet and coefficients used in firmware.
2. PCB or perfboard schematics, wiring list, and pin map for the Pico.
3. STLs and CAD for holders, housing, and display mount with version tags.
4. Latest firmware source with commit hash and build instructions.
5. Test datasets: raw and filtered CSVs, force-plate exports, and analysis scripts.

Risks and mitigations

1. Instantaneous speed error remains high with one stripe. Mitigate by increasing events per revolution and smoothing over multiple edges.
2. Load noise from mechanical play. Mitigate with stiffer holders, higher analog gain with proper headroom, and low-pass filtering near 6–8 Hz.
3. Wiring fatigue at tube exits. Mitigate with grommets, boots, and service loops.

Acceptance criteria for handoff

1. Distance error ≤2 percent over 50–150 ft across three paces.
2. Average speed error ≤2 percent across the same runs.
3. Instantaneous speed error ≤10 percent on 10–30 ft segments.
4. Average load error 2–3 percent vs force plates.
5. No UI freezes or watchdog resets during ten consecutive hallway runs.

Next steps for you

1. Run the bench and firmware checks, then collect one full validation session with raw logs.
2. Upgrade the wheel sensing to 8–16 events per revolution and retune smoothing.

3. Refit load filtering at 6–8 Hz and confirm amplifier gains.

4. Re-run the validation plan and record pass or fail against each target.

5. Lock a versioned release with updated calibration, firmware hash, and STL versions.

Conclusions/action items:

We have to go over all past work and verify that it is still valid. This is becuase if there is anything wrong with the past work, it will impede how we can continue. Also it is important to know what has already been done, in order to continue without repeating any steps.

9/11/25 Stroke Rehab in Adults

NICOLAS MALDONADO - Sep 11, 2025, 1:10 PM CDT

Title: Stroke Rehab

Date: 09/11/25

Content by: Nicolas Maldonado

Present: N/A

Goals: To familiarize with the current rehabilitation practices for strokes

Content:

- Scope includes inpatient, outpatient, and community phases. Uses AHA/ACC classes of recommendation and levels of evidence.
- Calls for a coordinated, multidisciplinary team with active patient and caregiver involvement.
- Stresses strong communication and workflow integration across disciplines and handoffs.
- Warns against under-resourcing rehab. Links adequate dose and duration to reduced downstream morbidity.

Conclusions/action items:

- Stand up a multidisciplinary stroke rehab team with clear roles and shared goals.
- Define communication protocols, documentation standards, and handoff checklists.
- Set therapy dose and duration targets and track delivery and tolerance.
- Plan transitions to home or community services with scheduled follow-up.
- Note and reference the 2017 corrections in formal citations.

Citation:

Winstein, C. J., Stein, J., Arena, R., Bates, B., Cherney, L. R., Cramer, S. C., Deruyter, F., Eng, J. J., Fisher, B., Harvey, R. L., Lang, C. E., MacKay-Lyons, M., Ottenbacher, K. J., Pugh, S., Reeves, M. J., Richards, L. G., Stiers, W., Zorowitz, R. D., & American Heart Association Stroke Council, Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, and Council on Quality of Care and Outcomes Research (2016). Guidelines for Adult Stroke Rehabilitation and Recovery: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke, 47(6), e98–e169. https://doi.org/10.1161/STR.0000000000000098

9/18/25 Components Initial Research

NICOLAS MALDONADO - Sep 18, 2025, 4:36 PM CDT

Title: Component Research - Initial

Date: 9/18/25

Content by: Nicolas maldonado

Present: N/A

Goals: Find components that work well in the design.

Content:

Pressure Sensors:

FSR 402:

Upside: Accurate, rated for up to 1000lbs, low profile

Downside: Very high cost, ~500 dollars

Load Cell - 50kg, Disc (TAS606):

Upside: rated for up to 50kg, small form factor, lower cost than other load cell

Downside: high cost ~100 dollars

Motion Tracker:

accel + gyro:

https://www.digikey.com/en/products/filter/motion-sensors/imus-inertial-measurement-units/567

Upside: Cheap, accurate

Downside: Can drift over time and become less accurate

Wheel encoder:

https://www.sparkfun.com/wheel-encoder-kit.html

Pros: Very accurate for distance/speed, doesn't drift.

Cons: Only works if your walker is wheeled. Won't capture acceleration unless paired with IMU.

Hybrid Approach:

Core sensor: A 6-DoF or 9-DoF IMU (e.g., LSM6DSOX or BNO055) → measures acceleration and gives smoothed speed estimates.

Optional add-on: If walker has wheels, add a rotary encoder to eliminate drift for distance/speed.

System integration: Microcontroller (ESP32 or TinyPICO like you're already using) collects data and fuses it.

Conclusions/action items:

11/05/25 Arduino and load cells

NICOLAS MALDONADO - Nov 06, 2025, 2:56 PM CST

Title: Ardino and load cells

Date: 11/05/25

Content by: Nicolas Maldonado

Present: N/A

Goals: N/A

Content:

The library's primary purpose is to make it straightforward to integrate load cells into Arduino projects. It handles communication with the HX711 chip, converts analog signals into readable digital values, and includes built-in calibration and noise reduction methods. It allows for accurate and stable weight readings without requiring users to write low-level code.

Key Folders and Files

- **examples/** – contains sample Arduino sketches demonstrating setup, calibration, and reading load cell data. These are ideal starting points for testing and understanding the library.
- **src/** – includes the main source files (HX711_ADC.cpp and .h) that manage communication and data processing.
- **extra/** – may include documentation or configuration examples.
- **README.md** – outlines installation steps, usage instructions, and calibration procedures.
- **LICENSE** – the library is distributed under the MIT License, allowing for open use and modification.
- **library.properties** and **keywords.txt** – define metadata and keyword highlighting for the Arduino IDE.

Functionality

The library communicates with the HX711 through two Arduino digital pins: DOUT and SCK. It reads the amplified signal from the load cell, averages multiple samples to reduce noise, and outputs a stable digital reading. Users can apply a calibration factor to translate the raw output into physical units such as grams or kilograms. The library also provides functions for taring (zeroing the scale), powering down the HX711, and adjusting sampling parameters.

Typical Arduino Setup

1. Connect the HX711 module to the Arduino using two digital pins (commonly D2 for DOUT and D3 for SCK).
2. Wire the load cell to the HX711 amplifier, ensuring proper connection of the red, black, white, and green wires.
3. Open one of the example sketches in the Arduino IDE.
4. Upload the sketch and open the Serial Monitor.

5. Tare the scale, place a known weight on the load cell, and use it to determine the calibration factor.
6. Record this factor for use in your main program.

Applications

- Weight measurement devices such as kitchen or laboratory scales
- Force or pressure sensing systems
- Smart prosthetics and biomedical devices
- Robotics and automation systems requiring load or torque monitoring

Practical Tips

- Always calibrate with a known mass before collecting data.
- Secure and shorten wires when possible to minimize electrical noise.
- Ensure the load cell and HX711 share a stable ground connection.
- If readings are unstable, check connections and consider shielding signal wires.
- Use the example sketches as templates for custom applications.

Conclusions/action items:

The HX711_ADC library is a reliable, well-documented tool for integrating load cells with Arduino. It provides clear examples, calibration methods, and flexibility for multiple sensors, making it suitable for both simple and advanced measurement systems.

11/06/25 Circuitry

NICOLAS MALDONADO - Nov 06, 2025, 2:55 PM CST

NICOLAS MALDONADO - Nov 06, 2025, 2:56 PM CST

Title: circuitry

Date: 11/06/25

Content by: Nicolas Maldonado

Present: N/A

Goals: N/A

Content:

Load Cell Electrical Basics
A standard load cell operates on a **Wheatstone bridge** circuit composed of four strain gauges. When weight or force is applied, the strain gauges deform slightly, changing their resistance and producing a minimal differential voltage (typically in the millivolt range).

- **Excitation voltage (E+) and (E−)**: The input voltage applied to the bridge, usually 5 V or 3.3 V from the HX711.
- **Signal output (A+ and A−)**: The differential voltage that changes in response to strain. These connect to the HX711's input amplifier.
  Because the signal is tiny, it requires amplification and filtering before it can be accurately digitized.

HX711 Signal Path
The HX711 performs three main electrical functions:

1. **Amplification:** It uses a low-noise programmable gain amplifier (PGA) with selectable gain (32, 64, or 128). This boosts the millivolt-level signal from the load cell to a range suitable for digital conversion.
2. **Analog-to-Digital Conversion:** A 24-bit ADC samples the amplified signal, providing high resolution and sensitivity.
3. **Data Communication:** The HX711 outputs digital data serially through two pins—DOUT (data output) and SCK (clock input)—to the Arduino.

Typical Circuit Connections

1. **Load Cell to HX711**
   - **Red (E+)** → HX711 **VCC** or **E+**
   - **Black (E−)** → HX711 **GND** or **E−**
   - **White (A−)** → HX711 **A−** (negative signal input)

- **Green (A+)** → HX711 **A+** (positive signal input)
  Some load cells include additional wires (B+/B−) for a second channel, but only one channel (A) is typically used.

2. **HX711 to Arduino**

   - **VCC** → Arduino **5V** (or **3.3V** for compatible boards)
   - **GND** → Arduino **GND**
   - **DT (DOUT)** → Arduino digital input pin (commonly D3)
   - **SCK (Clock)** → Arduino digital output pin (commonly D2)
   - The HX711 communicates using a simple clocked serial protocol. Each pulse on the SCK line shifts out one bit of data from the DOUT line. The Arduino library handles timing and data retrieval automatically.

Power and Signal Considerations

- **Voltage Supply:** The HX711 typically operates from 2.7 V to 5 V. Supplying a stable voltage source is critical since fluctuations affect the bridge excitation and the resulting output signal.
- **Grounding:** All grounds (Arduino, HX711, and load cell) must share a common ground reference to avoid measurement drift.
- **Noise Reduction:** Keep data and excitation lines short. Avoid running signal wires near motors or high-current circuits. Twisted-pair wiring or shielded cables can reduce electromagnetic interference.
- **Filtering:** The HX711 internally averages samples and can output at 10 Hz or 80 Hz. Lower sampling rates provide better noise performance.

Multiple Load Cells
Each HX711 can handle one or two load cells (through channels A and B), but only one channel can be read at a time. For multiple load cells in parallel (such as a four-corner scale), the signal wires can be combined into a single Wheatstone bridge configuration, while excitation and ground lines are shared. Alternatively, separate HX711 modules can be used for each sensor for individual readings.

Calibration and Output Scaling
Once the circuit is wired, the Arduino reads raw digital values proportional to the applied force. Calibration involves applying a known weight and calculating a **calibration factor**, which scales the digital output to meaningful physical units. The calibration constant is then saved in the Arduino code or EEPROM for consistent readings.

Conclusions/action items:

The HX711 serves as the essential bridge between the analog world of strain gauges and the digital processing of an Arduino. Proper wiring—ensuring shared grounds, short leads, and stable power—is vital for accuracy. By understanding the signal path from the load cell's Wheatstone bridge through the HX711's amplifier and ADC to the Arduino's input, you can build reliable systems for weight, pressure, or force measurement.

Load sensor connection

NICOLAS MALDONADO - Dec 02, 2025, 12:46 PM CST

Title: Load sensor connection

Date: 11/21/25

Content by: Nicolas Maldonado

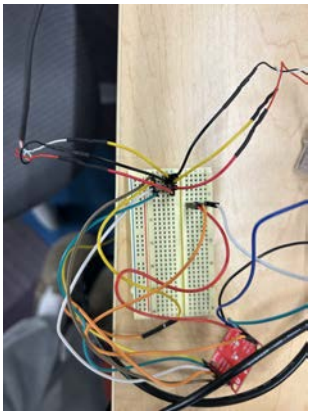
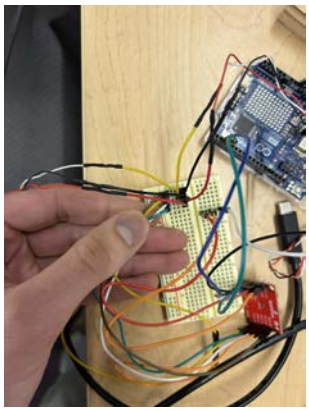
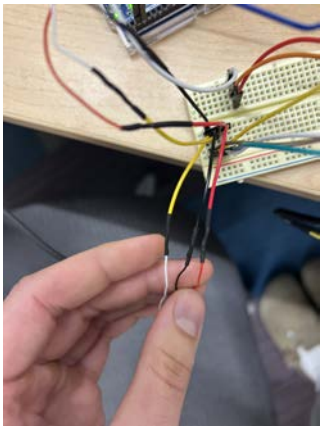
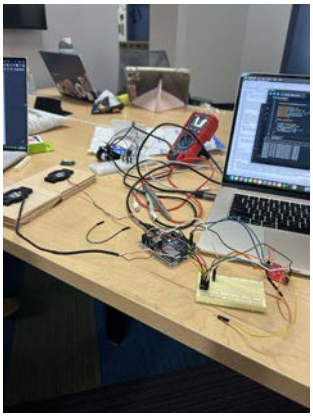
Present: N/A

Goals: Get load cells to work

Content:

After extensive iteration, the team has successfully restored the load sensors to operation, and we have finally reached this goal.

Initially, we connected the Red, Black, and White cables in a Wheatstone bridge configuration, with Red and Black as VCC and GND, and White as Vref. This was a bad assumption, and through trial and error, we found the red wire to be Vref and White wire to be VCC+. This resulted in the following wiring for the sensors into the HX711 amp:

Conclusions/action items:

Load sensor Code

Title: Load sensor connection

Date: 11/21/25

Content by: Nicolas Maldonado

Present: N/A

Goals: Get load cells to work

Content:

We were struggling to get the code to work properly, but this was mainly due to wiring issues. We used vaious github resources to get the code to properly c

```
/* Example using the SparkFun HX711 breakout board with a scale By: Nathan Seidle SparkFun Electronics Date: November 19th, 2014 License: This code is p
 This is the calibration sketch. Use it to determine the calibration_factor that the main example uses. It also outputs the zero_factor useful for proje
 Setup your scale and start the sketch WITHOUT a weight on the scale Once readings are displayed place the weight on the scale Press +/- or a/z to adjus
 This example assumes pounds (lbs). If you prefer kilograms, change the Serial.print(" lbs"); line to kg. The calibration factor will be significantly d
 Your calibration factor may be very positive or very negative. It all depends on the setup of your scale system and the direction the sensors deflect f
 Most any pin on the Arduino Uno will be compatible with DOUT/CLK.
 The HX711 board can be powered from 2.7V to 5V so the Arduino 5V power should be fine.
*/
#include "HX711.h"
#define DOUT  3#define CLK  2
HX711 scale;
float calibration_factor = -7050; //-7050 worked for my 440lb max scale setup
void setup() {  Serial.begin(9600);  Serial.println("HX711 calibration sketch");  Serial.println("Remove all weight from scale");  Serial.println("After
  scale.begin(DOUT, CLK);  Serial.println(scale.is_ready() ? "HX711 ready" : "HX711 not found");
  scale.set_scale();  scale.tare(); //Reset the scale to 0
  long zero_factor = scale.read_average(); //Get a baseline reading  Serial.print("Zero factor: "); //This can be used to remove the need to tare the sc
void loop() {
  scale.set_scale(calibration_factor); //Adjust to this calibration factor
  Serial.print("Reading: ");  Serial.print(scale.get_units(), 1);  Serial.print(" lbs"); //Change this to kg and re-adjust the calibration factor if you
  if(Serial.available())  {    char temp = Serial.read();    if(temp == '+' || temp == 'a')      calibration_factor += 10;    else if(temp == '-' || tem
```

```
/* Example using the SparkFun HX711 breakout board with a scale By: Nathan Seidle SparkFun Electronics Date: November 19th, 2014 License: This code is p
 This example demonstrates basic scale output. See the calibration sketch to get the calibration_factor for your specific load cell setup.
 This example code uses bogde's excellent library: https://github.com/bogde/HX711 bogde's library is released under a GNU GENERAL PUBLIC LICENSE
 The HX711 does one thing well: read load cells. The breakout board is compatible with any wheat-stone bridge based load cell which should allow a user
 The HX711 board can be powered from 2.7V to 5V so the Arduino 5V power should be fine.
*/
#include "HX711.h"
#define calibration_factor -16320.0 //This value is obtained using the SparkFun_HX711_Calibration sketch
#define DOUT  3#define CLK  2
HX711 scale;
void setup() {  Serial.begin(9600);  Serial.println("HX711 scale demo");
  scale.begin(DOUT, CLK);  scale.set_scale(calibration_factor); //This value is obtained by using the SparkFun_HX711_Calibration sketch  scale.tare(); /
  Serial.println("Readings:");}
void loop() {  Serial.print("Reading: ");  Serial.print(scale.get_units(), 1); //scale.get_units() returns a float  Serial.print(" lbs"); //You can chan
```

Conclusions/action items:

We need to test the code and calibrate the load sensors in the final housing. we were able to calibrate the sensors to be accurate in our test setup, but final testing is still in order.

Lidar code

Title: Lidar Code

Date: 11/22/25

Content by: Nicolas Malodonado

Present: N/A

Goals: Finish lidar code

Content:

We had a little trouble getting the lidar code operational with our sensor, but it was mostly the units rather than the sensor. We got a final product.

```
#include <Wire.h>#include <LIDARLite.h>
// ----- LIDAR -----LIDARLite myLidarLite;
// ----- Rate limiting -----unsigned long lastRead = 0;const unsigned long interval = 50; // 20 Hz
// ----- Speed calculation state -----float prev_ft = NAN;unsigned long prev_ms = 0;bool ema_initialized = false;float speed_ema_ft_s = NAN;
// Convert cm → feetinline float cmToFeet(int cm) {  return cm * 0.0328084f;}
// ---------------------------------------------------------------------------// LIDAR reading + speed calculation// ---------------------------------
  // true = with bias correction (per LIDARLite library)  int dist_cm = myLidarLite.distance(true);
  // If invalid reading, return previous values (if any)  if (dist_cm <= 0) {    distance_ft_out = prev_ft;    speed_ft_s_out = (isnan(speed_ema_ft_s) ?
  float dist_ft = cmToFeet(dist_cm);
  // Instantaneous speed (ft/s), positive means target is approaching  float inst_speed_ft_s = NAN;
  if (prev_ms != 0) {    float dt_s = (now - prev_ms) / 1000.0f;    if (dt_s > 0) {      inst_speed_ft_s = (prev_ft - dist_ft) / dt_s; // approaching →
      // Exponential moving average for smoother speed      const float alpha = 0.25f;      if (!ema_initialized) {        speed_ema_ft_s = inst_speed_f
  prev_ft = dist_ft;  prev_ms = now;
  distance_ft_out = dist_ft;  speed_ft_s_out = (isnan(speed_ema_ft_s) ? 0 : speed_ema_ft_s);}
// ---------------------------------------------------------------------------// SETUP// ---------------------------------------------------------------------
  // Initialize LIDAR-Lite  myLidarLite.begin(0, true); // I2C addr 0 (default), reset = true  myLidarLite.configure(0);   // Default configuration
  Serial.println("LIDAR-Lite test starting...");}
// ---------------------------------------------------------------------------// LOOP — Serial Plotter friendly output// ------------------------------
    float dist_ft = 0.0f;    float speed_ft_s = 0.0f;
    updateLidar(dist_ft, speed_ft_s);
    // If we still don't have a valid distance yet, just skip printing    if (isnan(dist_ft)) {      return;    }
    // Format: label:value \t label:value (works nicely in Serial Plotter)    Serial.print("distance_ft:");    Serial.print(dist_ft, 2);    Serial.print
    Serial.print("speed_ft_s:");    Serial.println(speed_ft_s, 2);  }}
```

Conclusions/action items:

Continue to refine code and combine load cell and lidar code

Code complete

NICOLAS MALDONADO - Dec 09, 2025, 6:54 PM CST

NICOLAS MALDONADO - Dec 09, 2025, 6:59 PM CST

Title: Complete code

Date: 11/22/25

Content by: Nicolas Malodonado

Present: N/A

Goals: Finish code

Content:

```
#include "HX711.h"#include <Wire.h>#include <LIDARLite.h>

// ----- HX711 -----#define calibration_factor -18670.0#define DOUT  3#define CLK   2HX711 scale;

// ----- LIDAR -----LIDARLite myLidarLite;

// ----- Rate limiting -----unsigned long lastRead = 0;const unsigned long interval = 50; // 20 Hz

// ----- Speed calculation state -----float prev_ft = NAN;unsigned long prev_ms = 0;bool ema_initialized = false;float speed_ema_ft_s = NAN;

// Convert cm → feetinline float cmToFeet(int cm) { return cm * 0.0328084f; }

// ---------------------------------------------------------------------------// LIDAR reading + speed calculation// ---------------------------------

   if (dist_cm <= 0) {       // Return previous values if invalid reading       distance_ft_out = prev_ft;       speed_ft_s_out = speed_ema_ft_s;

   float dist_ft = cmToFeet(dist_cm);   float inst_speed_ft_s = NAN;

   if (prev_ms != 0) {       float dt_s = (now - prev_ms) / 1000.0f;       if (dt_s > 0) {           inst_speed_ft_s = (prev_ft - dist_ft) / dt_s; // po

           const float alpha = 0.25f; // EMA smoothing           if (!ema_initialized) {               speed_ema_ft_s = inst_speed_ft_s;               e

   prev_ft = dist_ft;   prev_ms = now;

   distance_ft_out = dist_ft;   speed_ft_s_out = (isnan(speed_ema_ft_s) ? 0 : speed_ema_ft_s);}

// ---------------------------------------------------------------------------// SETUP// ---------------------------------------------------------------------------

   Wire.begin();   delay(200);            // Let LIDAR boot

   // HX711   scale.begin(DOUT, CLK);   scale.set_scale(calibration_factor);   scale.tare();

   // LIDAR   myLidarLite.begin(0, true);   myLidarLite.configure(0);}

// ---------------------------------------------------------------------------// LOOP — single unified Serial Plotter output line// --------------------

       // ---- Read HX711 ----       float weight_lbs = scale.get_units(1);

       // ---- Read LIDAR + speed ----       float dist_ft = 0;       float speed_ft_s = 0;       updateLidar(dist_ft, speed_ft_s);

       // ------------------------------------------------------       // Unified Serial Plotter Format       // label:value \t label:value \t label

       Serial.print("distance_ft:");       Serial.print(dist_ft, 2);       Serial.print("\t");

       Serial.print("speed_ft_s:");       Serial.println(speed_ft_s, 2);   }}
```

circuitry fixes

NICOLAS MALDONADO - Dec 09, 2025, 6:58 PM CST

Title: Cicruitry fixes

Date: 12/02/25

Content by: Nicolas Malodonado

Present: N/A

Goals: We had some trouble with the soldering, so we had to clean up some of the connection points and restart the soldering.

Content:

NICOLAS MALDONADO - Dec 09, 2025, 6:58 PM CST

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IMG_8202.HEIC (2.19 MB)

Sensor Initial Design - 1

NICOLAS MALDONADO - Sep 25, 2025, 2:00 PM CDT

Title: Sensor Initial Design 1

Date: 9/25/25

Content by: Nicolas Maldonado

Present: N/A

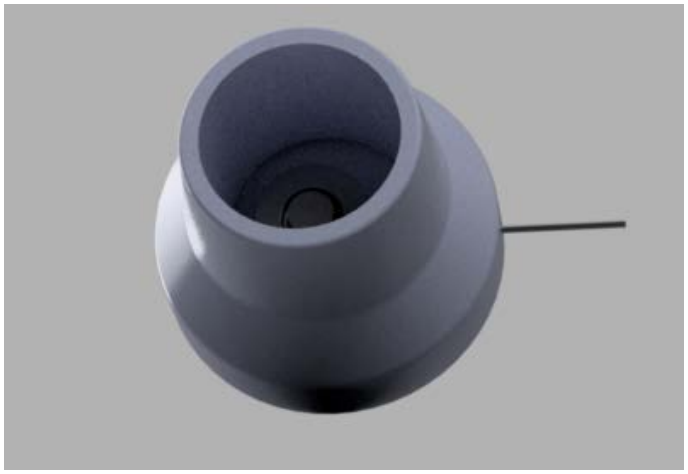
Goals: Draft a design

Content:

A load cell is placed inside the rubber end of the walker so that we can measure the amount of pressure being put into the walker.

