Project 3
Design Notebook

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter
Team 09, Section 01

02.08.17

Meeting #1

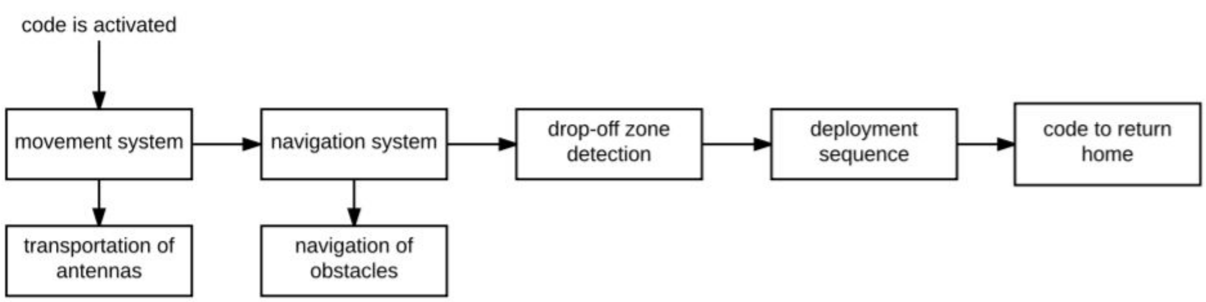
Agenda

Create initial design specifications, create initial ALV design, determine first set of RFAI questions.

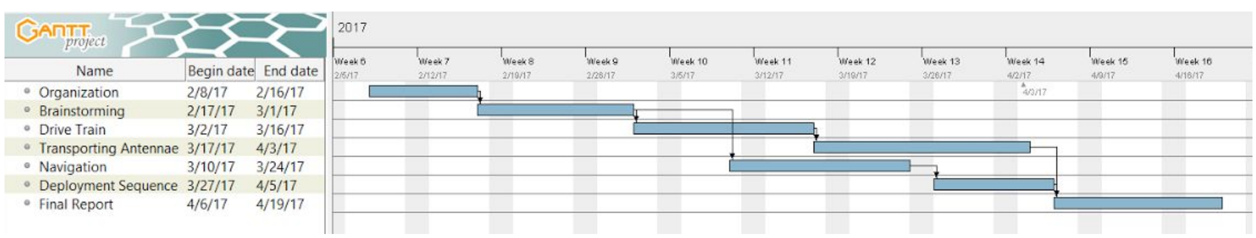
9:00pm

Design Specifications

The following FBD was produced.



The following gantt chart was produced.



9:30pm

Possible RFAI Questions:

- What are the dimensions of the cargo containers the ALV will be transporting?
- What is the minimum speed requirement?
- What are the specific dimensions of all unknown hazards?

10:30pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

02.12.17

Meeting #2