Conclusions/action items:

NICOLAS MALDONADO - Sep 25, 2025, 1:10 PM CDT



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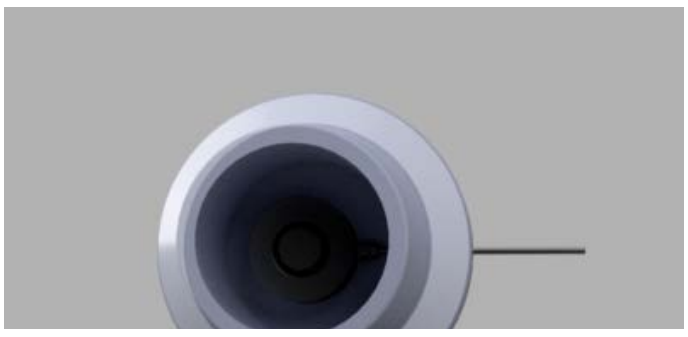
NICOLAS MALDONADO - Sep 25, 2025, 1:10 PM CDT



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Component Housing Design - 1

NICOLAS MALDONADO - Sep 25, 2025, 2:00 PM CDT

Title: Component Housing design 1

Date: 9/25/25

Content by: Nicolas malodonado

Present: N/A

Goals: To draft an inital design for the project

Content:

I drafted a component housing that will hold the accel+gyro and battery. it will attatch to the tubing of the walker body

Conclusions/action items:

NICOLAS MALDONADO - Sep 25, 2025, 1:54 PM CDT

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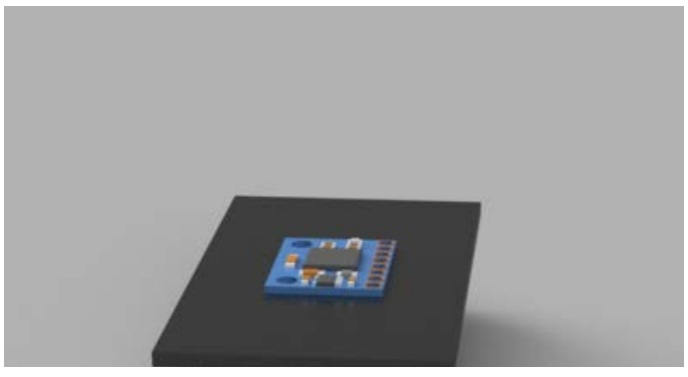
NICOLAS MALDONADO - Sep 25, 2025, 1:54 PM CDT



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Training Documentation

NICOLAS MALDONADO - Oct 30, 2025, 4:00 PM CDT

Title: Training Documentation

Date: 10/30/25

Content by: Nicolas Maldonado

Present: N/A

Goals: N/A

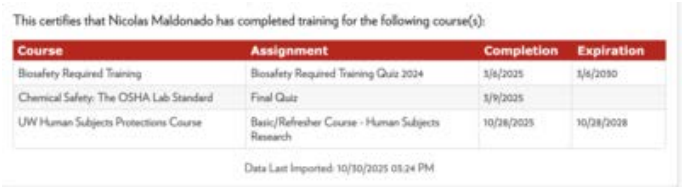
Content:

N/A

Conclusions/action items:

N/A

NICOLAS MALDONADO - Oct 30, 2025, 3:56 PM CDT


This certifies that Nicolas Maldonado has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024	3/6/2025	3/6/2030
Chemical Safety: The OSHA Lab Standard	Final Quiz	3/9/2025	
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	10/28/2025	10/28/2028

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NICOLAS MALDONADO - Oct 30, 2025, 3:56 PM CDT

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Lecture 1 - 9/10/25

NICOLAS MALDONADO - Sep 10, 2025, 2:08 PM CDT

Title: Lecture 1 notes

Date: 9/10/25

Content by: Nicolas Maldonado

Present: N/A

Goals: N/A

Content:

Job search tips:

- -Keep track of what you do
- -Quality source matters
- -Applying is step 1 (then follow up)
- -Think beyond the title
- - it takes time

Resume Tips

- -Tailor the resume to the position
- -Create balance to show a full picture of you
- -Design Projects WITHOUT years and semesters

Cover Letter

- -Always base it on the job posting (custom)
- -Amplify your most significant selling points
- -Clear and Consistent
- -Address someone
- -Only do it if it is beneficial to you or required

For BME

- -Find overlap with other disaplines
- -BME is a good mix of many feilds and can be better for certain positions

Conclusions/action items:

Lecture 2 - 9/17/25

NICOLAS MALDONADO - Sep 17, 2025, 2:00 PM CDT

Title: "Exploring Your Leadership Style"

Date: 9/17/25

Content by: Nicolas Maldonado

Present: N/A

Goals: take notes on lecture

Content:

- Qualities of a good leader: vision, empathy, decision-making, transparency, self-awareness, communication
- Levels of leadership: personal, interpersonal, team, organizational
- Self-assessment tools: Myers-Briggs (personality), DiSC (behavior), CliftonStrengths (talent areas)
- Leadership styles:
    - Power model: hierarchy, authority, control
    - Servant leadership: service, empathy, shared decision-making
    - Authentic leadership: transparency, honesty, emotional intelligence
- Leadership orientations:
    - People-oriented: trust, relationships, inclusion
    - Process-oriented: efficiency, systems, working alongside team
    - Thought-oriented: big-picture, strategy, innovation
    - Impact-oriented: high standards, influence, inspiration
- Developing your style:
    - Leadership doesn’t require a title
    - Start with leading yourself: self-awareness, reflection, feedback
- Goal-setting practices:
    - Start small, focus on one skill
    - Find mentors, ask questions, track progress
    - Key skills to practice: communication, decision-making, adaptability, problem-solving, empathy, conflict resolution, responsibility

Conclusions/action items:

- Use self-assessment tools to grow awareness
- Set one personal leadership goal and one interpersonal/team goal for the semester

Lecture 3 - 9/24/25

NICOLAS MALDONADO - Sep 24, 2025, 2:08 PM CDT

Title: Near Peer Mentoring

Date: 9/24/25

Content by: Nicolas Maldonado

Present: N/A

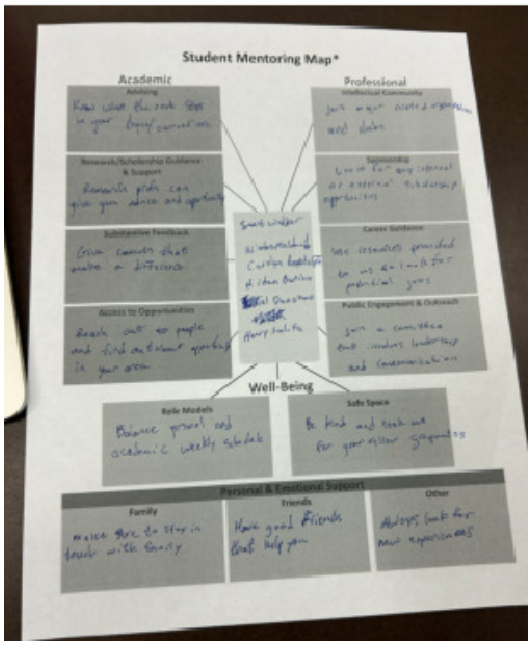
Goals: Take notes

Content:

- Purpose of mentoring BME 200 students:
  - Provide instructional and emotional support
  - Peer mentors are approachable and relatable
  - Share experiences (courses, internships, research)
  - Increase belonging and confidence
  - Build transferrable skills for both mentor and mentee
- Transferrable skills from mentoring:
  - Leadership
  - Communication and active listening
  - Study practices
  - Self-awareness and interpersonal skills
- General benefits:
  - Higher self-esteem and confidence
  - More patience
  - Positive habits and personal growth
  - Identifying gaps in knowledge
  - Sense of accomplishment
- Qualities of a good mentor:
  - Build trust and psychological safety
  - Be reliable, supportive, enthusiastic, and available
  - Be transparent and open
  - Listen actively and humanize challenges
- Effective listening practices:
  - Remove distractions and stop talking
  - Show interest, maintain eye contact
  - Focus on main ideas, ask questions, check for understanding
  - React to ideas, avoid quick judgments
- Activities:
  - Reflect on what you wish you knew in BME 200
  - Create and share a “Mentor Map” action plan with your team

Conclusions/action items:

NICOLAS MALDONADO - Sep 24, 2025, 2:00 PM CDT



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Lecture 4 - 10/01/25

NICOLAS MALDONADO - Oct 01, 2025, 3:08 PM CDT

Title: Lecutre 4

Date: 10/1/25

Content by: Nicolas Maldonado

Present: N/A

Goals: Take notes on lecutre

Content:

- **Why I am mentoring BME 200 students:**
  - I know how challenging the transition into BME can be, and I want to make it easier for others.
  - Mentoring gives me the chance to share lessons I’ve learned and help students avoid mistakes I made.
  - It’s also an opportunity for me to practice leadership, communication, and other skills that will help me long term.
- **What it means to be a good mentor:**
  - Listening first and making mentees feel heard.
  - Being approachable, patient, and supportive.
  - Sharing my experiences honestly—both successes and struggles.
  - Encouraging positive habits and helping mentees build confidence.
- **What I wish I knew in BME 200:**
  - How important time management and teamwork would become later on.
  - Better strategies for studying and keeping up with coursework.
  - That it’s okay to ask for help early—professors, TAs, and tutoring resources are there to be used.
  - Specific tools and resources that would have made things less overwhelming.
- **My Mentor Map:**
  - Share practical tips for staying organized and working effectively on group projects.
  - Check in with mentees regularly to answer questions and listen to concerns.
  - Point them toward resources I wish I had taken advantage of sooner.
  - Encourage them to set their own goals and reflect on what they want out of the class.

Conclusions/action items:

Lecture 5 - 10/8/25

NICOLAS MALDONADO - Oct 08, 2025, 2:45 PM CDT

Title: Introduction to WARF, IP, Disclosing & Licensing

Date: 10/8/25

Content by: Nicolas Maldonado

Present: N/A

Speakers: Jeanine Burmania (Senior Director of IP & Licensing), Justin Anderson (Senior IP Manager)

Content:

WARF Overview

- Mission: Support UW-Madison research by funding, managing assets, and moving innovations to market : goal is financial return + global impact.
- Independent nonprofit (501(c)(3)); governed by UW-Madison alumni board + Chancellor.
- Tech transfer = moving campus research : marketplace. WARF helps with IP rights & commercial licenses.

Examples of Tech Transfer:

- IP licenses
- Sponsored research
- Consulting
- Fee-for-service

1. **Patents** – exclusive rights granted by government (USPTO). No global patent.
    - Holder can exclude others from making, using, selling, importing.
    - 3 types: Design, Plant, Utility.
    - Utility patents:
        - Provisional = 1-year placeholder.
        - Non-provisional = 20-year protection, must “teach” public how invention works.
        - Avg. cost ~$30K, takes 2–5 yrs. to issue.
    - Statutory requirements:
        - 101: Eligible (not natural/abstract).

        - 102: Novel.
        - 103: Non-obvious.
        - 112: Enabled + described (others must be able to reproduce).
    - Patent examiners = scientists trained by USPTO.
2. **Copyrights** – protects creative works in tangible medium (e.g., books, code, music).
3. **Trademarks** – protects names, logos, marks, etc. Must be used in commerce; identifies source.
4. **Trade Secrets** – protects confidential info of value (ex: formulas, methods). Lasts as long as secret is kept.

Disclosing Inventions to WARF

- WARF gets ~400 new disclosures/year.
- Process: describe innovation, note advantages, list contributors, funding & disclosure info.
- Meeting = go deeper, ask WARF about patenting, plan next steps.

How WARF Assesses Inventions

- **IP factors:** type of protection, breadth/strength, disclosure history, development stage.
- **Licensing factors:** applications, chance of commercial partner, revenue potential.

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How WARF Assesses Inventions

- **IP factors:** type of protection, breadth/strength, disclosure history, development stage.
- **Licensing factors:** applications, chance of commercial partner, revenue potential.

AI & Intellectual Property

- **Patents:**
    - AI cannot be inventor : must be human (“natural person”).
    - Exception: South Africa allowed AI as inventor.
    - AI can *assist* inventing (likely yes, under Pannu Factors).
- **Copyright:**

- Must be original human authorship.
- AI role must be incidental, not main creator.
- Prompts alone are not enough for authorship.
- Derivative works need significant human contribution.
- Traditional authorship elements by AI : not protected.

Conclusions/action items:

Lecture 6 - 10/15/25

NICOLAS MALDONADO - Oct 15, 2025, 3:47 PM CDT

Title: Institutional Review Boards and Clinical Translation

Date: 10/15/25

Content by: Nicolas Maldonado

Present: N/A

Goals: Understand the basics of testing, ethics, and regulations

Content:

- **Ethics Evolution:** unethical research => ethical principles => regulations
  - WWII Nazi experiments => *1947 Nuremberg Code*
  - Willowbrook hepatitis studies (1956–1971)
  - Milgram obedience study (1960s)
  - *Tuskegee Syphilis Study* (1932–1972) => *1974 National Research Act*
- **Belmont Report Principles:** Respect for Persons : Beneficence : Justice
- **Regulatory Framework:**
  - DHHS “Common Rule”
  - FDA oversight for clinical and device research

Determining Research Status:

- *Research* = systematic investigation aiming for generalizable knowledge
- *Human subject* = living person with data or biospecimens collected through interaction/intervention or identifiable info
- *Device research* = evaluating safety/effectiveness of diagnostic or therapeutic devices

Summary

- Always confirm if your project qualifies as human subjects research.

- Complete CITI and GCP trainings early.
- Prepare thorough, participant-centered protocols.
- Consult the IRB or FDA oversight offices for device-related studies.
- Maintain compliance post-approval to ensure ethical and legal integrity.

Conclusions/action items:

Lecture 8 - 10/29/25

NICOLAS MALDONADO - Oct 29, 2025, 2:35 PM CDT

Title: Navigating FDA Device Requirements

Date: 10/29/25

Content by: Nicolas Maldonado

Present: N/A

Goals:

- Learn about FDA protocols and regulations for Investigational Device Exemptions (IDE)
- Understand how the FDA classifies and regulates medical devices

Content:

Definition of a Medical Device

A *medical device* is any instrument, apparatus, implant, or similar article — including software — that:

1. Is recognized in the official National Formulary or U.S. Pharmacopeia, **or**
2. Is intended for use in diagnosing, curing, treating, or preventing disease in humans or animals.

Software as a Medical Device (SaMD)

- Software designed for one or more medical uses.
- Can operate on general-purpose platforms or within virtual environments.
- May be **standalone** or integrated into a hardware device.
- Key distinction: “Traditional” (hardware-based) vs. “Non-traditional” (software-based).

General Controls Include:

- Device registration and listing
- Adverse event reporting
- Labeling requirements
- Good Manufacturing Practices (GMP)
- Design and document controls
- Production and management oversight

Special Controls May Include:

- Performance standards
- Specific labeling
- Post-market surveillance

Market Submission Types

1. **510(k) Exempt** – Only registration and listing required.
2. **510(k) – Premarket Notification** – Must show *substantial equivalence* to a legally marketed device.
3. **PMA – Premarket Approval** – Full submission of safety and effectiveness data.
4. **De Novo Classification** – For novel devices with no predicate; creates a new classification.

Each submission includes:

- Device definition and classification
- Product code
- Submission type
- GMP requirements
- Relevant consensus standards

Conclusions/action items:

- **Identify device type early** to determine proper regulatory pathway.
- **Match risk level with control type** — higher risk demands stricter oversight.
- **Use FDA resources** (21 CFR, PMA/510(k)/De Novo databases) to guide research compliance.
- **Understand SaMD implications** — software intended for medical use is regulated like any device.

Lecture 9 - 11/12/25

NICOLAS MALDONADO - Nov 12, 2025, 8:04 PM CST

Title:

Date: 11/12/25

Content by: Nicolas Maldonado

Present: N/A

Goals:

Content:

Cases:

Nazi prisoner experiments (WWII): Led directly to the Nuremberg Code (1947), the first framework demanding voluntary consent.

Willowbrook Hepatitis Studies (1956–1971): Children with disabilities were intentionally infected with hepatitis.

Milgram Obedience Experiments (1960s): Exposed risks of psychological harm and deception

Tuskegee Syphilis Study (1932–1972): Black men with syphilis were denied treatment; directly resulted in the National Research Act (1974) and the establishment of IRBs.

The Belmont Report (1979)
Three core principles:

Respect for Persons: Protect autonomy and provide extra protections to those with diminished autonomy.

Beneficence: Maximize benefits and minimize harm.

Justice: Ensure a fair distribution of research burdens and benefits.

These principles shape how IRBs evaluate research plans today.

Regulatory foundations

The Common Rule (45 CFR 46): Federal regulations outlining IRB structure, criteria for approval, and protections for vulnerable groups.

Revised Common Rule (2018): Streamlined some processes to reduce administrative burden.

FDA regulations (21 CFR 56): Additional layers for drug/device studies.

IRB Composition
IRBs must include:

Scientists (MD, PhD, MPH)

Non-scientists

Community members

Diverse backgrounds and perspectives

IRB Purpose

Protect rights and welfare of participants.

Review ethical considerations (Belmont principles).

Apply federal rules (Common Rule, HIPAA, FERPA), state laws, and institutional policy.

Ensure risks are minimized and reasonable relative to expected benefits.

Common Rule Approval Criteria

Risks minimized and justified.

Equitable participant selection.

Informed consent process is adequate.

Privacy and confidentiality protections are appropriate

Human subject:A living individual about whom a researcher obtains:

Data through intervention/interaction, or

Identifiable private information or biospecimens.

Examples that do require review

Surveys, interviews, observations linked to individuals

Use of identifiable medical records

Collection of specimens (blood, hair, cells)

Device, drug, or product studies in humans

Conclusions/action items:

Lecture 10 - 11/20/25

NICOLAS MALDONADO - Nov 20, 2025, 2:34 PM CST

Title: Product Development

Date: 11/19/25

Content by: Nicolas Maldonado

Present: N/A

Goals:

Content:

1. Why Medical Device NPD Is Hard

- Industry is heavily regulated (FDA + international bodies).
- Development is expensive because verification/validation (including clinical work) drives cost.
- Requires large, cross-functional teams.
- Very competitive market → speed matters.

2. How Companies Pick Projects

- Annual cycle:
  - Corporate strategy
  - Product portfolio review
  - Project review
  - Budget + resource allocation

3. Types of Projects

- Line extensions (sizes, configurations)
- Product improvements
- New-to-company products
- New-to-world innovations
  - (Risk, cost, and timeline increase as you move down the list.)

5. The Stage-Gate System (Core Framework)

Used by most medical device companies to manage risk and keep projects on track.

- Stage 0 – Ideation: identify opportunities, unmet needs, early sketches.
- Stage 1 – Exploration: define the problem, generate concepts, high-level business case.
- Stage 2 – Concept Definition: narrow to 1 top concept; deeper business and IP analysis; major go/no-go.
- Stage 3 – Design Development: build functional prototypes, initial testing, start Design Controls documentation.
- Stage 4 – Design Confirmation: verification/validation testing, finalize drawings, freeze design, submit regulatory paperwork.
- Stage 5 – Design Transfer & Commercialization: tooling, IFUs, service plans, manufacturing setup, launch planning.

6. Design Controls

- Required for Class II/III devices.
- Document customer needs, requirements, inputs/outputs, testing, reviews.
- Closely tied to risk management.
- Ensures the final product actually meets the defined problem

7. Case Study: ORwell Fluid Management

- Need: safer, cleaner, simpler high-volume surgical fluid collection.
- Followed entire Stage-Gate process from concept to commercialization.
- Ultimately discontinued → competitive pricing pressure, high service/installation cost, tougher financial outlook.

- Shows that good engineering isn’t enough; business factors matter.

Conclusions/action items:

2025/09/18 Notes on Current Evidence for Walking Recovery After Stroke,

Carolyn Randolph - Sep 18, 2025, 4:21 PM CDT

Title: Notes on Walk the Talk: Current Evidence for Walking Recovery After Stroke, Future Pathways and a Mission for Research and Clinical Practice

Date: September 18, 2025

Content by: Carolyn Randolph

Present: N/A

Goals: Take note of relevant information to project.

Content: Moore, Sarah A., et al. “Walk the talk: Current evidence for walking recovery after stroke, future pathways and a mission for research and clinical practice.” Stroke, vol. 53, no. 11, 7 Sept. 2022, pp. 3494–3505, https://doi.org/10.1161/strokeaha.122.038956.

80% of stroke patients experience difficulty walking following a stroke.1/4 are not able to walk independently 3 months after the stroke. Speed and endurance are particularly important considerations. Slower walking speed is correlated with more falls, higher mortality rate, and lower quality of life. Capacity describes what patients are capable of doing in a controlled research or clinical setting. Whereas performance relates to what they are able to do in their own environment. The process of recovering from a stroke is non-linear and the majority of progress is seen within the first few weeks. The 10 meter walk test and the 6-minute walking test are examples of tests conducted by practitioners of stroke patients.

Conclusions/action items: For this project performance is what is being measured as opposed to capacity. 3 of the 4 important indicators of recovery will be tracked by the device.

2025/09/10 Notes on Monitoring Walker Assistive Devices

Carolyn Randolph - Sep 11, 2025, 1:42 PM CDT

Title: Notes on Monitoring Walker Assistive Devices: A Novel Approach Based on Load Cells and Optical Distance Measurements

Date: September 10, 2025

Content by: Carolyn Randolph

Present: Carolyn Randolph

Goals: Take note of relevant information from article.

Content: Viegas, Vítor et al. “Monitoring Walker Assistive Devices: A Novel Approach Based on Load Cells and Optical Distance Measurements.” Sensors (Basel, Switzerland) vol. 18,2 540. 10 Feb. 2018, doi:10.3390/s18020540

This paper focuses more on reducing the risk of using a walker. It does so by monitoring force unbalance and incoordination. It reports that data via bluetooth. The design implements load cells to measure force and Light Detection and Ranging (LIDAR) to measure distance. Two sets of equations are used to evaluate the two risk factors. Force Sensing Resistors were replaced by load cells. Bluno nano was used as the microprocessor. The LIDAR was suspended from the walker with a selfie-stick. Computation and detection was done via the application "Spy Walker". The walker used has no wheels.

Conclusions/action items: The load cells to measure pressure and optical sensor to measure distance could be applied to the design. The gait tracking is more complicated than what is necessary for this project.

2025/09/11 Notes on Adaptive Navigation of a Smart Walker

Carolyn Randolph - Sep 11, 2025, 2:12 PM CDT

Title: Notes on Adaptive Navigation of a Smart Walker

Date: September 11, 2025

Content by: Carolyn

Present: N/A

Goals: Take note of relevant information to project.

Content: Sutera, G., Guastella, D. C., Cancelliere, F., & Muscato, G. (2025). Adaptive Navigation of a Smart Walker with Shared Control. Actuators, 14(5), 224. https://doi.org/10.3390/act14050224

This smart walker detects user's intent and facilitates safe motion in the desired direction. It does so via force/torque sensors in the handle bars, lidar to detect objects in the way, and motors to guide the direction. It also includes a touchscreen. The device can navigate memory challenged users to selected room. The walker created in this design includes four wheels. The design utilizes a Raspberry Pi as the microcontroller. The walker includes an emergency stopping system.

Conclusions/action items: The paper focuses mainly on the concept of shared control which is not relevant to the project. However, the force sensing handles propose an alternative placement for tracking force.

2025/09/18 Notes on A Smart Robotic Walker With Intelligent Close-Proximity Interaction

Carolyn Randolph - Sep 18, 2025, 3:56 PM CDT

Title: Notes on A Smart Robotic Walker With Intelligent Close-Proximity Interaction Capabilities for Elderly Mobility Safety

Date: September 18, 2025

Content by: Carolyn Randolph

Present: N/A

Goals: Take note of relevant information to project.

Content: X. Zhao et al., “A Smart Robotic Walker With Intelligent Close-Proximity Interaction Capabilities for Elderly Mobility Safety,” Front. Neurorobot., vol. 14, Oct. 2020, doi: 10.3389/fnbot.2020.575889.

ThIs walker is voice activated with motors and can be called over by the user. It locks upon sudden pressure changes and unlocks with a gentle squeeze of the handle. The device can detect objects in path and avoid collisions. There are acceleration and deceleration buttons for the users to control speed. To detect pressure, the device employs high-sensitivity sensors inside the soft chambers of the handles. Specifically air pressure sensors. A finite state machine can analyze pressure data to predict falls and other emergencies. Gait information is collected with lidar and infrared temperature sensors. Each wheel has a rotary encoder and odometer to record measurements of movement

Conclusions/action items: Overall, the design presented in this paper is more complex than what is needed for the project, however the air pressure sensors in the handle as well as the rotary encoder and odometer could be employed.

2025/10/08 Fabrication Methods

Carolyn Randolph - Oct 27, 2025, 8:23 PM CDT

Title: Fabrication Methods

Date: October 8, 2025

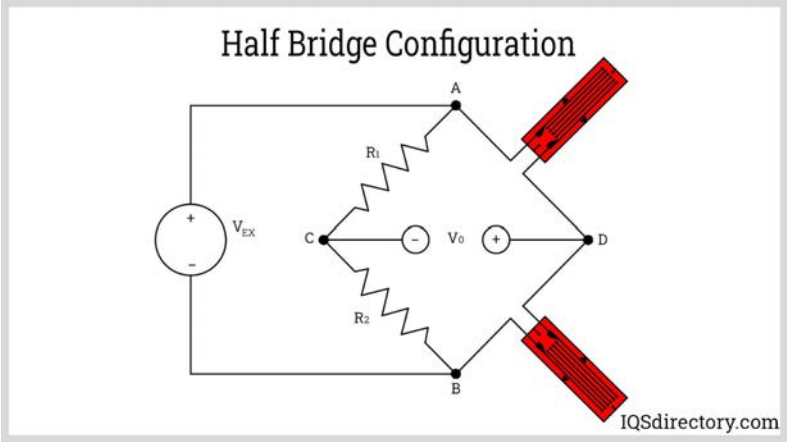
Content by: Carolyn Randolph

Present: N/A

Goals: List initial Fabrication Steps

Content:

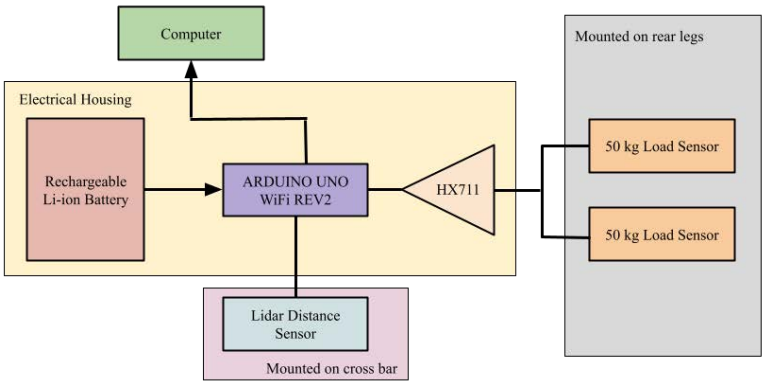
Fabrication will consist of three main categories: 3D printing, circuitry and coding, and attachment/integration to the walker. The end caps will be 3D printed using Thermoplastic Polyurethane (TPU), as it closely resembles the material currently used for the end caps. Polylactic Acid will be used to 3D print the electrical housing unit, which will be attached to the crossbar using rubber-cushioned metal cable clamps. The microprocessor used for this project is the ARDUINO UNO WiFi REV2. This will process the signals from the sensors and, with the WiFi or Bluetooth capabilities, can be connected to the clinician's computer or phone to view the data. The Garmin LIDAR-Lite Optical Distance Sensor - V3 will be used to measure the distance from the walker to the wall, and the device will be programmed to extract speed from this measurement. The two load sensors will work by deforming under the pressure of the walker user, changing the electrical resistance measured by the Wheatstone bridge circuit, producing a voltage proportional to the force. This will be accompanied by a load cell amplifier HX711, which allows for the weight to be read easily from the load cells. Because this design includes two load cells instead of four, a half-bridge configuration will connect them to the amplifier.



Half wheatstone bridge configuration showing strain gauges in red.

Principles, Types and Configurations of Strain Gauges." Accessed: Oct. 09, 2025. [Online].
Available: https://www.iqsdirectory.com/articles/load-cell/strain-gauge.html

A KBT 12V 2400mAh Rechargeable Lithium-ion Battery will serve as the power source for the device. The figure below shows a schematic of the circuit and components of the design.



Conclusions/action items: Add to preliminary report and continue to develop steps.

2025/10/17 Code for Lidar

Carolyn Randolph - Oct 17, 2025, 10:41 AM CDT

Title: Code for Lidar

Date: October 17, 2025

Content by: Carolyn

Present: N/A

Goals: Take notes on potential code.

Content: https://github.com/garmin/LIDARLite_Arduino_Library

We can use the following code to calculate distance. From there we will need to convert to to US units (either ft or mi) and use the internal clock on the Arduino to calculate speed.

```
LIDARLite Arduino Library
  v3/GetDistancePwm

  This example shows how to read distance from a LIDAR-Lite connected over the
  PWM interface.

  Connections:
  LIDAR-Lite 5 Vdc (red) to Arduino 5v
  LIDAR-Lite Ground (black) to Arduino GND
  LIDAR-Lite Mode control (yellow) to Arduino digital input (pin 3)
  LIDAR-Lite Mode control (yellow) to 1 kOhm resistor lead 1
  1 kOhm resistor lead 2 to Arduino digital output (pin 2)

  (Capacitor recommended to mitigate inrush current when device is enabled)
  680uF capacitor (+) to Arduino 5v
  680uF capacitor (-) to Arduino GND

  See the Operation Manual for wiring diagrams and more information:
  http://static.garmin.com/pumac/LIDAR_Lite_v3_Operation_Manual_and_Technical_Specifications.pdf

------------------------------------------------------------------------------*/

unsigned long pulseWidth;

void setup()
{
  Serial.begin(115200); // Start serial communications

  pinMode(2, OUTPUT); // Set pin 2 as trigger pin
  digitalWrite(2, LOW); // Set trigger LOW for continuous read

  pinMode(3, INPUT); // Set pin 3 as monitor pin
}

void loop()
{
  pulseWidth = pulseIn(3, HIGH); // Count how long the pulse is high in microseconds

  // If we get a reading that isn't zero, let's print it
  if(pulseWidth != 0)
  {
    pulseWidth = pulseWidth / 10; // 10usec = 1 cm of distance
    Serial.println(pulseWidth); // Print the distance
  }
}
```

Conclusions/action items: Once the Lidar gets here test out the code.

2025/10/23 - External Wiring Design

John Puccinelli - Dec 16, 2025, 12:28 PM CST

Title: Design Idea for External Wiring

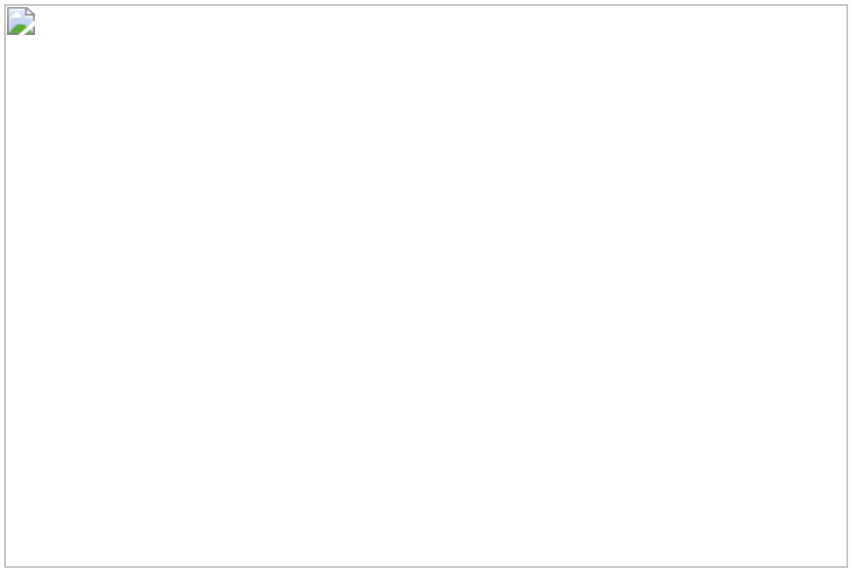
Date: October 23, 2025

Content by: Carolyn Randolph

Present: Carolyn Randolph

Goals: Consider potential way to route the wiring from the load cells to the electrical housing.

Content: Seeing as the structure of the walker cannot be altered and the add-ons should be easy to switch from walker to walker we need to design an alternative to routing the wires through the legs of the walker. At the same time the wires should not be exposed both for safety and to improve the visual appeal. One possible solution is using heat shrink cable sleeves with one half of a velcro strip adhered and the other half adhered to the outside of the legs up to the electrical housing. An example of the heat shrink sleeve is 3M™ Heat Shrink Cable Sleeve ITCSN:



https://westwayelectricsupply.com/3m-electrical-products-itcsn-0800-6in-black-12-3pc-pks?gad_source=1&gad_campaignid=22326013353&gbraid=0AAAADuk0K28kpAL1lCttTbtAYVGtyg0w&gclid=CjwKCAjwpOfHBhAxEiwAm1SwEgpVaCp6-al-qkWm0gh20sq_tlui0V8uybKUfelbxvx3yogaxWyI_hoC3aEQAvD_BwE

Conclusions/action items: Discuss with team and order supplies

2025/10/6 - Air Pressure and Lidar Design

Carolyn Randolph - Oct 27, 2025, 8:11 PM CDT

Title: Air Pressure and Lidar Design

Date: October 6, 2025

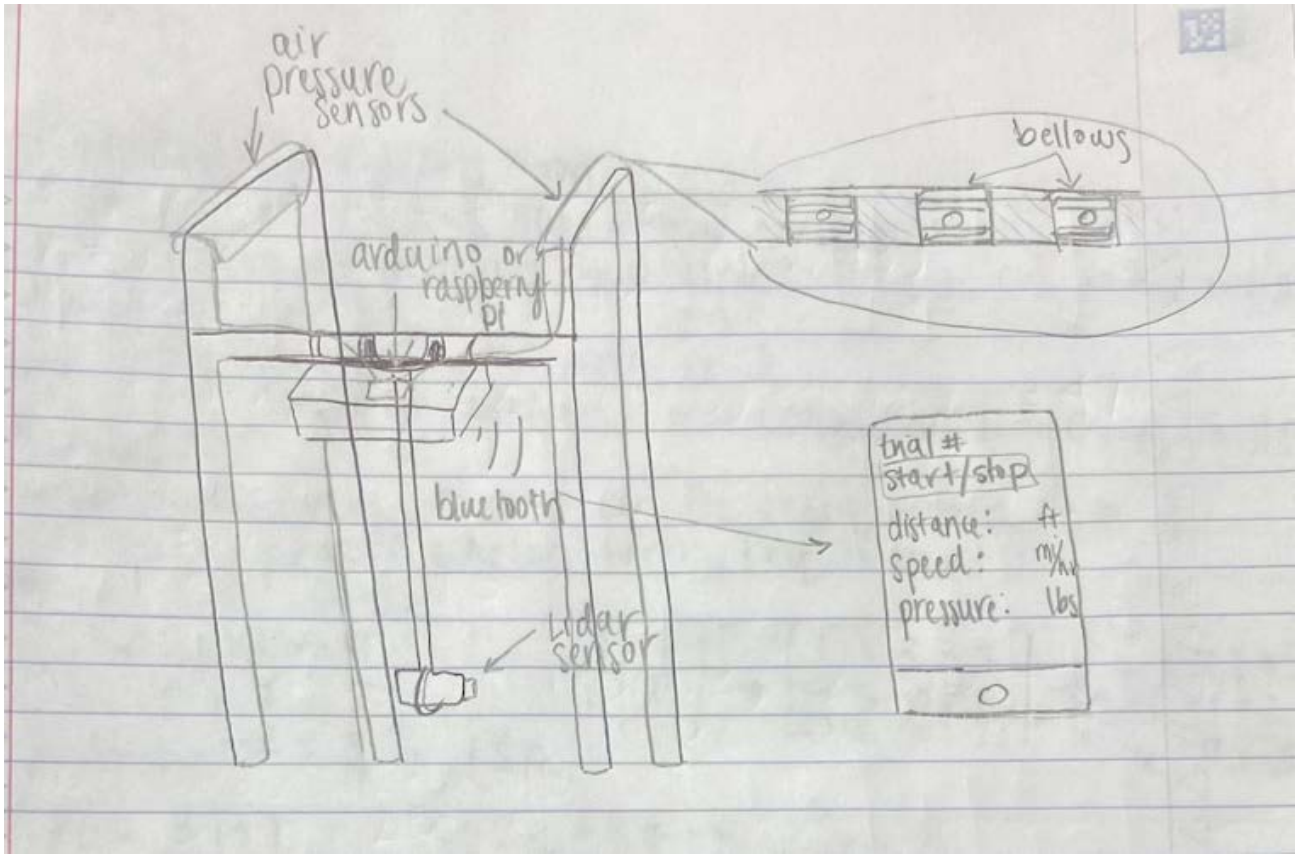
Content by: Carolyn Randolph

Present: Carolyn Randolph

Goals: Demonstrate alternative design idea

Content:

This design works by employing bellows in the handles to measure changes in air pressure and the lidar for the distance and speed.



Conclusions/action items: This design will not work because squeezing the handles could impact the pressure reading.

2025/10/6 - Film Pressure Sensor and Accelerometer Design

Carolyn Randolph - Oct 27, 2025, 8:18 PM CDT

Title: Air Pressure and Lidar Design

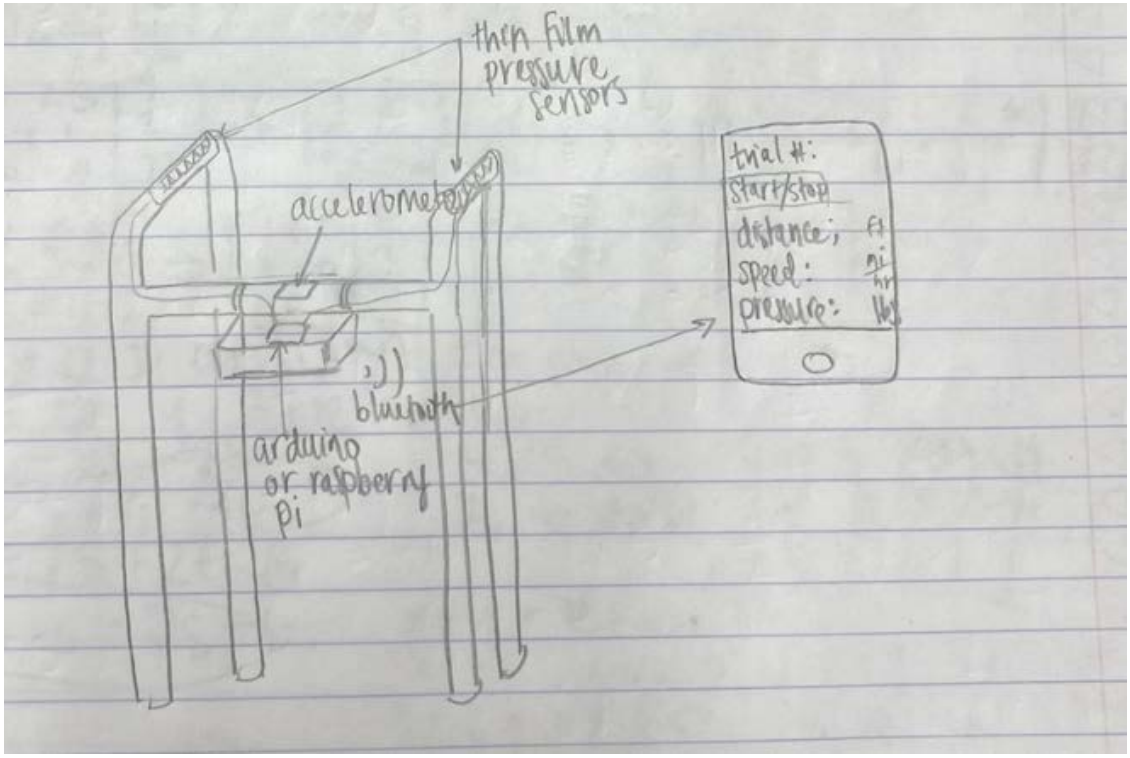
Date: October 6, 2025

Content by: Carolyn Randolph

Present: Carolyn Randolph

Goals: Demonstrate alternative design idea

Content: This design employs piezoelectric strips on the handle bars that deform and change voltage when pressure is applied. To track the speed and distance an accelerometer is used.



Conclusions/action items: This design will not work because squeezing the handles could impact the pressure reading and the accelerometer is less effective.

2025/11/25 - Perfboard Soldering

Carolyn Randolph - Dec 03, 2025, 6:07 PM CST

Title: Perfboard Soldering

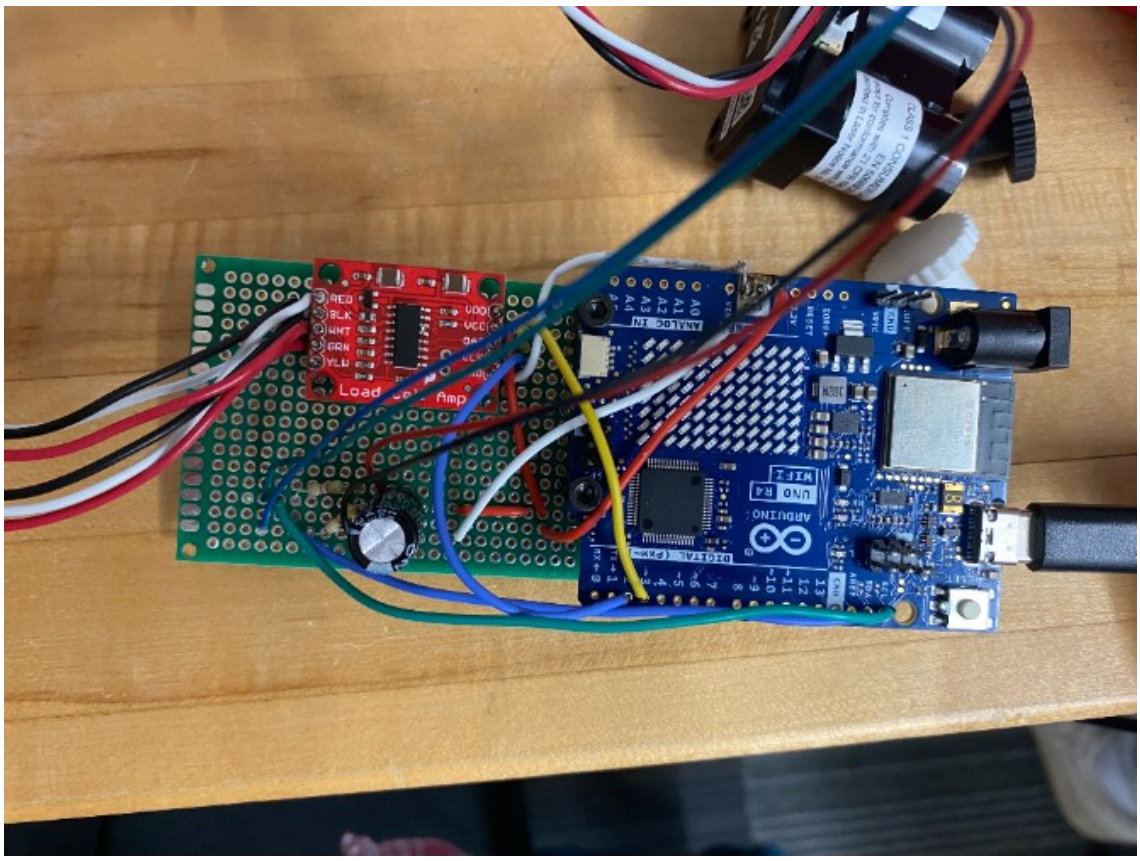
Date: November 25, 2025

Content by: Carolyn Randolph

Present: Carolyn Randolph, Nial Donohoo

Goals: Show the perfboard soldering

Content: The perfboard design is similar to the design of the breadboard, but because the perfboard does not provide connection along the rows, solder must be added. To make the connections the previously used jumper cables were replaced with solder core wire to ensure stable connections.



Connections were soldered directly to the arduino.

Conclusions/action items: Because this was our first time soldering to a perfboard something went wrong with the load cells which will have to be troubleshooted.

2025/11/10 Combined Code

Carolyn Randolph - Dec 03, 2025, 6:15 PM CST

Title: Code for Lidar

Date: November 10, 2025

Content by: Carolyn Randolph

Present: N/A

Goals: Document the combined code for LiDAR and load cells

Content:

```
#include "HX711.h"

#include <Wire.h>

#include <LIDARLite.h>


// ----- HX711 -----

#define calibration_factor -18670.0

#define DOUT 3

#define CLK 2

HX711 scale;


// ----- LIDAR -----

LIDARLite myLidarLite;


// ----- Rate limiting -----

unsigned long lastRead = 0;

const unsigned long interval = 50; // 20 Hz


// ----- Speed calculation state -----
```

```
float prev_ft = NAN;

unsigned long prev_ms = 0;

bool ema_initialized = false;

float speed_ema_ft_s = NAN;


// Convert cm → feet

inline float cmToFeet(int cm) { return cm * 0.0328084f; }


// LIDAR reading + speed calculation

void updateLidar(float &distance_ft_out, float &speed_ft_s_out)

{

unsigned long now = millis();

int dist_cm = myLidarLite.distance(true);


if (dist_cm <= 0) {

// Return previous values if invalid reading

distance_ft_out = prev_ft;

speed_ft_s_out = speed_ema_ft_s;

return;

}


float dist_ft = cmToFeet(dist_cm);

float inst_speed_ft_s = NAN;


if (prev_ms != 0) {
```

```
float dt_s = (now - prev_ms) / 1000.0f;

if (dt_s > 0) {

inst_speed_ft_s = (prev_ft - dist_ft) / dt_s; // positive = approaching


const float alpha = 0.25f; // EMA smoothing

if (!ema_initialized) {

speed_ema_ft_s = inst_speed_ft_s;

ema_initialized = true;

} else {

speed_ema_ft_s = alpha * inst_speed_ft_s +

(1 - alpha) * speed_ema_ft_s;

}

}

}


prev_ft = dist_ft;

prev_ms = now;


distance_ft_out = dist_ft;

speed_ft_s_out = (isnan(speed_ema_ft_s) ? 0 : speed_ema_ft_s);

}


// SETUP

void setup() {
```

```
Serial.begin(115200); // Required for Serial Plotter

Wire.begin();

delay(200); // Let LIDAR boot

// HX711

scale.begin(DOUT, CLK);

scale.set_scale(calibration_factor);

scale.tare();

// LIDAR

myLidarLite.begin(0, true);

myLidarLite.configure(0);

}

// LOOP — single unified Serial Plotter output line

void loop() {

unsigned long now = millis();

if (now - lastRead >= interval) {

lastRead = now;

// ---- Read HX711 ----

float weight_lbs = scale.get_units(1);

// ---- Read LIDAR + speed ----
```

```
float dist_ft = 0;

float speed_ft_s = 0;

updateLidar(dist_ft, speed_ft_s);




// Unified Serial Plotter Format

// label:value \t label:value \t label:value

Serial.print("weight_lbs:");

Serial.print(weight_lbs, 2);

Serial.print("\t");


Serial.print("distance_ft:");

Serial.print(dist_ft, 2);

Serial.print("\t");


Serial.print("speed_ft_s:");

Serial.println(speed_ft_s, 2);

}

}
```

Conclusions/action items: Create connection to WiFi webpage

2025/10/20 Calibration Code

Carolyn Randolph - Dec 03, 2025, 6:18 PM CST

Title: Code for Calibration of load cells

Date: October 20, 2025

Content by: Carolyn Randolph

Present: N/A

Goals: Show the code accessed from the github repository used to calibrate the load cells.

Content:

```
/*

Example using the SparkFun HX711 breakout board with a scale

By: Nathan Seidle

SparkFun Electronics

Date: November 19th, 2014

License: This code is public domain but you buy me a beer if you use this and we meet someday (Beerware license).



This is the calibration sketch. Use it to determine the calibration_factor that the main example uses. It also

outputs the zero_factor useful for projects that have a permanent mass on the scale in between power cycles.



Setup your scale and start the sketch WITHOUT a weight on the scale

Once readings are displayed place the weight on the scale

Press +/- or a/z to adjust the calibration_factor until the output readings match the known weight

Use this calibration_factor on the example sketch



This example assumes pounds (lbs). If you prefer kilograms, change the Serial.print(" lbs"); line to kg. The
```

```
calibration factor will be significantly different but it will be linearly related to lbs (1 lbs = 0.453592 kg).



Your calibration factor may be very positive or very negative. It all depends on the setup of your scale system

and the direction the sensors deflect from zero state

This example code uses bogde's excellent library: https://github.com/bogde/HX711

bogde's library is released under a GNU GENERAL PUBLIC LICENSE

Arduino pin 2 -> HX711 CLK

3 -> DOUT

5V -> VCC

GND -> GND



Most any pin on the Arduino Uno will be compatible with DOUT/CLK.



The HX711 board can be powered from 2.7V to 5V so the Arduino 5V power should be fine.



*/

#include "HX711.h" //This library can be obtained here http://librarymanager/All#Avia_HX711

#define LOADCELL_DOUT_PIN 3

#define LOADCELL_SCK_PIN 2

HX711 scale;
```

```
float calibration_factor = -18760; //-7050 worked for my 440lb max scale setup


void setup() {

Serial.begin(9600);

Serial.println("HX711 calibration sketch");

Serial.println("Remove all weight from scale");

Serial.println("After readings begin, place known weight on scale");

Serial.println("Press + or a to increase calibration factor");

Serial.println("Press - or z to decrease calibration factor");


scale.begin(LOADCELL_DOUT_PIN, LOADCELL_SCK_PIN);

scale.set_scale();

scale.tare(); //Reset the scale to 0


long zero_factor = scale.read_average(); //Get a baseline reading

Serial.print("Zero factor: "); //This can be used to remove the need to tare the scale. Useful in permanent scale projects.

Serial.println(zero_factor);

}


void loop() {


scale.set_scale(calibration_factor); //Adjust to this calibration factor


Serial.print("Reading: ");

Serial.print(scale.get_units(), 1);

Serial.print(" lbs"); //Change this to kg and re-adjust the calibration factor if you follow SI units like a sane person
```

```
Serial.print(" calibration_factor: ");

Serial.print(calibration_factor);

Serial.println();


if(Serial.available())

{

char temp = Serial.read();

if(temp == '+' || temp == 'a')

calibration_factor += 10;

else if(temp == '-' || temp == 'z')

calibration_factor -= 10;

}

}
```

Conclusion: Use this code to calibrate and recalibrate the load cells throughout the process.

2025/11/28 Webpage Code

Carolyn Randolph - Dec 08, 2025, 11:22 AM CST

Title: Code for Lidar

Date: October 17, 2025

Content by: Carolyn

Present: Aidan Burich, Carolyn Randolph

Goals: Take notes on potential code.

Content: Githubs used: https://github.com/garmin/LIDARLite_Arduino_Library , https://github.com/bogde/HX711, libraries/WiFiS3/examples/AP_SimpleWebServer/AP_SimpleWebServer.ino

```
#include "HX711.h"
#include <Wire.h>
#include <LIDARLite.h>
#include <WiFiS3.h>

// Load Cell
#define calibration_factor -18670.0
#define DOUT 3
#define CLK 2
HX711 scale;

// LIDAR
LIDARLite myLidarLite;

// WiFi Access Point
const char* ssid = "Smart_Walker";
const char* password = "12345678";
WiFiServer server(80);

// Update timing
unsigned long lastRead = 0;
const unsigned long sensorInterval = 50;   // 20 Hz
const unsigned long webpageInterval = 1000; // 1s refresh

// Speed State
float prev_ft = NAN;
unsigned long prev_ms = 0;
float speed_ema_ft_s = NAN;
bool ema_initialized = false;

// Latest values
float distance_ft = 0;
float speed_ft_s = 0;
float weight_lbs = 0;

// Trial Control
bool trialRunning = false;
float trialWeightSum = 0;
unsigned long trialWeightCount = 0;

// NEW: Trial metrics
float trialStartDist = NAN;
float trialEndDist = NAN;

// NEW: Avg speed during trial
float trialSpeedSum = 0;
unsigned long trialSpeedCount = 0;
```

```
// Convert LIDAR cm → feet
inline float cmToFeet(int cm) { return cm * 0.0328084f; }

// Calculate LIDAR distance + smoothed speed
void updateLidar(float &dist_out, float &speed_out) {
    unsigned long now = millis();
    int d = myLidarLite.distance(true);
    if (d <= 0) return;

    float dist_ft = cmToFeet(d);
    float instant = 0;

    if (prev_ms) {
        float dt = (now - prev_ms) / 1000.0;
        if (dt > 0) {
            // NOTE: speed = previous − current (walking toward sensor positive)
            instant = (prev_ft - dist_ft) / dt;

            const float alpha = 0.25;
            if (!ema_initialized) {
                speed_ema_ft_s = instant;
                ema_initialized = true;
            }
            else {
                speed_ema_ft_s = alpha * instant + (1 - alpha) * speed_ema_ft_s;
            }
        }
    }
    prev_ft = dist_ft;
    prev_ms = now;

    dist_out = dist_ft;
    speed_out = speed_ema_ft_s;
}

// Return HTML for 1s auto refresh
void sendWeb(WiFiClient &client) {
    client.println("HTTP/1.1 200 OK");
    client.println("Content-Type: text/html");
    client.println("Connection: close");
    client.println();
    client.println("<!DOCTYPE html><html><head>");
    client.println("<meta charset='UTF-8'>");
    client.println("<meta name='viewport' content='width=device-width'>");
    client.println("<meta http-equiv='refresh' content='1'>");
    client.println("<style>");
    client.println("body{font-family:Arial;text-align:center;}");
    client.println("h1{margin-top:18px;}");
    client.println("div{font-size:1.5em;margin:10px;}");
    client.println(".btn{padding:10px 20px;margin:5px;font-size:1em;border:none;border-radius:6px;}");
    client.println(".start{background:#4CAF50;color:white;}");
    client.println(".stop{background:#d32f2f;color:white;}");
    client.println("</style>");
    client.println("</head><body>");
    client.println("<h1>Smart Walker Live Telemetry</h1>");
    client.print("<div>Status: ");
    client.print(trialRunning ? "RUNNING" : "STOPPED");
    client.println("</div>");
    client.print("<div>Weight (lbs): "); client.print(weight_lbs, 2); client.println("</div>");
    client.print("<div>Distance (ft): "); client.print(distance_ft, 2); client.println("</div>");
    client.print("<div>Speed (ft/s): "); client.print(speed_ft_s, 2); client.println("</div>");
    client.println("<a href='/start'><button class='btn start'>Start Trial</button></a>");
    client.println("<a href='/stop'><button class='btn stop'>Stop Trial</button></a>");
    client.println("<p>Page auto-refreshes every 1 second.</p>");
```

```
    client.println("</body></html>");
}

// SETUP
void setup() {
    Serial.begin(115200);

    // Sensors
    Wire.begin();
    delay(200);
    scale.begin(DOUT, CLK);
    scale.set_scale(calibration_factor);
    scale.tare();

    myLidarLite.begin(0, true);
    myLidarLite.configure(0);

    // WiFi
    WiFi.beginAP(ssid, password);
    delay(500);
    Serial.print("WiFi AP IP: ");
    Serial.println(WiFi.localIP());
    server.begin();
}

// LOOP
void loop() {
    unsigned long now = millis();

    // SENSOR LOOP (20 Hz)
    if (trialRunning && now - lastRead >= sensorInterval) {
        lastRead = now;

        // Weight
        weight_lbs = scale.get_units(10);

        // Distance + speed
        updateLidar(distance_ft, speed_ft_s);

        // Track average weight
        trialWeightSum += weight_lbs;
        trialWeightCount++;

        // NEW — track speed average
        if (!isnan(speed_ft_s)) {
            trialSpeedSum += speed_ft_s;
            trialSpeedCount++;
        }

        // NEW — track end distance always
        trialEndDist = distance_ft;

        Serial.print("weight:"); Serial.print(weight_lbs,2);
        Serial.print("\tdist:"); Serial.print(distance_ft,2);
        Serial.print("\tspeed:"); Serial.println(speed_ft_s,2);
    }

    // WEB REQUEST HANDLING
    WiFiClient client = server.available();
    if (client) {
        while (client.connected() && !client.available()) delay(1);
        String req = client.readStringUntil('\r');
        client.flush();

        // Handle start/stop trial
        if (req.indexOf("GET /start") >= 0) {
            trialRunning = true;
```

```
            // reset metrics
            trialWeightSum = 0;
            trialWeightCount = 0;

            trialSpeedSum = 0;
            trialSpeedCount = 0;

            trialStartDist = distance_ft;
            trialEndDist   = distance_ft;

            Serial.println("=== Trial START ===");
        }

        if (req.indexOf("GET /stop") >= 0) {
            trialRunning = false;
            Serial.println("=== Trial STOP ===");

            // ---- AVERAGE WEIGHT
            if (trialWeightCount > 0) {
                float avgWeight = trialWeightSum / trialWeightCount;
                Serial.print("Trial Average Weight (lbs): ");
                Serial.println(avgWeight, 2);
            }

            // ---- NEW: AVERAGE SPEED
            if (trialSpeedCount > 0) {
                float avgSpeed = trialSpeedSum / trialSpeedCount;
                Serial.print("Trial Average Speed (ft/s): ");
                Serial.println(avgSpeed, 2);
            }

            // ---- NEW: ABSOLUTE ΔDISTANCE
            if (!isnan(trialStartDist) && !isnan(trialEndDist)) {
                float deltaAbs = fabs(trialEndDist - trialStartDist);
                Serial.print("Absolute ΔDistance (ft): ");
                Serial.println(deltaAbs, 2);
            }
        }

        sendWeb(client);
        client.stop();
    }
}
```

Conclusions/action items:

2025/11/23- CITI Human Subjects Training

Carolyn Randolph - Dec 03, 2025, 6:11 PM CST

Title: CITI Human Subjects Training

Date: November 23, 2025

Content by: Carolyn Randolph

Present: Carolyn Randolph

Goals: Demonstrate completion of required training for the semester

Content:

CITI PROGRAM

Completion Date 23-Nov-2025
Expiration Date 23-Nov-2028
Record ID 73107829

This is to certify that:

Carolyn Randolph

Not valid for renewal of certification through CME.

Has completed the following CITI Program course:

Basic/Refresher Course - Human Subjects Research
(Curriculum Group)
UW Human Subjects Protections Course
(Course Learner Group)
1 - Level 1
(Stage)

Under requirements set by:

University of Wisconsin - Madison

CITI
Collaborative Institutional Training Initiative
101 NE 3rd Avenue, Suite 320
Fort Lauderdale, FL 33301 US
www.citiprogram.org

Conclusions/action items:

2025/09/10 Lecture Notes 1

Carolyn Randolph - Sep 10, 2025, 2:08 PM CDT

Title: Lecture Notes 1

Date: September 10, 2025

Content by: Carolyn Randolph

Present: N/A Lecture Setting

Goals: Take notes on BME career preparation.

Content: The ECS website has a job tracker excel spreadsheet to stay organized. Indeed, google jobs are examples of aggregator sites and should not be used to apply. Don't only apply to "perfect" positions. Tailoring your resume to the job description is important. Make design project descriptions specific to the work you do. Your resume is always under construction. Cover letters package the information of the resume in a more concise format. Look at where program overlaps with other disciplines. Don't filter very specifically within Handshake. Technical skills should be listed in skills as opposed to soft skills.

Conclusions/action items: Download job tracker. Look at companies visiting for the career fair next week.

2025/09/17 Lecture Notes 2

Carolyn Randolph - Sep 17, 2025, 2:07 PM CDT

Title: Lecture Notes 2

Date: September 17, 2025

Content by: Carolyn Randolph

Present: N/A Lecture Setting

Goals: Take notes on Exploring Leadership Styles

Content: Self-awareness is important to being a leader and considering what kind of leader you are and want to become. Empathy helps connect with the people you are leading. Multiple levels of leadership; organizational, team, interpersonal, personal. Three different examples of leadership styles are the power model, servant leadership, and authentic leadership. Power model: based on outdated theories from the 1940s that define the leader as the most important. Servant leadership works on developing and empowering the people on the team. Authentic leadership is based of gaining and building trust through authenticity and openness to others. The power model can still be useful, but may be a less favorable experience at times for the followers. Authentic leadership doesn't provide that much structure and therefore can be less efficient. Thought-Oriented Leadership aligns with the results of my Clifton Strengths test because I value strategic thinking and foresight. Leadership doesn't require a title. Helpful to identify mentors. I am looking forward to practicing coaching and mentoring this semester. This could look like checking in with the sophomores on the team and answering their questions as well as guiding them through the project.

Conclusions/action items: Review Clifton Strengths assessment.

2025/09/24 Lecture Notes 3

Carolyn Randolph - Sep 24, 2025, 2:08 PM CDT

Title: Lecture Notes 3

Date: September 24, 2025

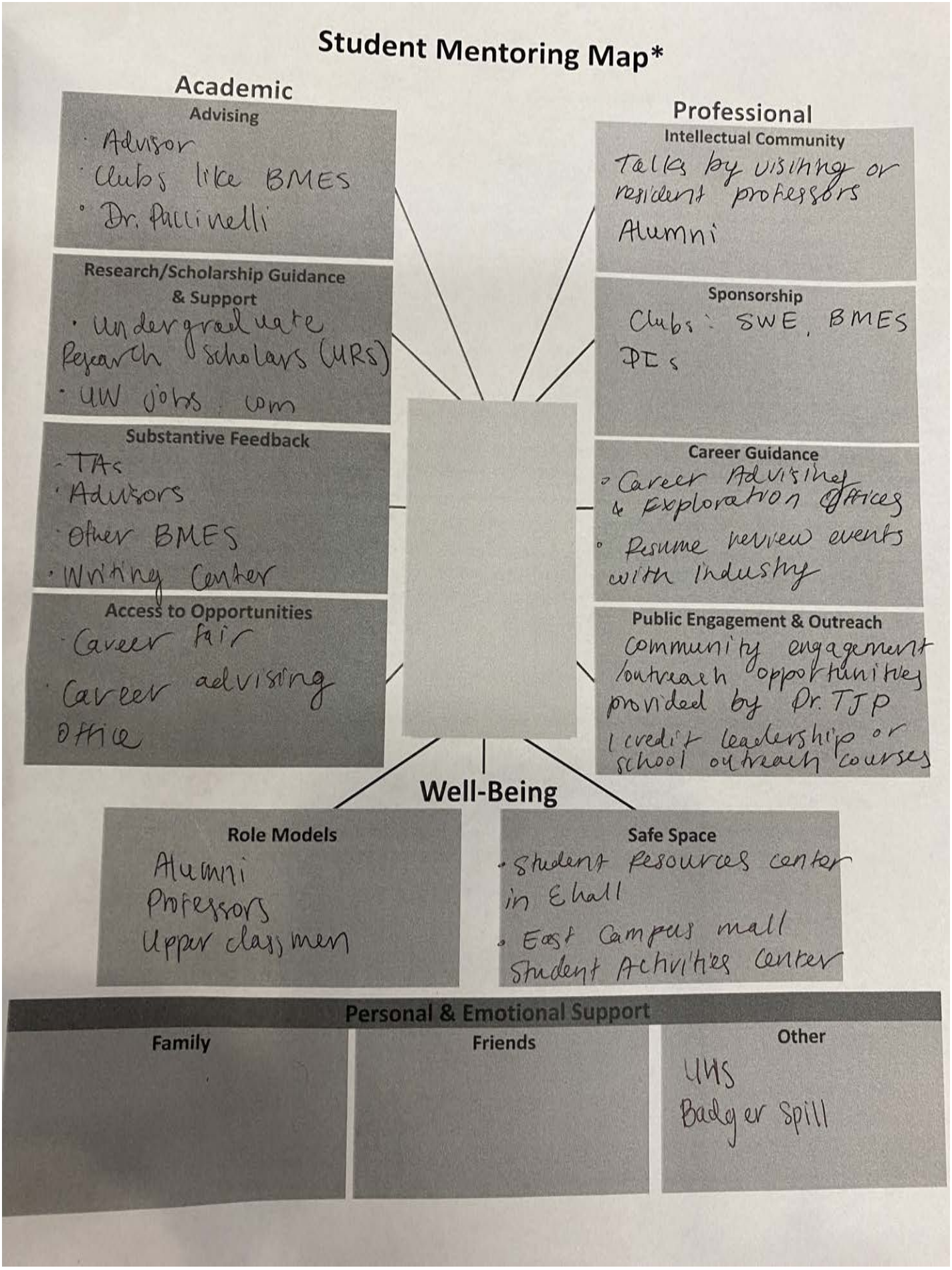
Content by: Carolyn Randolph

Present: N/A Lecture Setting

Goals: Take notes on Mentoring

Content: See one, do one, teach one. Benefits of the mentoring infrastructure include: Increased belonging. Peer mentors are more approachable. Transferrable skills such as leadership, communication, active listening, study practices, self awareness, interpersonal skills.

Advice on how to be a good mentor: Humanize their challenges and coach them. Listening effectively includes asking questions and following up as well as reacting to ideas not to the person.



Conclusions/action items: Share info with sophomores

2025/10/01 Lecture Notes 4

Carolyn Randolph - Oct 08, 2025, 1:17 PM CDT

Title: Lecture Notes 4

Date: October 1, 2025

Content by: Carolyn Randolph

Present: N/A Lecture Setting

Goals: Take notes on Sustainability in BME

Content: Three paradigms of sustainability; social, environmental, economic. Circular economy, keeping resources circulating in the economy. Think about when it is vs. when it is not worth it to recycle materials. Life cycle assessments are quantitative. Easy choices are ones that reduce environmental impact and cost. Break even points are when two options are equal. For example of speculums, depends on the amount of exams being conducted. Carbon dioxide equivalents are normalized to compare the global warming potential or a different gas to carbon dioxide. There are three classes to categorize infection risk. As long as you wash the reusable surgical gowns its the same as the disposable ones. Often decisions are subject to supply restrictions.

Conclusions/action items: Consider application to project. For example, the durability of the different sensors involved as well as the sustainability of the battery.

2025/10/08 Lecture Notes 5

Carolyn Randolph - Oct 08, 2025, 2:08 PM CDT

Title: Lecture Notes 5

Date: October 8, 2025

Content by: Carolyn Randolph

Present: N/A Lecture Setting

Goals: Take notes on IP and patenting process.

Content: WARF is a non-profit organization that supports students and professors with patents, copyright, trademarks, and trade secrets. Technology transfer moves research results from campus out into the market. WARF works to facilitate securing IP rights and commercial licenses. Often times work is premature to receive trademarks and trade secrets because of this they are often incompatible with the work WARF does. Copyrights: protection for creative works that are expressed in a tangible medium, includes software code and surveys. Not as time sensitive as patents. Trademarks: protection for names, marks, logos, dress etc. More so protection for consumers not creators. Requires use in commerce. Trade Secrets: can be used to protect anything of value. Area of concern for company or employer. Patents: time-limited monopoly on invention. Must enable and fully describe to public, opposite of trade secret. Three kinds of patents - design, plant, utility. Provisional gives time to develop idea and documentation as a placeholder. Patents are expensive - around $30k mostly in attorney fees. WARF covers those expenses. Applies to process, machine, manufacture, or composition of matter. Preliminary requirements: eligible, novel, non-obvious, enabled and described. Patent examiners are scientists hired and trained by the USPTO to review patent applications along these requirements. Keeping notes on what did and didn't work is important. Broad claims and patents are advantageous. Spend a lot of time doing market analysis. Most of revenue/return comes from royalties.

Conclusions/action items: Reach out to WARF if questions come up.

2025/10/15 Lecture Notes 6

Carolyn Randolph - Oct 15, 2025, 2:10 PM CDT

Title: Lecture Notes 6

Date: October 15, 2025

Content by: Carolyn Randolph

Present: N/A Lecture Setting

Goals: Take notes on Bioengineering IP, Patenting and Law

Content: Andrea is an IP/Patent Lawyer who majored in BME. Patent litigation is very expensive. Important to have the right kinds of IP. Skipping steps before bringing stuff to market can be problematic for you or your company. The patent owner wants big broad protection, patent examiners on the other hand want the smallest fence. All working towards the same goal of protecting innovation. In a large company they usually have a legal team and know what they need vs. startups who don't have as much direction, but they have a story. Patent litigation can be exciting. Technical writing learned in engineering school is highly applicable in careers. If the patent isn't commercially viable then WARF won't pursue it. In universities the university usually owns the IP and possibly gives back licensing opportunities. In companies employers typically own the inventions contingent on what the employee agreements are. In startups you own the IP, must file early and use NDAs. Contributors do some component of work, but not directly related to the content of the patent. There are phases A-H on the biomedical start-up IP checklist. Trade secrets have more risk involved than patents. Utility patents cover the function of something. Design patents protect the visual appearance of a product. Claims are what you look at to see if you are infringing on a patent. Patentability search some can be done by yourself, but eventually you will need a lawyer. Trademark: logo, fonts, sounds, smells, colors. Copyright could be instruction manuals, source code, web design. Don't have to file anything for trade secret protection.

Conclusions/action items: Bring information to the sophomores.

2025/10/22 Lecture Notes 7

Carolyn Randolph - Oct 22, 2025, 2:03 PM CDT

Title: Lecture Notes 7

Date: October 22, 2025

Content by: Carolyn Randolph

Present: N/A Lecture Setting

Goals: Take notes on Advising for BME post-grad plans.

Content: Story should be able to connect to somebody you don't know and identify your unique connection. Masters can be a stepping stone, allow for a change in direction, gain depth. Shouldn't get a Masters just for the extra credit. MS can fill gaps in your resume, can make you more credible for shadowing or volunteering. Research MS 1.5-2 years for those continuing on for a PhD here. Can be funded as RA/TA/PA (tuition remission and stipend). Thesis required (must have a lab PI identified and willing to support before applying). Accelerated programs (1 year) funding (TA only) stipend only (no tuition remission). No co-op allowed. Accelerated is coursework only. Biomedical Innovation, Design, and Entrepreneurship is project-based and partnered with business school. To get automatically admitted need at least 3.0 overall/ 3.0 in the last 60 credits. Can get MS in other Engineering Department (generally takes longer). MBA generally industry pays for credits or evening options. REU - research experience for undergraduates is a must for PhD applications. Applying early is advantageous because they do rolling reviews. For med school sometimes need advanced writing elective. Research is required for med school. Volunteering is required especially patient contact time. "I will do anything" has limited appeal and sounds desperate.

Conclusions/action items: Consider options and process for post-grad.

2025/10/29 Lecture Notes 8

Carolyn Randolph - Oct 29, 2025, 2:11 PM CDT

Title: Lecture Notes 8

Date: October 29, 2025

Content by: Carolyn Randolph

Present: N/A Lecture Setting

Goals: Take notes on FDA and regulation

Content: Important takeaways: devices are different than drugs. For drugs, understanding what receptors are engaged. Lipinski's rule of five for drug trials to see what receptors are engaged. FDA determines if benefits outweigh the risks. Three classes of devices based on risk that correspond to different pathways. Clinicians have limited window into regulation. Instead of phase I, II, III devices have early-feasibility, feasibility etc. 510(k) pathway pushed by industry to accept that given there are predicate devices, don't have to same level of testing. De Novo, no predicate, but can become predicate. HDE probable benefit outweighs the risk. 1976 FDA started regulating devices. At first had no universal reporting system. Companies had an incentive to not look for it. Although medical device recalls represent a failure to protect safety of patients there is little to no effect on revenue. Often times very little expertise in FDA and companies to determine failure modes. If any one point failed what would happen - failure mode analysis. Most industry papers are signed off by clinicians that barely read it.

Conclusions/action items:

2025/11/12 Lecture Notes 9

Carolyn Randolph - Nov 12, 2025, 2:02 PM CST

Title: Lecture Notes 9

Date: November 12, 2025

Content by: Carolyn Randolph

Present: N/A Lecture Setting

Goals: Take notes on IRBs

Content: Historical problematic research includes Tuskegee syphilis study, WWII Nazi prisoner experiments, Guatemala syphilis experiments, and Willowbrook hepatitis experiments took advantage of vulnerable groups. Nuremberg Code emphasis on voluntary consent. Declaration of Helsinki focused on medical research, HIPAA ect. National Research act led to IRBs. Belmont Report requirement to acknowledge autonomy and protect those with diminished autonomy. Maximize possible benefits and minimize possible harms. 1991 Dept of Health and Human Services issued 45 CFR 46 includes criteria for approving research, protections for vulnerable groups, requirements for IRB operations. 2018 revised common rule reduced administrative burden. IRB diversity of membership required; race, gender, cultural background and diverse expertise MD, PhD, MPH, faculty, clinicians, non-scientists- community members, IRB staff. Volunteer position. The purpose is to protect the rights and welfare of people enrolled in research. Reviews human research according to common rule, HIPAA, FERPA, state laws. No retrospective approval of research that has already been done. Informed consent: participants need to be able to make an informed decision unless a waiver is applicable. Privacy protects the person themselves, confidentiality protects their data. There are sometimes quality improvement projects that don't qualify as research. Won't apply to medical devices, FDA has broader definition of human subjects need to contact FDA regulated research oversight program. After approval, begin study, changes of protocol must have approval before implementing change, reportable events: noncompliance, unanticipated problem, new information.

Conclusions/action items:

2025/11/19 Lecture Notes 10

Carolyn Randolph - Nov 19, 2025, 2:07 PM CST

Title: Lecture Notes 10

Date: November 19, 2025

Content by: Carolyn Randolph

Present: N/A Lecture Setting

Goals: Take notes on bringing devices to market.

Content: How new product development works at most medical device companies. Highly regulated by FDA and other regulatory bodies outside of the US. Very resource intensive involving sizeable teams. Competitive especially for cardiovascular. Corporate business strategy focuses on the next 3-5 years. Define which product categories to develop, sustain, or eliminate. Select and prioritize projects to support over the next 1-3 years. Outline budget as part of annual process. Line extensions- addition of sizes and configurations. Product improvements- change existing product due to market feedback and/or new customer needs. New to company- not new to market, but new to company. New to world - most rare and risky creates new markets. Product development engineers and project managers tend to lead teams. Stage-gate process: stage 0 ideation, stage 1 exploration 8-10 opportunities primary and secondary market research, stage 2 concept stage, stage 3 real engineering takes place testing and development in iterative process, stage 4 design confirmation is longest part in process verification and validation, stage 5 design transfer and commercialization. The cloud, funnel, and tunnel. with gate reviews between each stage including go/no-go decision, design freeze, and launch. Last step is post market surveillance.

stage 0: choose area of opportunity

review market trends and/or competitive threats

unmet needs- interview and ask questions

high-level back of napkin ideas

stage 1: exploration

define problem and reqs

high-level business case

technical scouting

stage 2: concept definition

freedom to operate is very important

down-select from 8-10 to 2-3 to one leading concept

robust business case including market opportunities, initial forecast

stage 3: design development

move to functional prototype

confirm regulatory pathway

begin formal design control documentation

risk assessments

design control mandatory for FDA class 2 & 3 and almost all EMA devices, risk management portfolio, documentation

stage 4: Design Confirmation

most intense part of process

finalize product and component drawings- hone in on tolerances

accelerate manufacturing process development along with plans for quality control

"freeze" design at the end of this stage

submit regulatory documentation

Stage 5: Design transfer and commercialization

IFUs

marketing and sales - collateral, spin and story

wanted the fluid to be visible

Post market surveillance - complaints, accounts sales, business and regulatory issues observed, product and process improvement opportunities

Ideas can move to parking lot for future consideration.

Conclusions/action items:

9/14/2025 Walkers with Wheels vs No Wheels Walkers

HENRY SALITA - Sep 14, 2025, 12:49 PM CDT

Title: Walkers with Wheels vs No Wheels Walkers

Date: 9/14/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To better understand the use of walkers and when they are effective and when they aren't.

Content:

Purpose of the review

- To find out if walkers with wheels (rollators, gutter/forearm-support frames) are more effective than walkers without wheels (standard “pick-up” or Zimmer frames) in preventing falls among older adults.
- Focused on outcomes like fall prevention, mobility, energy cost, and safety.

What evidence they found

- Only one systematic review (2013) with two small observational studies met criteria.
- No randomized controlled trials directly comparing wheeled vs non-wheeled walkers.
- Because of this, the evidence is considered low quality and limited.

Main findings

- Energy cost: Using a fixed (non-wheeled) walker required more effort. The Physiological Cost Index (PCI, a measure of energy used for walking) was higher:
    - Fixed walker = PCI 2.01
    - Rollator = PCI 1.23
        - Suggests rolling helps conserve energy.
- Heart rate: Users had a lower maximum heart rate when walking with wheeled walkers compared to fixed.
- Timed Up and Go (TUG): Performance was faster with wheeled walkers. This means people could stand up, walk, and sit down more quickly.
- Six-Minute Walk Test (6MWT): In patients with chronic obstructive pulmonary disease (COPD), gutter (forearm-support) walkers let them walk farther and with less oxygen desaturation compared to non-wheeled. Rollators fell in between.
- Falls: The review could not show clear differences in actual fall numbers because the included studies did not track falls as a main outcome.

Limitations

- Very small number of studies, all observational (not randomized).
- Device descriptions were vague (e.g., different rollator or gutter frame models not specified).
- Missing data on long-term outcomes like hospitalizations, quality of life, or injury severity.
- Because of this, the review could not draw strong conclusions about which walker is “better” for preventing falls.

Conclusions/action items:

The review basically says that wheels with walkers make it easier to walk. The actual reading was trying to decide what the best walker for old people is that prevents falls, but it didn't come to a solid conclusion about that. The main thing I took away from this reading is the importance of arm support on walkers. Not only does it make it easier to walk with a walker, but it makes me think about the possibilities of recording data through fore arm supports, specifically the weight-bearing aspectct of the design, which, according to our client, is our most important metrics to record.

-Come up with some preliminary designs

- Get walker/material from client

Continue to research throughout the entire project.

Reference:

K. X. Li and K. Farrah, Walkers with Wheels Versus Walkers Without Wheels for Fall Prevention in Older Adults: A Review of the Comparative Clinical Effectiveness. Ottawa, ON: Canadian Agency for Drugs and Technologies in Health, 2019. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK549405/

9/16/2025 Notes on the importance of gait speed in predicting future recover

HENRY SALITA - Sep 17, 2025, 11:01 AM CDT

Title: Notes on the correlation of the gait speed with the quality of life and the quality of life classified according to speed-based community ambulation in Thai stroke survivors

Date: 9/16.2025

Content by: Henry Salita

Present: Henry Salita

Goals: To better understand the importance of recording gait speed in regard to predictions of future recovery. This is the reason to why we are measuring this metric.

Content:

Study Basics

- 92 Thai stroke survivors, avg age ~63.
- Gait speed → measured with 10-Meter Walk Test (10MWT).
- Quality of life → measured with Stroke Impact Scale (SIS 3.0).

Key Findings

- Average gait speed: 0.51 m/s.
- Strong correlation between gait speed and SIS total score ($r \approx 0.64$, $p < 0.001$).
- Faster gait speed = higher scores in strength, mobility, ADLs, hand function, social participation, and recovery perception.
- Weak or no correlation in emotion, memory, communication.

Speed Thresholds (clinically meaningful)

- <0.4 m/s = household ambulation, lowest QoL.
- 0.4–0.8 m/s = limited community ambulation.
- 0.8 m/s = community ambulation, highest QoL.
- Community ambulators (≥0.8 m/s) had SIS ~730 vs ~479 in household ambulators.

Design Relevance

- Thresholds (0.4 & 0.8 m/s) can be built into device as progress markers.
- Device must measure speed accurately within ~0.1–0.2 m/s.

- Logging days per week walked in community aligns with patient QoL outcomes.
- Data collected (speed + frequency) can show functional recovery over time.
- Clinicians and patients value gait speed because it links to independence and social participation.

Conclusions/action items:

This study shows that gait speed is not just a number, but it also predicts quality of life and independence after stroke, which I believe could be comparable to other people in neurorehabilitation. For our smart walker, measuring and tracking speed gives data that clinicians already recognize as meaningful. By targeting the different speed thresholds, the Smart Walkers can provide feedback that directly connects to patient outcomes, making it both clinically useful and justifiably important.

- Research the reasons and importance of the other metrics we will be recording

- Do the PDS as its due on thursday the 18th

- I personally want to start sketching out some design ideas as I believe that I am better understanding the direction of our project.

Reference:

[1] P. Khanittanuphong and S. Tipchatyotin, “Correlation of the gait speed with the quality of life and the quality of life classified according to speed-based community ambulation in Thai stroke survivors,” NeuroRehabilitation, vol. 41, no. 1, pp. 135–141, 2017, doi: 10.3233/NRE-171465.

10/10/2025 Amount of weight the a walker bears

HENRY SALITA - Oct 10, 2025, 11:06 AM CDT

Title: Force Exerted on Walker Research

Date: 10/10/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To further my understanding of how much vertical force is actually applied to the walker for rehabilitation purposes. This will help us better understand what load cells we can use.

Content:

The main idea was to figure out how much weight the walker actually carries and how patients use their arms vs. legs.

They found that:

- The amount of weight each person put on their walker was different, but each person was very consistent in their own walking pattern.
- At some points, the walker carried 33% to 67% of the person's body weight
- The highest loads usually happened when the person's less-injured leg was swinging through the air, meaning their arms and the walker were taking most of the load at that moment.
- Sometimes the center of pressure (basically where the walker's weight is focused) moved close to the edges of the walker base, which could make it unstable or risky.
- Overall, the walker's job is to help the arms take some of the work off the legs, which makes sense for rehab after leg injuries or amputation.

The authors say this kind of testing is really useful because it shows how much stress the walker itself experiences, and why proper training and design matter. It also means that smart walkers (like yours) could use force sensors to measure this load and help track progress or safety.

R. D. Pardo, D. A. Winter, and A. B. Deathe, "System for routine assessment of walker-assisted gait," Medical Engineering & Physics, vol. 15, no. 3, pp. 190–196, 1993, doi: 10.1016/S0268-0033(93)90036-H.

Conclusions/action items:

This information actually helps me a lot as this leads me to believe that we will be able to use 50kg load cells. This is becuase they can support an overload of 150%, thats like the absolute max. This lead me to believe that the majority of the time they use the walker we are building off of for people less than 300lb (150kg), and following what the article says, if that person puts the higher end of their weight on the walker then we are still find because it will be below the recommended overload weight. Either way it seems that the majority of the time these load sensors will be perfectly fine, and when they are pushed a little bit they will be able to handle the stress applied if nesseary.

11/23/2025 TPU durabillity> PLA

HENRY SALITA - Nov 23, 2025, 3:00 PM CST

Title: Henry Salita

Date: 11/23/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To have research that supports our use of TPU for the load cell housing, a testament to its durability.

Content:

- TPU vs. PLA — Justification Notes (with IEEE citations)
- TPU offers excellent flexibility, durability, abrasion resistance, and tensile performance, making it far more suitable than PLA for components that undergo repeated loading and deformation [1].
- TPU's energy absorption capabilities (honeycomb, foam, and lattice structures) allow it to handle impacts and vibrations without cracking —PLA cannot provide comparable shock absorption [1].
- Interlayer adhesion in TPU improves significantly with proper temperature and infill settings, producing tough prints that resist delamination during load-bearing applications [1].
- TPU is widely used in prosthetics, orthoses, protective gear, and even non-pneumatic tires, demonstrating proven performance in high-stress, cyclic-load environments similar to walker use cases [1].
- PLA/TPU blend studies show that TPU is the toughness-enhancing phase, confirming that TPU alone is the correct choice when strength, flexibility, and fatigue resistance are required [1]

Reference:

[1] S. M. Desai, R. Y. Sonawane, and A. P. More, "Thermoplastic polyurethane for three-dimensional printing applications: A review," Polymers for Advanced Technologies, vol. 34, no. 7, pp. 2061–2082, 2023.

Conclusions/action items:

To sum up, TPU is a safer option for us to use for the load cell housing as it will be supporting the weight of the walker and whatever force is applied. This could be up to 300 lbs of weight, and because of this, we are using TPU because, in comparison to PLA, it is much more capable of handling stress and has more friction, which will be good as the walker slides across the ground. This is the material we will be printing our Load Cell housing designs in going forward..

9/10/2025 Notes on A review of the functionalities of smart walkers

HENRY SALITA - Sep 14, 2025, 12:20 PM CDT

Title: A review of the functionalities of smart walkers research notes

Date: 9/10/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To understand the functionalities of other existing smart walkers in relevance to our smart walker projects goals.

Content:

ait Definition- a person's manner of walking. (this word comes up a lot)

This article is about many kinds of smart walkers that share different goals. This includes: providing security (avoiding falls and obstacles), postural control of patients, and navigational assistance. In order to do so, recently, researchers began to also focus their work on trying to standardize and create an effective way to assess and evaluate gait.

* That last part is what I want to focus on, the effective way to assess and evaluate gait

Smart Walkers
The need for smart walkers (SW) comes from problems with older simple designs, falling being the main concern.
Our SW will not aid in gait, just record data

Big concern with the safety of SW and its ability to balance with the added stuff
Weight from technical modifications should be more towards the button for better stability.
Shouldn’t interfere with users' decisions or how they want to use it. (not really applicable because our devices isn’t making decisions)
Keep it light
More productive use
Easier to transport

When it comes to sensing and recording data, types of sensors and their locations are important. So bellow I will briefly talk about those mentioned in this article:

Sensors and where they go!
Handles (grips): force sensors to read push/turn and vertical load.
Forearm supports: force sensors to capture support load and gait events.
Wheels: encoders for distance/speed; used also to estimate user velocity.
Front/base of walker: laser range finder (LRF) pointed at legs to track leg position and user walker distance.
Chest-level (safety): infrared sensor to detect forward falls (chest approaching frame.)
Not really for us
On the user: ultrasonic at ankles, foot accelerometers
The drawback is that the user has to wear sensors

For our projects I feel like the best options for us on placement of sensors would be on the wheels and the base, because we want to keep our walker safe and usable.

Reference:
[1] M. Martins, C. Santos, A. Frizera, and R. Ceres, “A review of the functionalities of smart walkers,” Medical Engineering & Physics, vol. 37, pp. 917–928, 2015.

Conclusions/action items:

This article mentions that there are many uses for smart walkers, such as assisting with walking, visual navigation, or collecting data. For our project, our main concern and purpose of our smart walker is to collect data for physician's use. Building off of that though, the reivew mentions how there are many possible ways to measure all the metrics we need to record: different sensors and the locations of those sensors. That is something we will have to figure out as we research more, but the majority of the weight, hopefully not that much, should be placed more towards the bottom of the walker to ensure safety and stability of the walker. We need to make sure the walker stays light weight so it is still effective for rehabilitation and easy to transport.

Next steps:

1. Meet with the client to get a better understanding of the project needs.

2. Research further into what works on smart walkers and what doesn't.

3. Meet with the group and discuss the preliminary design direction we want to head in.

9/18/2025 Relevant Standards (Included in PDS)

HENRY SALITA - Sep 18, 2025, 2:11 PM CDT

Title: Relevant Standards (Included in PDS)

Date: 9/18/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To understand some of the legal regulations and things we need to keep in mind as we are designing our project.

Content:

- ISO 11199-1:2021: Assistive products for walking — Walking frames — Requirements and test methods

1. This standard highlights the performance, safety, and durability requirements for walking frames, such as our Smart Walker. This includes the load, fatigue, and stability testing. This is intended to ensure that walkers and any add-ons do not compromise user safety or functionality.

- ISO 14971:2019: Medical devices — Application of risk management to medical devices

1. This standard defines a structured process for identifying hazards, estimating and evaluating risks, implementing control measures, and monitoring effectiveness. This standard is important for documenting and managing risks for many components of our Smart Walker such as structural failure, inaccurate weight data, or electrical hazards associated with the add-on.

References:

International Organization for Standardization, ISO 11199-1:2021 — Assistive products for walking — Walking frames — Requirements and test methods. Geneva, Switzerland: ISO, 2021. [Online]. Available: https://www.iso.org/standard/76651.html

International Organization for Standardization, ISO 14971:2019 — Medical devices — Application of risk management to medical devices. Geneva, Switzerland: ISO, 2019. [Online]. Available: https://www.iso.org/standard/72704.html

Conclusions/action items:

The standards listed above are guidelines to keep in mind while designing our project, ensuring compliance with legal requirements. These are just two, and there are many other standards and requirements we have for our project. Additionally, there are likely more standards or requirements that we need to consider.

-continue to research standards and legal requirements

-research more into current patents that overlap with some of our initial designs

- continue to design so we know what specific regulations and patents we need to keep in mind.

9/23/2025 Notes on Accuracy of Pedometers

HENRY SALITA - Sep 23, 2025, 4:30 PM CDT

Title: Notes on Accuracy of Pedometers

Date: 9/23/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To understand if buying or implementing a market pedometer to track data would be sufficient for tracking speed and distance.

Content:

Study Purpose

- Investigated pedometer accuracy during slow overground walking in older adults (average age ≈ 64 years).
- Compared five pedometer brands: Omron HJ105, Yamax Digiwalker 200, SportLine 330, New-Lifestyles 2000, and ActiCal accelerometer.

Methods

- Participants: 18 community-dwelling older adults, healthy, no gait aids.
- Speeds tested: 0.46 m/s (50 steps/min), 0.66 m/s (66 steps/min), 0.85 m/s (80 steps/min), and self-selected ≈ 1.31 m/s.
- Criterion measure: manual step counts by observers.
- Devices worn at waist per manufacturer instructions.

Key Results

- Accuracy strongly dependent on walking speed.
    - Mean error across all devices:
        - 56% at 50 steps/min (0.46 m/s)
        - 40% at 66 steps/min (0.66 m/s)
        - 19% at 80 steps/min (0.85 m/s)
        - 9% at self-selected (~1.3 m/s)
          Pedometer Accuracy article

- Brand comparison:
    - Worst error at slowest speed: Yamax Digiwalker (~67% error).
    - Best at slowest speed: Omron HJ105 (~45% error).
    - At self-selected speed, New-Lifestyles 2000 had lowest error (~1.8%).
      Pedometer Accuracy article
- Reliability (ICCs at self-selected speed): varied widely.
    - New-Lifestyles very reliable (ICC 0.98).
    - Omron poor (ICC 0.26).

Discussion & Implications

- All pedometers under-count steps significantly at <0.9 m/s, regardless of mechanism (mechanical vs. piezoelectric vs. accelerometer).
- Mechanism type didn’t guarantee better accuracy. Piezoelectric pedometers were not consistently superior at slow speeds.

- Waist-mounted devices are not reliable for clinical populations or frail elderly who often walk slowly.
- Prior work suggested ankle-mounted devices may perform better at slow gait (due to higher acceleration signals).
- Some devices failed to register *any steps* in multiple slow-speed trials—serious limitation.

Limitations

- Forced cadences with a metronome may alter natural gait.
- Only waist placement tested.
- Only three units per brand—may not represent all device variability.

General Takeaways

- Pedometer error skyrockets at slow walking speeds—exactly the range for walker users.
- Off-the-shelf waist devices are not suitable for accurate monitoring in this population.
- Ankle placement or walker-integrated sensors (wheel encoders, IMUs) are promising alternatives.
- Highlights the design gap your Smart Walker could fill: reliable measurement for slow/assisted gait, where commercial pedometers fail.

Conclusions/action items:

What I have taken away from this is that simply buying a pedometer to incorporate into our design is most likely not a plausable idea as the extreme inaccuracy of the data that i collects, and the precise information we need to give to the clinician. This leads me to belive we will need to formulate a different way of tracking distance and speed, not a pedometer. Unless there is a signifcanly more accurate model available currently on the market as that article was written a decent amount of time ago. Maybe there is an app in your phone?

For the future we need to:

- Find and research other potential ways to track distance and speed on walker.

- Continue to design or sketch preliminary ideas I have gathered after my initial research.

Citation of article:

J. B. Martin, K. M. Krč, E. A. Mitchell, J. J. Eng, and J. W. Noble, “Pedometer accuracy in slow walking older adults,” International Journal of Therapy and Rehabilitation, vol. 19, no. 7, pp. 387–393, Jul. 2012, doi: 10.12968/ijtr.2012.19.7.387.

10/17/2025 Load Sensor Hookup Guide Notes

HENRY SALITA - Oct 17, 2025, 2:01 PM CDT

Title: Load Sensor Hookup Guide Notes

Date: 10/17/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To better understand the load cells and the process of getting them to become functional sensors.

Content:

How Load Cells Work

- A load cell measures force using strain gauges—tiny metal films that change electrical resistance when stretched or compressed.
- These resistance changes are very small, so the HX711 amplifier boosts the signal so the Arduino can read it.
- A half-bridge load cell has two strain gauges and three wires.
- When two half-bridges are connected in opposite directions, they form a full Wheatstone bridge, which balances voltage changes and gives an accurate reading of applied force.

Wiring Setup:

Load Cells to HX711

- Both Red wires → E+
- Both Black wires → E−
- White from cell 1 → A+
- White from cell 2 → A−

HX711 to Arduino

- VCC → 5V
- GND → GND
- DT → Pin 3
- SCK → Pin 2

Calibration and Code

- The HX711 needs to be calibrated before giving accurate readings.
- Calibration means finding a calibration factor by comparing readings to a known weight.
- **SparkFun and other sources provide example Arduino code for calibration and measurement** (for example, SparkFun_HX711_Calibration and SparkFun_HX711_Example).
- These templates can be downloaded from the SparkFun website or the HX711 Arduino library.

Power and Performance

- The system runs on 5V and uses about 30–40 mA total

- A 500–1000 mAh battery can power it for most of a day.
- Higher voltage (5V) gives stronger and cleaner readings than 3.3V.

Good Practices

- Mount the load cells so the force goes straight through them—no side pressure or bending.
- Add mechanical stops to protect the sensors from overload.
- Keep wires short and twisted to reduce noise.
- Always tare (zero) before each use.
- For smoother data, average or filter the readings in your code.

S. Al-Mutlaq, “RETIRED – Load Cell Amplifier HX711 Breakout Hookup Guide,” SparkFun Electronics, Jun. 11, 2015. [Online]. Available: https://learn.sparkfun.com/tutorials/retired---load-cell-amplifier-hx711-breakout-hookup-guide

Conclusions/action items:

The information above is a rough outline of information that will guide us and help wire our sensors. There is a more in depth walkthrough in the link in the reference above. I feel like I understand the functions of the load sensors and how they work more than before which will aid me in contributing to the wiring and coding of the sensors.

12/2/2025 Lidar Accuracy Testing

HENRY SALITA - Dec 03, 2025, 10:56 PM CST

Title: Lidar Accuracy Testing

Date: 12/2/2025

Content by: Henry Salita

Present: Henry Salita

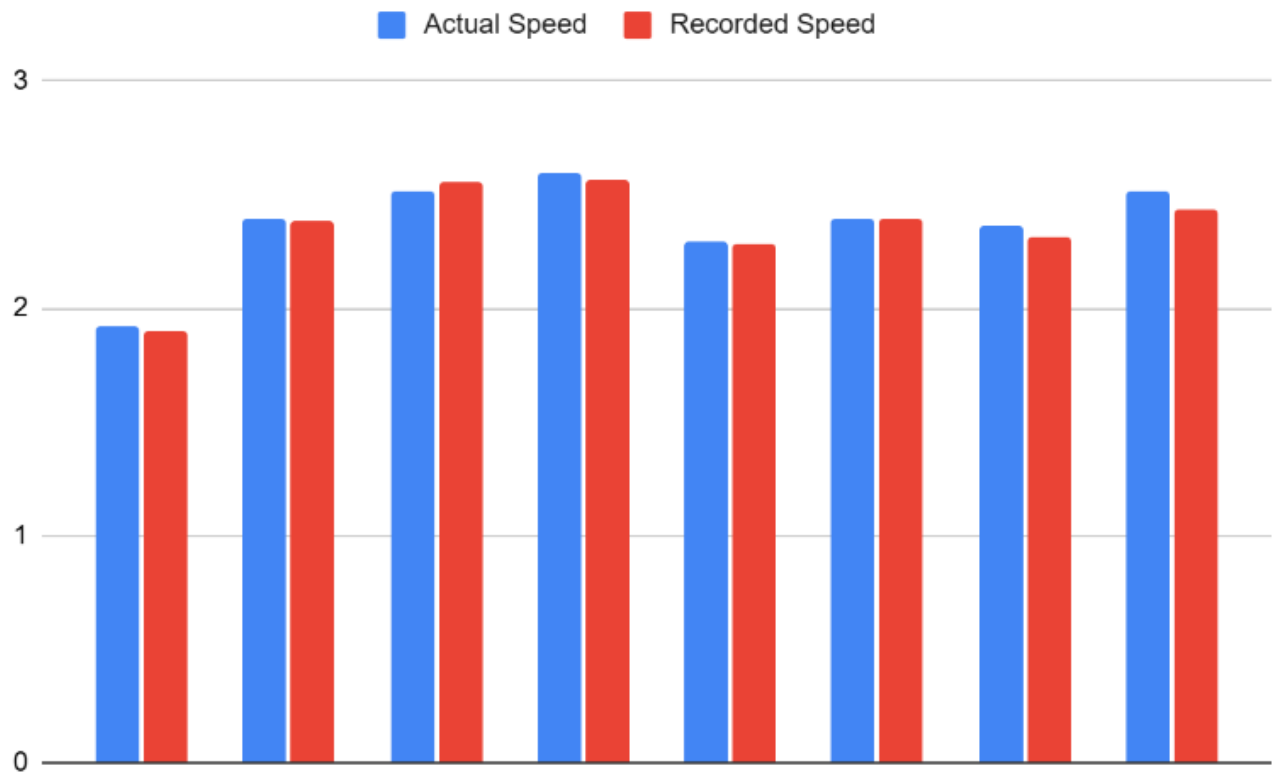
Goals: To test the accuracy of the lidar sensors when tracking distance and speed.

Content:

In a long straight hallway we used a tape measure and marked out every 15 feet away from the starting wall. We would start the trail from each of these 15 feet markers up to 120 feet, we then recorded the the data that the walker recorded, and compared them to the results we manually recorded, by using a phone stop watch and starting from marked distances.

Here are the results:

Actual Distance	Recorded Distance	Distance Error %	Manual Time	Actually Speed	Recorded Speed	Speed Error %
15	14.5	3.3333	7.8	1.923076923	1.899	1.252
30	30.02	.06666	12.51	2.398081535	2.383	0.6289
45	45.21	.46666	17.88	2.516778523	2.559	1.6776
60	60.039	.065	23.13	2.594033722	2.561	1.27345
75	75	0	32.76	2.289377289	2.284	0.23488
90	90.354	.39333	37.63	2.391708743	2.399	0.3048555556
105	102.231	2.637	44.37	2.366463827	2.309	2.428257143
120	116.437	2.969	47.74	2.513615417	2.432	3.246933333
Average Error %s		1.24141369				1.380859504



Conclusions/action items:

This overall concludes that our lidar sensors are working well and accurately, to up to about a percent of error which is well within our require bounds. Basically this just proves our lidar sensor is good to go.

9/17/2025 Preliminary sketch of weight bearing add ons

HENRY SALITA - Sep 17, 2025, 9:33 PM CDT

Title: Preliminary Sketch of Weight-Bearing Add-ons

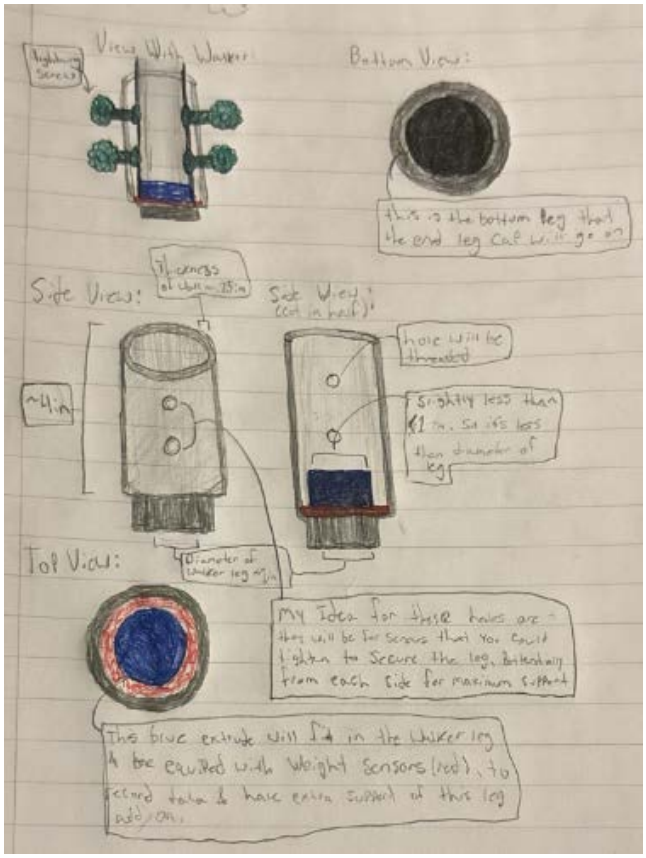
Date: 9/17/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To sketch out some initial ideas for how to measure the amount of weight borne on the walker. These sketches will help communicate possible design directions more clearly.

Content:



Conclusions/action items:

The preliminary sketches illustrate my initial concept for measuring weight-bearing on a walker without compromising normal use. This will help me and others in my group to understand my initial ideas I have for this project and will allow me to better communicate with my group members a direction to go into.

Action Items

Create CAD models that show my sketches, which I have already started on.

Compile a list of suitable sensors and electronics to order for prototyping and that could work for these potential designs.

Share initial sketches and ideas with the team to gather feedback.

9/25/2025 Initial weight bearing CAD design

HENRY SALITA - Sep 25, 2025, 2:31 PM CDT

Title: Initial weight bearing CAD design

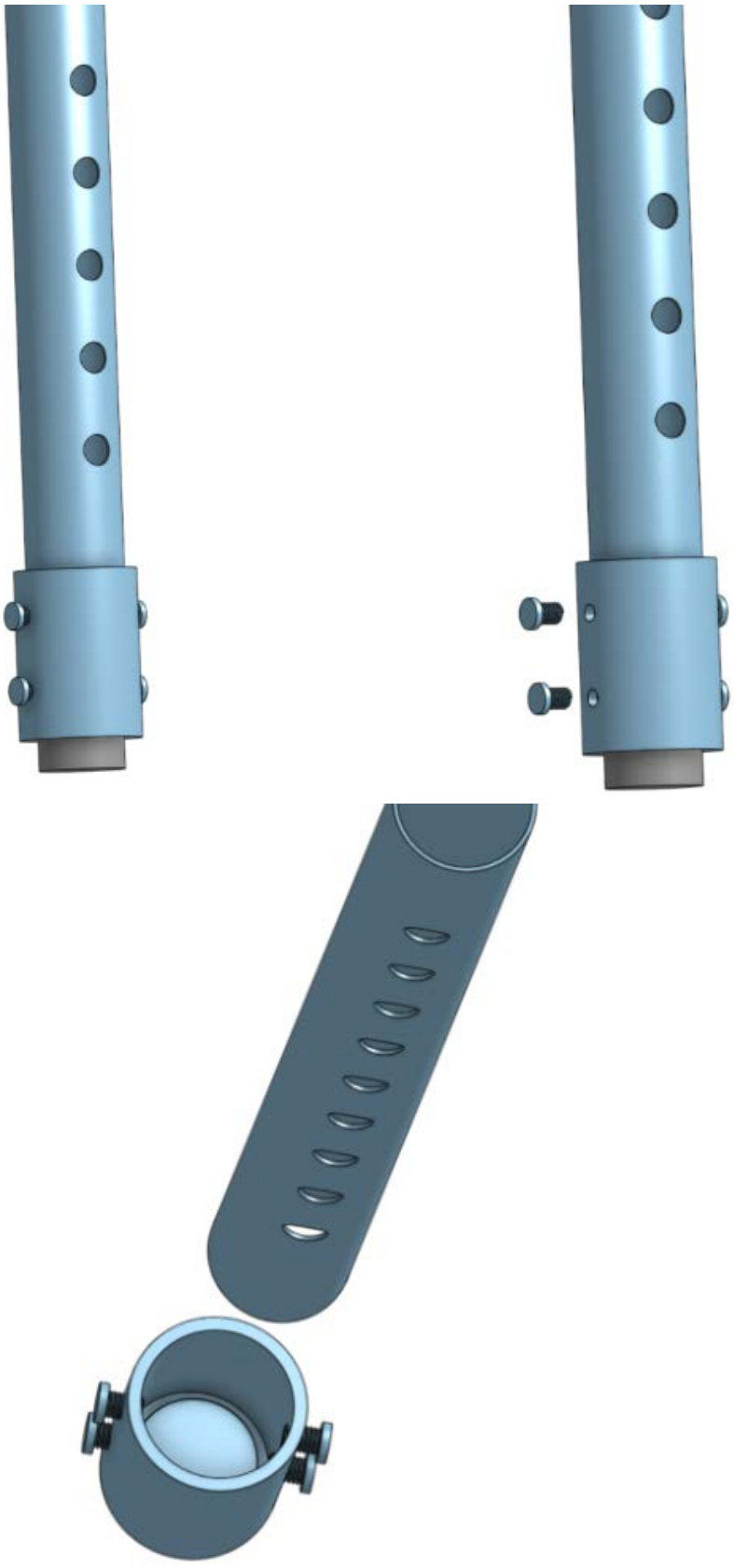
Date: 9/25/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To have a 3d model to better visualize some initial ideas on how to record weight bearing data.

Content:



https://cad.onshape.com/documents/0262405e05eac33fdacf592c/w/17f21f4c9c643029f14e748b/e/01e5bf3e30a54a67f072d9ea?renderMode=0&uiState=68d597e6092f609764203e44

Conclusions/action items:

This are some of my initial ideas for how we will track the weight bearing data for the walker. This will require some redesigning for when we actually have to incorporate the load sensors into our designs. Though I have an idea for that and have started sketching it on paper, which is an entry I will

include after this. Additionally when you are actually in the document for this on OnShape you actually have the ability to move the screws in and out and the walker leg up and down to get a better idea of how all the piece I made fit together.

9/25/2025 Sketches of initial weight bearing with load cell design

HENRY SALITA - Sep 25, 2025, 2:45 PM CDT

Title: Sketches of initial weight bearing with load cell design

Date: 9/25/2025

Content by: Henry Salita

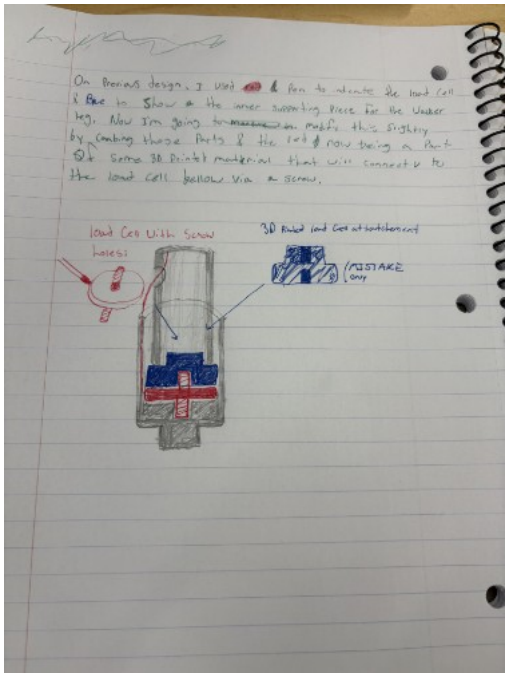
Present: Henry Salita

Goals: To visually have a representation of how I want to incorporate a load sensor into my initial designs.

Content:

amazon link: http://www.amazon.com/Tension-Compression-Bellows-Accuracy-Stainless/dp/B0D5QBZTKN/ref=sr_1_6?crid=1OF0ZKKSWXTGF&dib=eyJ2IjoiMSJ9.oTkejYr0eh_ry4cJsK4bJqjhUbs6DRwR0hwwtJkfKKBnvhHI-lkWNDR-fmmiVKPgIac10QJkDljDgH7E6puuqg-pIeVkTWjL1jLM5Z0dYCJF5Gpwqpw15HqM63Il6TlcAWmnTZujKBmqMi6eg7lMCt4C4sZQt8DZWGbsVmSDKVDNVRtkZgGbX5SWWU4r1o5YgLN2QPuWfFXKrQ9PB0W0WYBCfPZVH_gu9vvRm1Kyo.svKJYDaI0jZgCTYtibteu2rnBgfe3D-mSgGxGufpTyg&dib_tag=se&keywords=load%2Bcell&qid=1758826921&sprefix=load%2Bcell%2Caps%2C95&sr=8-6&th=1

This is the link to a load sensor on amazon, not that we have to use this one specifically, but I based my design around the structure of this load cell. As you can see you can attach things to the load sensor throught these threaded screw like things stickin gout of the load cell. My idea is to thread the attachment I designed and directly attach it to the load cells we plan on using. Below is a visual representation of this.



Conclusions/action items:

I am really excited about this potential design because it seems very in the realm of possibilities for my groups weight bearing sensors. Additionally it seems like it will be fairly secure with out modifying the walker, as I believe the wiring could run through the holes for adjusting the heights or connect to some other electronics that will be located near by at the bottom of the walker. Thi is only a slight modification of what I have preciously thought of, now I just need to model this on some CAD software, most likely Onshape as that is the platform I am most familiar with.

10/4/2025 Weight bearing design CAD 2.0

HENRY SALITA - Oct 04, 2025, 7:16 PM CDT

Title: Weight bearing design CAD 2.0

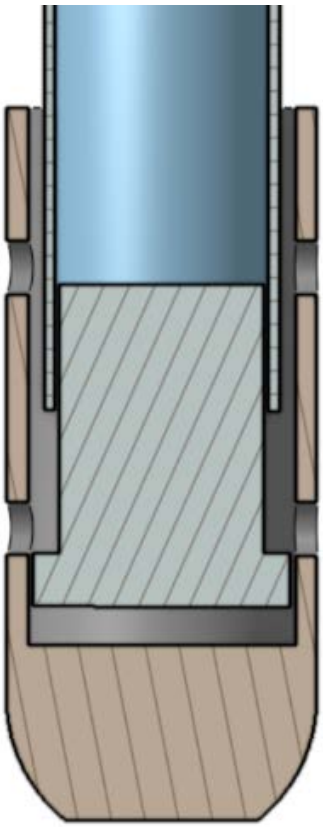
Date: 10/4/2025

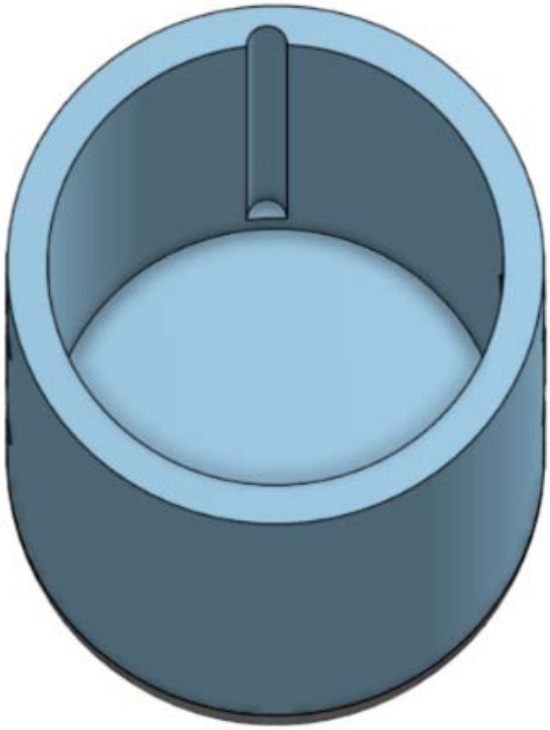
Content by: Henry Salita

Present: Henry Salita

Goals: To get a better visual understanding of my initial ideas.

Content:





Conclusions/action items:

The items above our what our initial final design is for the weight bearing aspect of the walker. We actually have a 3d printed prototype of this, and it has showed us many parts where it can improve, mainly the thickness of the walls, because it needs to be able to support a large amount a weight so the more support the better. Additionally I designed the measurements for this print based off dimensions I found online, so I need to varify that it fits to the walker we have, and if not make adjustments so it will.

10/9/2025 Initial weight bearing 3D Print

HENRY SALITA - Oct 09, 2025, 6:09 PM CDT

Title: Initial weight-bearing 3D Print

Date: 10/9/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To have a physical model of an initial final prototype.

Content:

Conclusions/action items:

This just gives us an idea of what a final prototype may look like. Going forward, it will have to be customized to the specific load cells we get. We will most likely print it out of a different material, and make the walls thicker to gain more support. Though this design on the walker could support all of my weight, so I am no longer worried that much about that.

10/10/2025 Potential Load cells 50kg

HENRY SALITA - Oct 10, 2025, 11:12 AM CDT

Title: Potential Load cells 50kg

Date: 10/10/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To identify a potential load cell we could use for our project.

Content:

https://www.sparkfun.com/load-sensor-50kg-generic.html **($6.25)**

Capacity	kg	40-50
Comprehensive Error	mv/v	0.05
Output Sensitivity	mv/v	1.0±0.1
Nonlinearity	%FS	0.03
Repeatability	%FS	0.03
Hysteresis	%FS	0.03
Creep	(3min)%FS	0.03
Zero Drift	(1min)%FS	0.03
Temp. Effect on Zero	%FS/10℃	1
Temp. Effect on Output	%FS/10℃	0.05
Zero Output	mV/V	±0.1
Input Resistance	Ω	1000±20
Output Resistance	Ω	1000±20
Insulation Resistance	MΩ	≥5000
Excitation Voltage	V	≤10
Operation Temp. Range	℃	0--+50
Overload Capacity	%FS	150

Conclusions/action items:

Above are load cells that are relatively inexpensive, would work in our designs, and where used on last years smart walker design. I feel like this could be a good fit for our project, thought we might want load cells that can support more weight, but after doing some research I feel as if this would still be a good option for us.

10/17/2025 Modified Load Cell holders for our specific sensors

HENRY SALITA - Oct 17, 2025, 12:54 PM CDT

Title: Modified Load Cell Holders

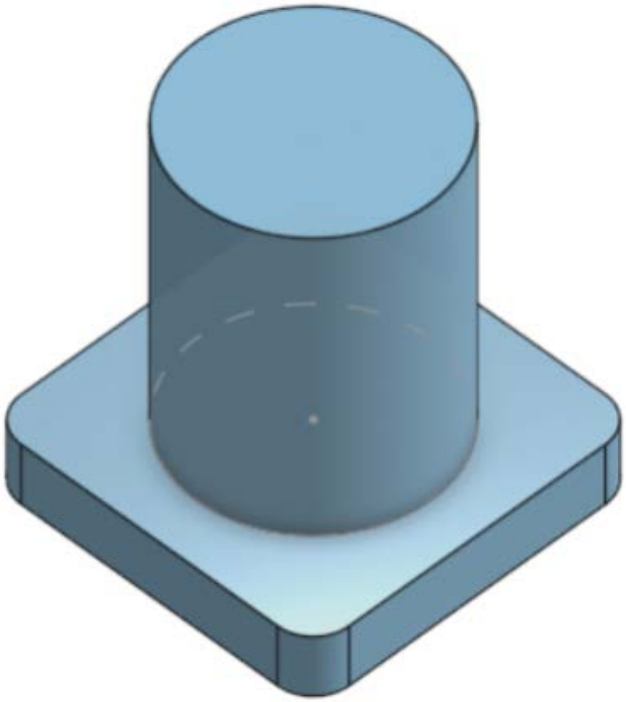
Date: 10/17/2025

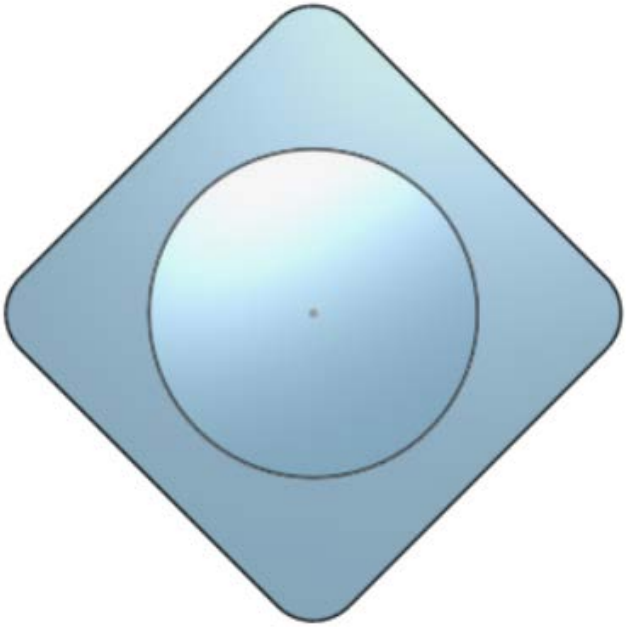
Content by: Henry Salita

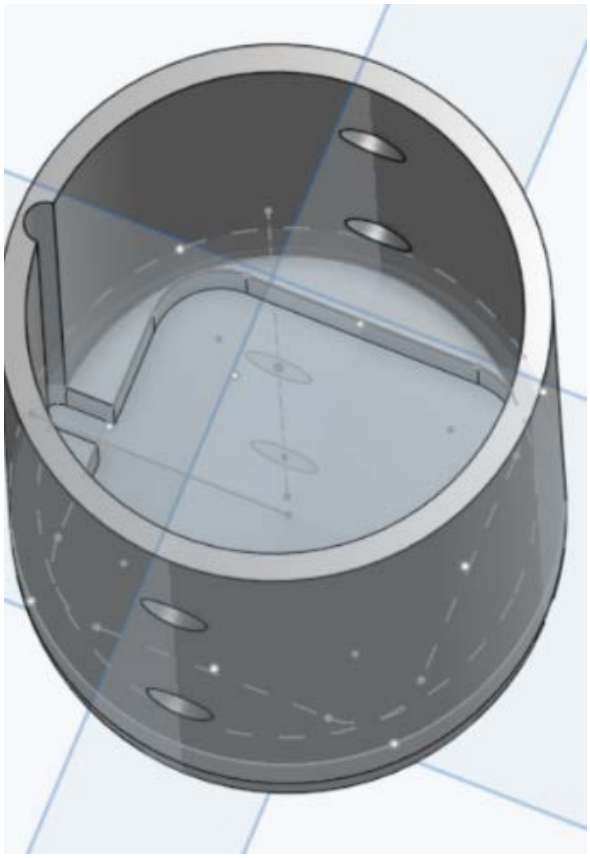
Present: Henry Salita

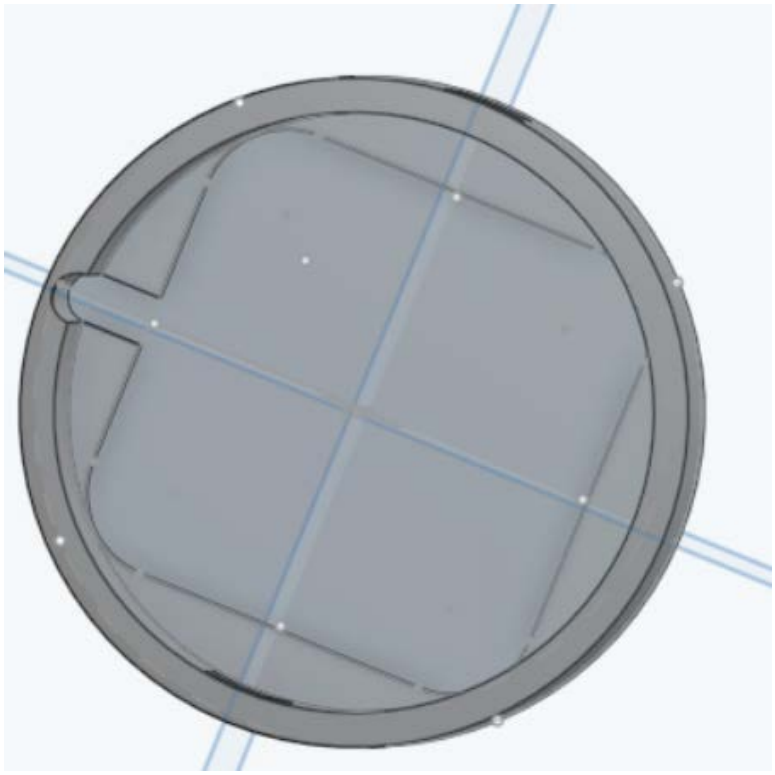
Goals: To remodel the load cell holders to specifically fit the sensors we have purchased.

Content:









Conclusions/action items:

Above are images of my revised CAD designs, and they have been modified to hold our sensors. Though its a great rough draft, it needs to be tweaked a little so the load cells fit more snug in their cutout and so overall we can make the design more compact and neat. Additionally, I will now start to model these things that I call gap fillers. It will both serve to make the add-on neater and have an easier time staying stable, which will be safer and give us potentially more accurate data as the sensor will be compressed the same way every time. Those gap fillers are what those holes in the side are for, potentially to thread and connect the "gap fillers" to pressure screws.

11/7/2025 pressure clamp Onshape

HENRY SALITA - Nov 07, 2025, 11:49 AM CST

Title: Pressure Clamp Onshape design

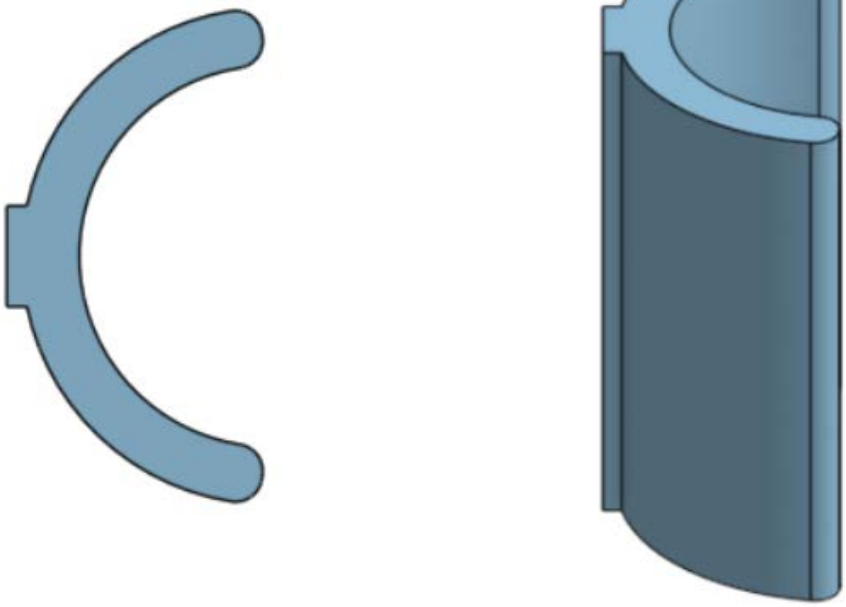
Date: 11/7/2025

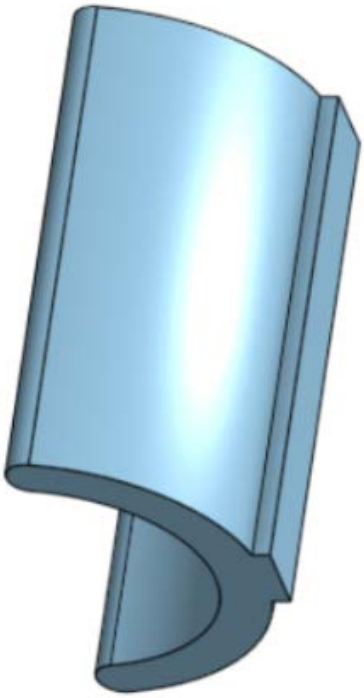
Content by: Henry Salita

Present: Henry Salita

Goals: To create a mechanism that could be incorporated into the load cell housing to secure it to the bottom of the walker leg.

Content:





https://cad.onshape.com/documents/2ca2d2fb87c5f94698fcb831/w/eea880590a834c2a62a2e3f6/e/08794a8f3953643c9a480688

Conclusions/action items:

This is just a rough draft, and will probably need some more slight modifications, though this is a clamp for the leg that has the room to be treaded for a screw. Additionally when it comes time to use these we will need to print two (one for each side of the walker leg.

11/16/2025 notes on making a clip in for the load cells

HENRY SALITA - Nov 17, 2025, 10:31 AM CST

Title: Clip in for the load cells

Date: 11/16/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To better understand snap clip joints for incorporating them into the load cell housing.

Content:

Qualitative Snap-Fit Notes (Simple + Useful)
1. Make the snap arm flexible, not stiff

Snap-fits work best when the arm can bend easily.
Longer arms or arms shaped in a curve (like a U or L) bend more smoothly and reduce stress.

2. Keep the snap protrusion small

The “hook” that holds the part in place should not stick out very far.
Smaller snaps are safer and more reliable in 3D-printed parts.

3. Smooth the base of the snap arm

Where the arm connects to the main body is where it is most likely to crack.
Adding a rounded base instead of a sharp corner greatly reduces this risk.

4. Watch your print orientation

3D-printed parts are weaker between layers.
The snap arm should bend along the printed layers, not across them, so it doesn’t break.

5. Material choice matters

More flexible or tough plastics survive repeated snapping much better.
Very brittle materials tend to crack at the snap arm over time.

6. Add guide features so the snap isn’t doing extra work

Let small walls, rails, or corners position the load cell.
The snap should only “lock” it in, not align or support it.

7. Avoid steep overhangs or sharp angles in the snap hook

Gentler shapes print better and reduce weak points in the joint.

Reference: K. L. Klahn, B. Leutenecker, and T. Meboldt, “Design Guidelines for Additive Manufactured Snap-Fit Joints,” Procedia CIRP, vol. 50, pp. 264–269, 2016.

Conclusions/action items:

The article explains how to design snap-fit features that are reliable in 3D-printed parts by focusing on flexibility, smooth geometry, and proper print orientation. These points help guide our load-cell clip design so it can snap in securely without cracking or overstressing the printed material. Additionally, the next step is for me to modify the 3D print to try and incorporate my own snap-in clip for the load cells.

11/21/2025 3D Print Setting Modifications

HENRY SALITA - Nov 23, 2025, 2:31 PM CST

Title: Print Setting Modifications

Date: 11/23/2025

Content by: Henry Salita

Present: Henry Salita

Goals: Explain 3D printing settings for PLA and TPU

Content:

PLA and TPU changes:

- %50 infill

- 5 loop wall

- Cubic infill

The reasons for these print setting modifications are to ensure that the prints our more structurally stable, specifically able to support more force in the vertical z axis. I printed these on bamboo lab printers and have thought about experimenting with increasing the infill percentage. Also, the seam alignment is random for the moment, though I might make it uniform if I decide that wont impact its structural integrity at all.

Conclusions/action items:

This information is just here so I can look back and reference the things I need to change in the settings of the print, so our prints are all the same. It wouldn't make sense to print things in different ways, which could cause inconsistency in the function of our project. Going forward, I will use these settings and update them as I see necessary.

11/23/2025 Final Load Cell Housing Design

HENRY SALITA - Nov 23, 2025, 2:20 PM CST

Title: Final Load Cell Housing Design

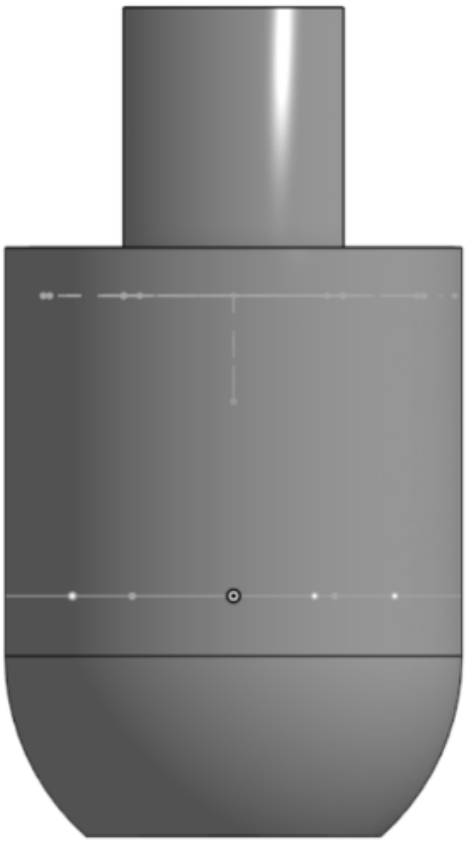
Date: 11/23/2025

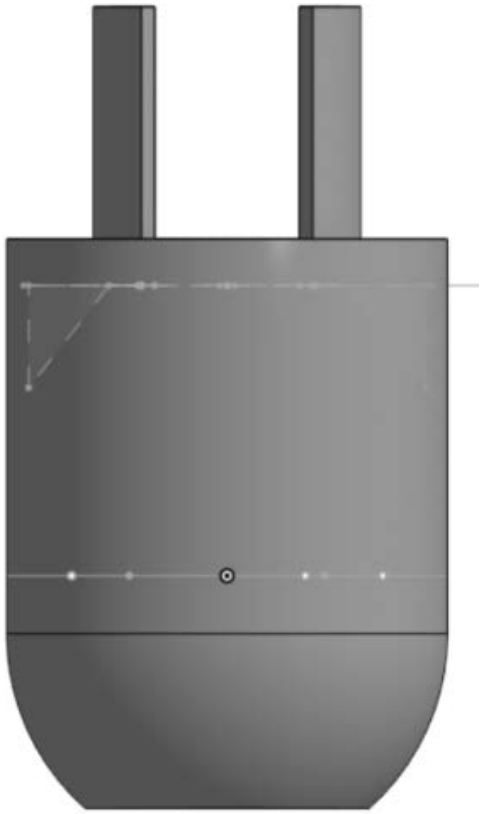
Content by: Henry Salita

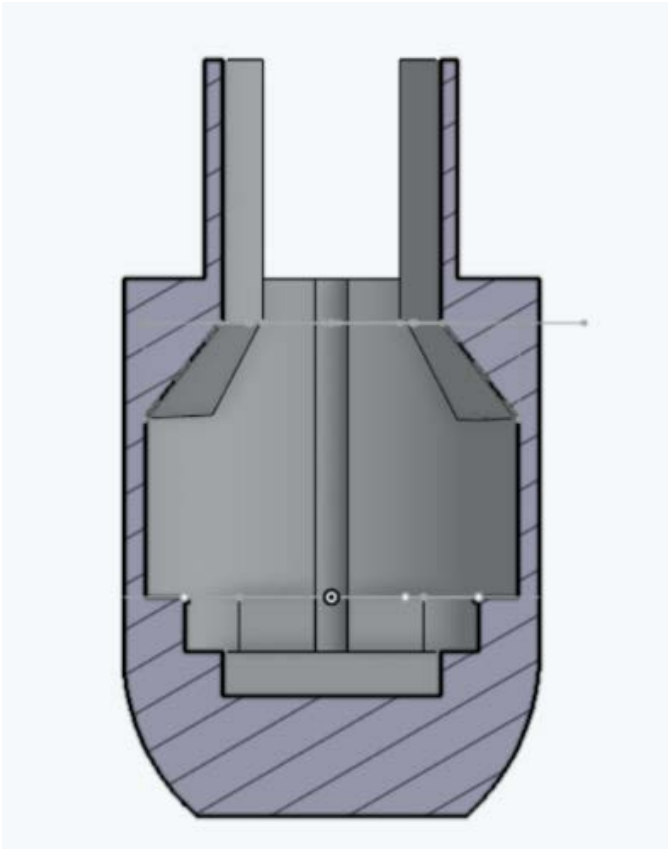
Present: Henry Salita

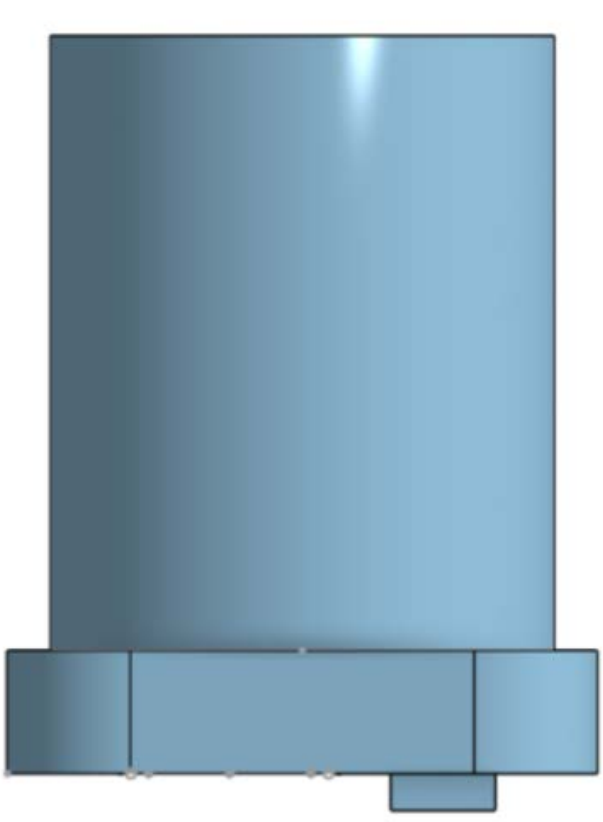
Goals: To show the final design.

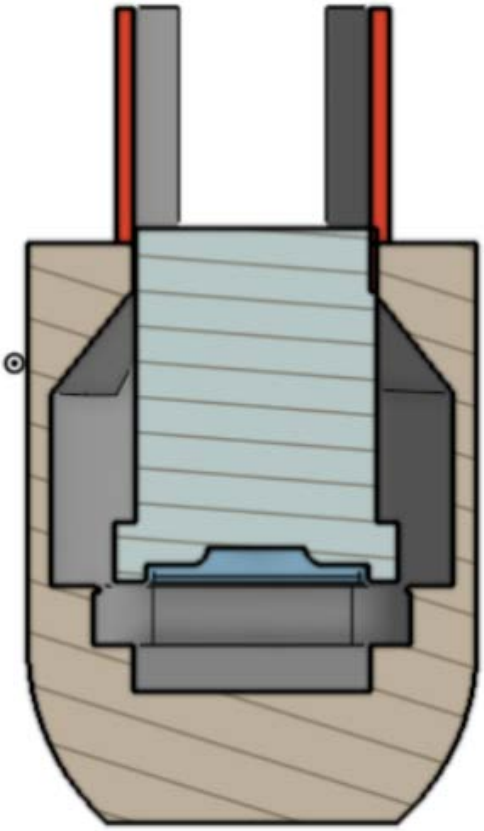
Content:











Link to Onshape Design

Conclusions/action items:

This is the final design for the load cell housing. This updated design is a way of attaching this component to the walker with one piece without impeding the structural integrity. Going forward, we need to test our functional load cells in these prints. Additionally, these prints are printed in TPU, which is a more durable and flexible material that is stronger than PLA.

12/3/2025 Final Load Cell Housing Modifications

HENRY SALITA - Dec 03, 2025, 10:37 PM CST

Title: Final Load Cell Housing Modifications

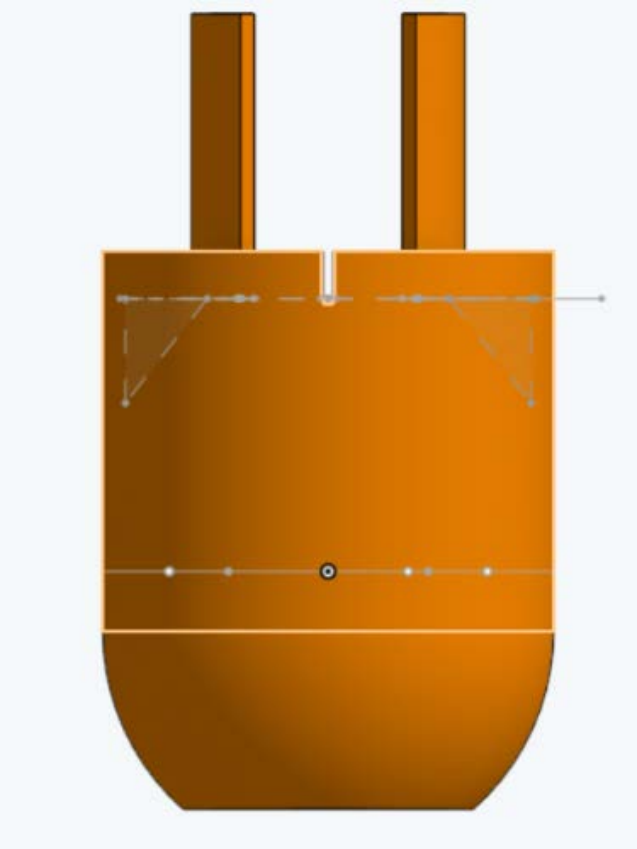
Date: 12/3/2025

Content by: Henry Salita

Present: Henry Salita

Goals: To allow the button like piece to be able to fit in the load cell housing.

Content:



Conclusions/action items:

It makes the top more flexible so we can fit in the load cell button which is the piece that applies pressure to the load cell.

Biosafety Training

HENRY SALITA - Oct 27, 2025, 11:10 PM CDT

Title: Biosafety Training

Date: 10/27/2025

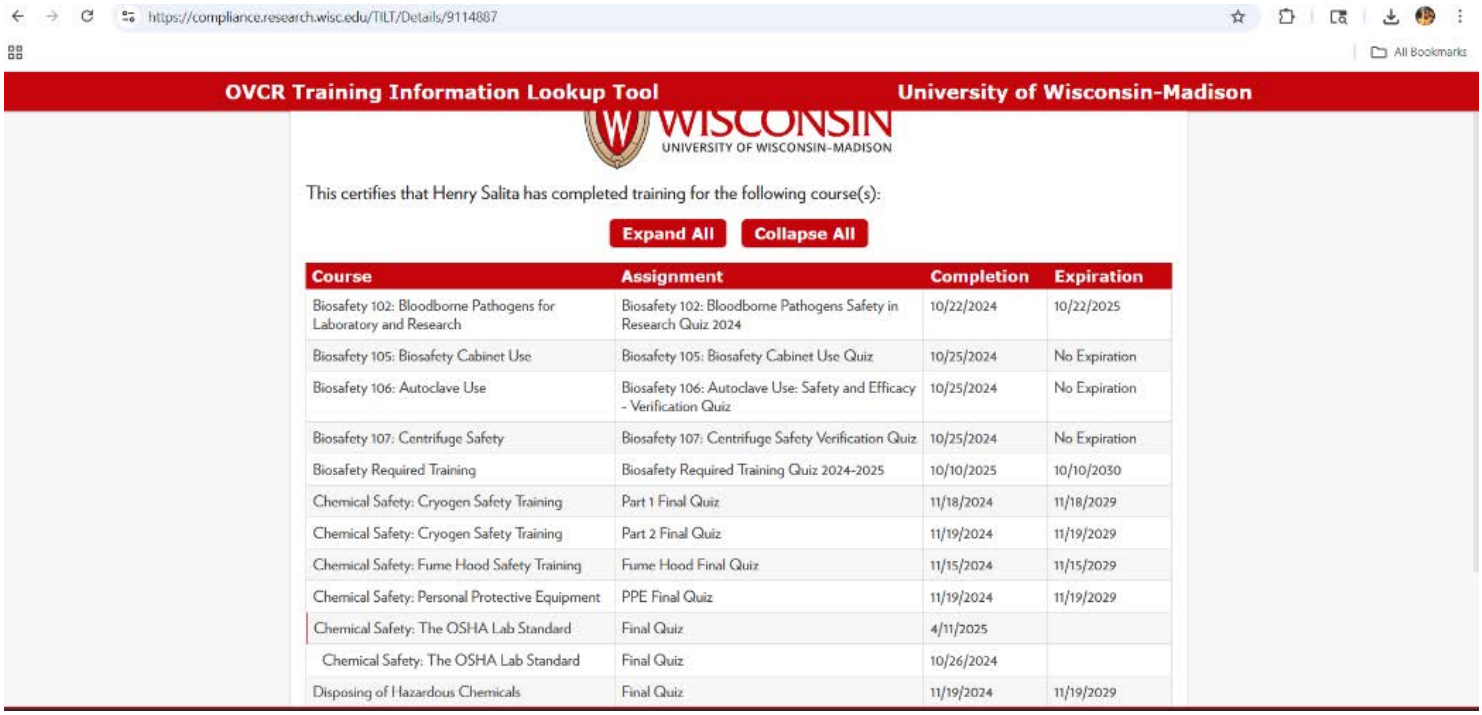
Content by: Henry Salita

Present: Henry Salita

Goals: Complete biosafety training

Content:

Screenshot of OVCR Training Information Lookup Tool to prove my completion of training below:



Course	Assignment	Completion	Expiration
Biosafety 102: Bloodborne Pathogens for Laboratory and Research	Biosafety 102: Bloodborne Pathogens Safety in Research Quiz 2024	10/22/2024	10/22/2025
Biosafety 105: Biosafety Cabinet Use	Biosafety 105: Biosafety Cabinet Use Quiz	10/25/2024	No Expiration
Biosafety 106: Autoclave Use	Biosafety 106: Autoclave Use: Safety and Efficacy - Verification Quiz	10/25/2024	No Expiration
Biosafety 107: Centrifuge Safety	Biosafety 107: Centrifuge Safety Verification Quiz	10/25/2024	No Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024-2025	10/10/2025	10/10/2030
Chemical Safety: Cryogen Safety Training	Part 1 Final Quiz	11/18/2024	11/18/2029
Chemical Safety: Cryogen Safety Training	Part 2 Final Quiz	11/19/2024	11/19/2029
Chemical Safety: Fume Hood Safety Training	Fume Hood Final Quiz	11/15/2024	11/15/2029
Chemical Safety: Personal Protective Equipment	PPE Final Quiz	11/19/2024	11/19/2029
Chemical Safety: The OSHA Lab Standard	Final Quiz	4/11/2025	
Chemical Safety: The OSHA Lab Standard	Final Quiz	10/26/2024	
Disposing of Hazardous Chemicals	Final Quiz	11/19/2024	11/19/2029

Conclusions/action items:

Completed Biosafety Training

Chemical Safety: The OSHA Lab Standard

HENRY SALITA - Oct 27, 2025, 11:14 PM CDT

Title: Chemical Safety: The OSHA Lab Standard

Date: 10/27/2025

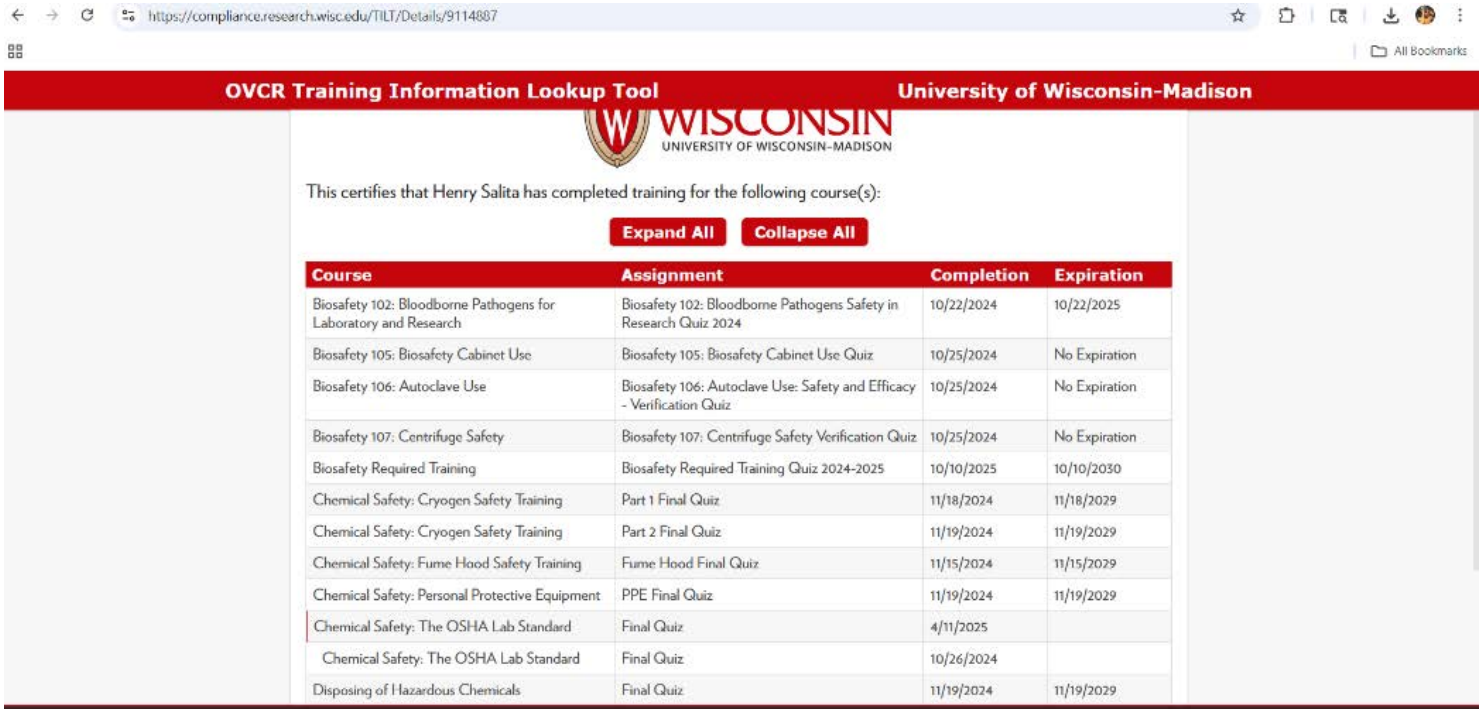
Content by: Henry Salita

Present: Henry Salita

Goals: Complete Chemical Safety: The OSHA Lab Standard training

Content:

Screenshot of OVCR Training Information Lookup Tool to prove my completion of training below:



Course	Assignment	Completion	Expiration
Biosafety 102: Bloodborne Pathogens for Laboratory and Research	Biosafety 102: Bloodborne Pathogens Safety in Research Quiz 2024	10/22/2024	10/22/2025
Biosafety 105: Biosafety Cabinet Use	Biosafety 105: Biosafety Cabinet Use Quiz	10/25/2024	No Expiration
Biosafety 106: Autoclave Use	Biosafety 106: Autoclave Use: Safety and Efficacy - Verification Quiz	10/25/2024	No Expiration
Biosafety 107: Centrifuge Safety	Biosafety 107: Centrifuge Safety Verification Quiz	10/25/2024	No Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024-2025	10/10/2025	10/10/2030
Chemical Safety: Cryogen Safety Training	Part 1 Final Quiz	11/18/2024	11/18/2029
Chemical Safety: Cryogen Safety Training	Part 2 Final Quiz	11/19/2024	11/19/2029
Chemical Safety: Fume Hood Safety Training	Fume Hood Final Quiz	11/15/2024	11/15/2029
Chemical Safety: Personal Protective Equipment	PPE Final Quiz	11/19/2024	11/19/2029
Chemical Safety: The OSHA Lab Standard	Final Quiz	4/11/2025	
Chemical Safety: The OSHA Lab Standard	Final Quiz	10/26/2024	
Disposing of Hazardous Chemicals	Final Quiz	11/19/2024	11/19/2029

Conclusions/action items:

Completed Chemical Safety: The OSHA Lab Standard

Intro to machining Training

HENRY SALI

Title: Intro to machining Training

Date: 10/27/2025

Content by: Henry Salita

Present: Henry Salita

Goals: Proof of Machining Training

Content:

HENRY SALITA

ID Number: 9086815983

Eligibility: CoE Students

Profile

Program Registrations

Bookings

My Memberships

Membership Type	Start Date	Expiry Date	Renew
Machining	Wed, Aug 20 2025	Permanent	Not Renewable
Machining - Training Eligible	Wed, Aug 20 2025	Wed, Dec 31 3000	Not Renewable
Shop Tools	Tue, Aug 20 2024	Thu, Jan 2 3000	Not Renewable
Laser Cutter	Tue, Aug 20 2024	Thu, Jan 2 3000	Not Renewable
Lab Orientation	Tue, Aug 20 2024	Wed, Dec 31 3000	Not Renewable
Shop Tools - Training Eligible	Tue, Aug 20 2024	Wed, Dec 31 3000	Not Renewable
Laser Cutter - Training Eligible	Tue, Aug 20 2024	Wed, Dec 31 3000	Not Renewable

Conclusions/action items:

machining training

10/17/2025 Load Cell + HX711 Amplifier for Arduino Purchase (Amazon)

HENRY SALITA - Oct 17, 2025, 1:05 PM CDT

Title: Load Cell + HX711 Amplifier for Arduino Purchase (Amazon)

Date: 10/17/2025

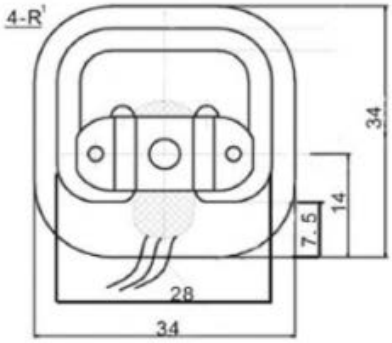
Content by: Henry Salita

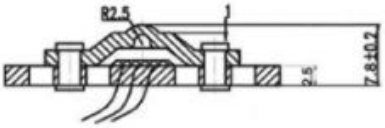
Present: Henry Salita

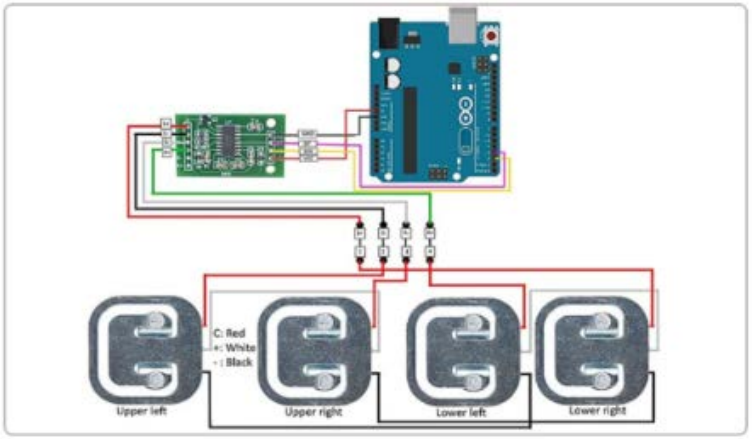
Goals: To purchase Load cell sensors

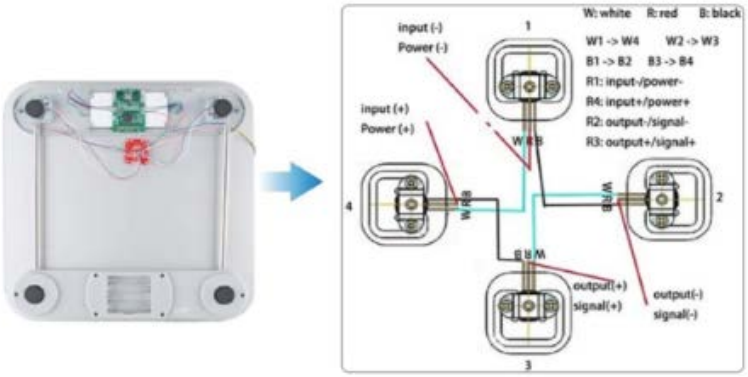
Content:

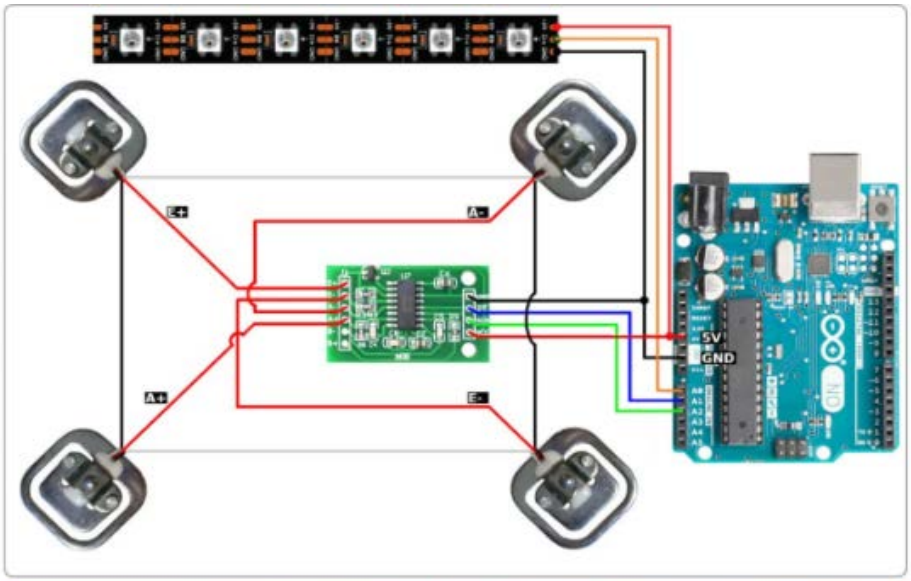

3.4cm(1.33in)
3.4cm(1.33in)

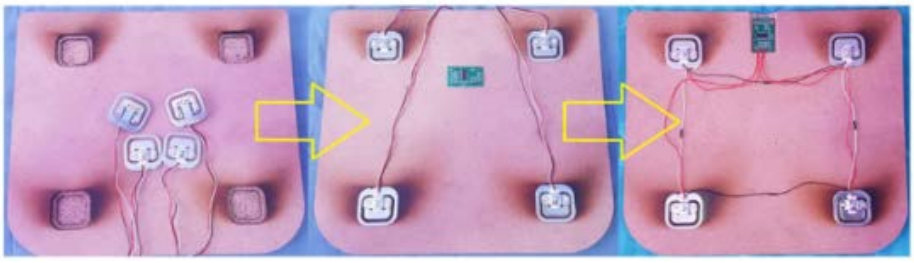

4-R'
34
14
7.5
28
34

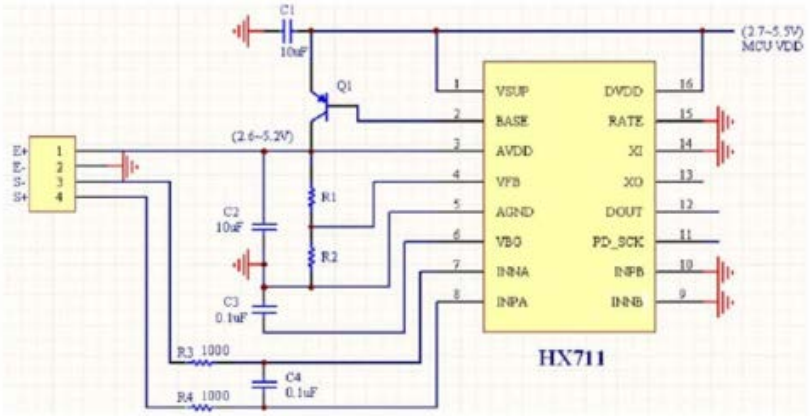

R2.5
7.8±0.2
2.5

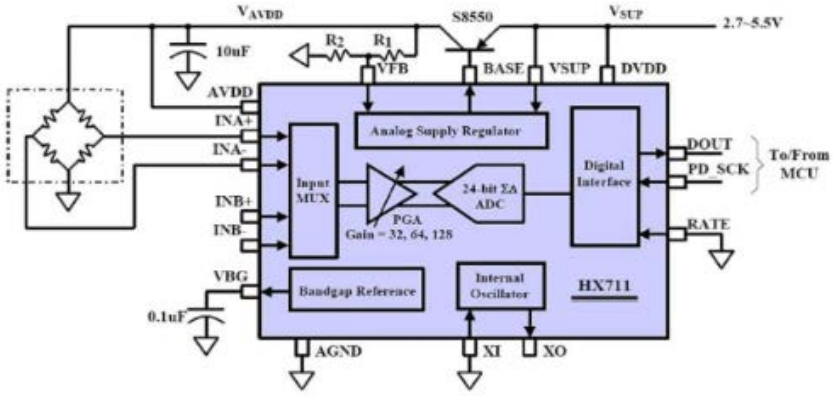

C: Red
+: White
-: Black
Upper left
Upper right
Lower left
Lower right

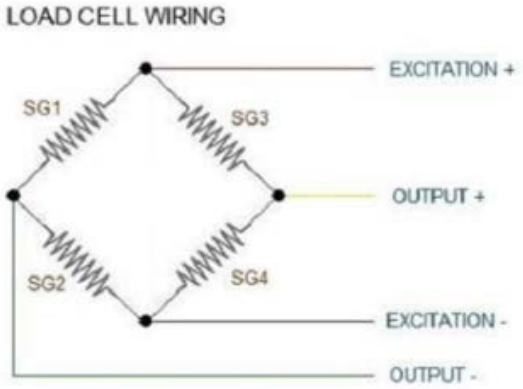

W: white
R: red
B: black
input (-)
Power (-)
input (+)
Power (+)
W1 -> W4
W2 -> W3
B1 -> B2
B3 -> B4
R1: input-/power-
R4: input+/power+
R2: output-/signal-
R3: output+/signal+
output(+)
signal(+)
output(-)
signal(-)

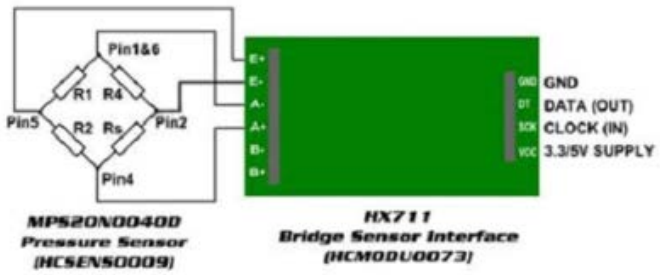

E+
A-
A+
E-
5V
GND




C1
10uF
(2.7~5.5V)
MCU VDD
Q1
(2.6~5.2V)
R1
C2
10uF
R2
C3
0.1uF
R3 1000
C4
0.1uF
R4 1000
VSUP
BASE
AVDD
VFB
AGND
VBG
INNA
INPA
DVDD
RATE
XI
XO
DOUT
PD_SCK
INPB
INNB
HX711


VAVDD
10uF
R2
R1
S8550
VSUP
2.7~5.5V
VFB
BASE
VSUP
DVDD
AVDD
INA+
INA-
INB+
INB
VBG
0.1uF
Analog Supply Regulator
Input MUX
PGA
Gain = 32, 64, 128
24-bit ΣΔ ADC
Digital Interface
DOUT
PD_SCK
RATE
To/From MCU
Bandgap Reference
Internal Oscillator
HX711
AGND
XI
XO


LOAD CELL WIRING
EXCITATION +
SG1
SG3
OUTPUT +
SG2
SG4
EXCITATION -
OUTPUT -


Pin1&6
R1 R4
Pin5
R2 Rs
Pin2
Pin4
E+
E-
A-
A+
B-
B+
GND
DT
SCK
VCC
GND
DATA (OUT)
CLOCK (IN)
3.3/5V SUPPLY
MPS20N0040D
Pressure Sensor
(HCSENS0009)
HX711
Bridge Sensor Interface
(HCMODU0073)

SPECIFICATION	Unit	SPECIFICA
CAPACITY	Kg	50
COMPREHENSIVE	%F.S	0.10
OUTPUT SENSITIVITY	mv / V	1.0± 15%
NONLINEARITY	%F.S	0.05
REPEATABILITY	%F.S	0.05
HYSTERESIS	%F.S	0.05
ZERO OUTPUT	mv/v	±0.3
CREEP (1 min)	%F.S	0.1
ZERO DRIFT (1 min)	%F.S	0.1
TEMP EFFECET ON ZERO	%F.S/10	0.3
TEMP EFFECET ON OUTPUT	%F.S/10	0.1
INPUT RESISTANCE	Ω	1000±10
OUTPUT RESISTANCE	Ω	1000±10
INSULATION RESISTANCE	MΩ	≥2000
EXCITATION VOLTAGE	V	10VDC
OPERATION TEMP RANGE	°C	-10~+50
OVERLOAD CAPACITY	%F.S	150

Amazon Link:

https://www.amazon.com/Half-Bridge-Weighting-Amplifier-Arduino-WIshioT/dp/B07B4DNJ2L/ref=sr_1_3?crid=MU7RGNK4JYP8&dib=eyJ2IjoiMSJ9.qEIrULPFZo6Wk3mjSlEBZynoUaDWYjG1z80eEWhOiyRq-aSo6niCOfZkbg1ow-_2HlLPMYcmLt_OI37M-GuM9CkZkQmADTQezSHHgyjRhFD1y7bM4H89o5s-J-uIyNcGzlRj0npNXegHrz9XwiW7TRuJrEtx2YkklfD5hfG79O1Xvg1Ak63Zbo6pPfG3HBlblXM--VRcUlyc_7z3cGXD7bWTVJ2O-DloMjQDxTThRvM.UdSerP4kOrinNGCOOV-ak3OU7kv7pD8TH1AePLOKdZI&dib_tag=se&keywords=4pcs+50kg+load+cell&qid=1760723909&sprefix=4pcs+50k%2Caps%2C137&sr=8-3

$16.85

Conclusions/action items:

The above includes images and specifications about the load cells that have been purchased for our project and have now arrived for us to use. Additionally, I have included the price (including shipping) as well as the link to the items we purchased. Going forward, we need to figure out how to wire this and then start testing with our walker. As I have already designed the CAD model for the add-on that will hold time on them onto the walker.

HENRY SALITA - Oct 27, 2025, 11:27 PM CDT

Below is the invoice from this purchase:

Order Summary

Order placed October 15, 2025 | Order # 112-0027395-7698650

Print

Ship to

Henry Salita
110 N BROOKS ST APT A
MADISON, WI 53715-1260
United States

Payment method

Visa ending in 1933

View related transactions

Order Summary

Item(s) Subtotal:	$8.99
Shipping & Handling:	$6.99
Total before tax:	$15.98
Estimated tax to be collected:	$0.87
Grand Total:	**$16.85**

Delivered October 16

Your package was left in the mail room.

4pcs 50kg Load Cell Half Bridge Strain Gauge Human Body Scale Weight Sensor + 1pcs HX711 Amplifier AD Module for Arduino

Sold by: DIYmalls

Return or replace items: Eligible through November 15, 2025

$8.99

Lidar (SENSOR OPTICAL 3-200CM I2C)

HENRY SALITA - Oct 27, 2025, 11:37 PM CDT

Title: Lidar (SENSOR OPTICAL 3-200CM I2C)

Date: 10/27/2025

Content by: Henry Salita

Present: Henry Salita

Goals: Purchase Lidar

Content:

Receipt for sensor OPTICAL 3-200CM I2C

SENSOR OPTICAL 3-200CM I2C

DigiKey part number

1568-14032-ND

Manufacturer part number

14032

Quantity	1
Backorder	0
Unit price	131.33000
Extended price	$131.33

Order summary

1	:Items in order
$131.33	:Subtotal
$6.99	:Shipping
$7.61	:Sales tax
$145.93	:Total

View order status

total price for this purchase was $145.93

Conclusions/action items:

Receipt for sensor OPTICAL 3-200CM I2C

10/31/2025 Load Cell (show and tell update) housing

HENRY SALITA - Nov 06, 2025, 3:08 PM CST

Title: Load Cell (show and tell update) housing

Date: 10/31/2025

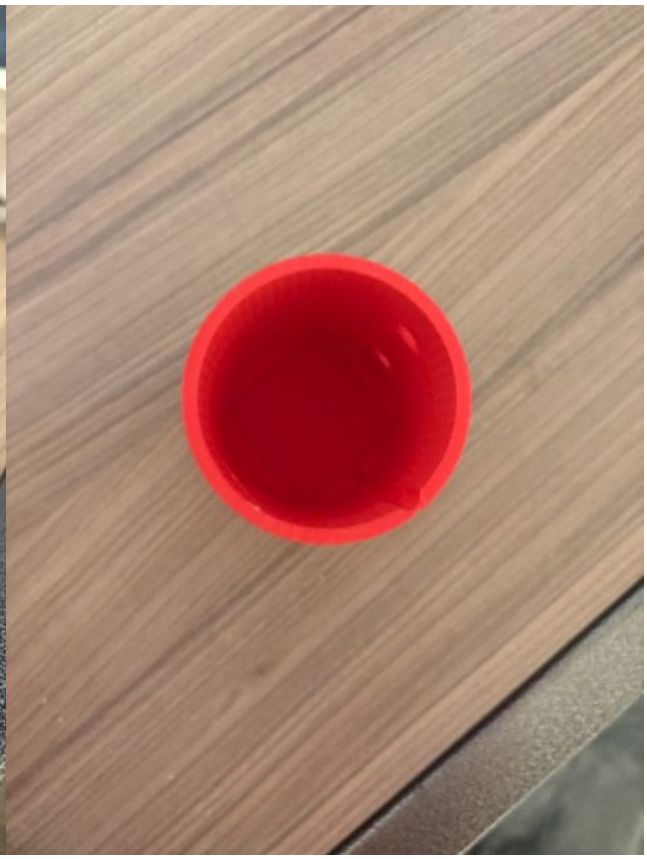
Content by: Henry Salita

Present: Henry Salita

Goals: Print the updated 3D model of load cell housing components.

Content:

This newly updated design is larger, so the load cells we have purchased specifically have the ability to fit within the housing. Additionally the cork like piece that compresses the load cell now is shaped to me a rectangular shape more like the load cell.



Conclusions/action items:

The button piece is not in this picture, but it fits into that carved out shape in the bottom of the 3D print. This is printed in PLA and the final product will be printed in a more durable material.

Full Purchase expense table 12/9/2025

HENRY SALITA - Dec 09, 2025, 3:44 PM CST

Title: Purchase Expense Table

Date: 12/9/2025

Content by: Henry Salita

Present: Henry Salita

Goals: Summarize project purchases

Content:

Item	Description	Manufacturer	Part Number	QTY	Cost Each	Total	Link
Walker	2-wheel walker, **gifted** by client	Performance Health Supply, Inc.	081561703	1	$136.73	$0	Link
Load Cell initial 3D print	3D print of End-Cap 2.0 design **gifted** by friend with printer.	bambu lab a1 mini	N/A	1	$1.60	$0	N/A
Load Cells + HX711	4 50 kg load cells with HX711	Nextion	702795764555	1	$16.85	$16.85	Link
LiDar	Sensor Optical 3-200CM 12C	DigiKey	DigiKey part number : 1568-14032-ND	1	145.93	145.93	Link
Load Cell initial 3D print	3D print of End-Cap 2.0 design for show and tell	Bambu lab	NA	1	$1.04	$1.04	Link
Arduino Uno Rev 4	Arduino with wifi abilities for our code and electronics.	Arduino	Sku: ABX00087	1	29.21	29.21	Link
Additional HX711 Purchase	Extra HX711 Load Cell Amplifier because we were struggling to get the amazon one to function correctly	SparkFun	SKU: SEN-13879		11.50	11.50	Link
Electrical Component Prints	PLA print of electrical component box	Bambu lab	NA	1	4.56	4.56	Link
Battery Housing	9v Battery Holder with ON/Off Switch for Arduino	Gikfun	EK2107	1	19.28	19.28	Link
Velcro Straps	1.5ft of velcro to securely attach the wires along the walker leg	Wendt Commons	NA	1	5.19	5.19	NA
BME Design Account	This is a combination of shrink wrap for our prints, batteries, and a series of trial and final prints for the load cell and electrical box housing.	Wendt Commons	BME Design	NA	43.58	43.58	NA
TOTAL:						**$277.06**	

Conclusions/action items:

Expense table

11/7/2025 Tong Distinguished Entrepreneurship Lecture notes

HENRY SALITA - Nov 07, 2025, 12:46 PM CST

Title: Long Distinguished Entrepreneurship Lecture Notes

Date: 11/7/2025

Content by: Henry Salita

Present: Henry Salita

Goals: Notes on Long Distinguished Entrepreneurship Lecture Notes

Content:

- Here like story/professional timeline- BME --> BME industry ---> Harvard MBA ----> venture capital ----> chief of staff to CEO president (aetna) ----> Unified Women's Healthcare president and Chief operating officer-----> Hopscotch Health (founder and CEO Advanced Primary Care for Rural Communities -----> Blue Cross Blue Shield Association (Chief Operating Officer)
- Above just explains its ok not to know your path, lots of directions.
- What does great look like? Improved Provider Experience, Improved Patient Outcomes, Lower Cost of Care, and Improved Patient Experience.
- 5.3 Trillion a year on health care
- 2x more per capita than other similar countries

- In the future, we want to move more towards aligned incentives and measurement
    - Everyone rewarded for outcomes, not activity
    - Performance is transparent and known to all
- Integration is an engineering problem

"run towards the hard problems... they are the ones that change the world"

Conclusions/action items:

Lecture summary above

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

John Puccinelli - Nov 03, 2014, 3:20 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items:

BME Design-SPRING 2025-notebook

NICOLAS MALDONADO - Sep 05, 2025, 1:37 PM CDT

BME Design-Spring 2025 - NOLAN BLOMMILLIS
Complete Notebook

PDF Version generated by

James Waldenberger

on

Apr 30, 2025 @ 8:40 PM CDT

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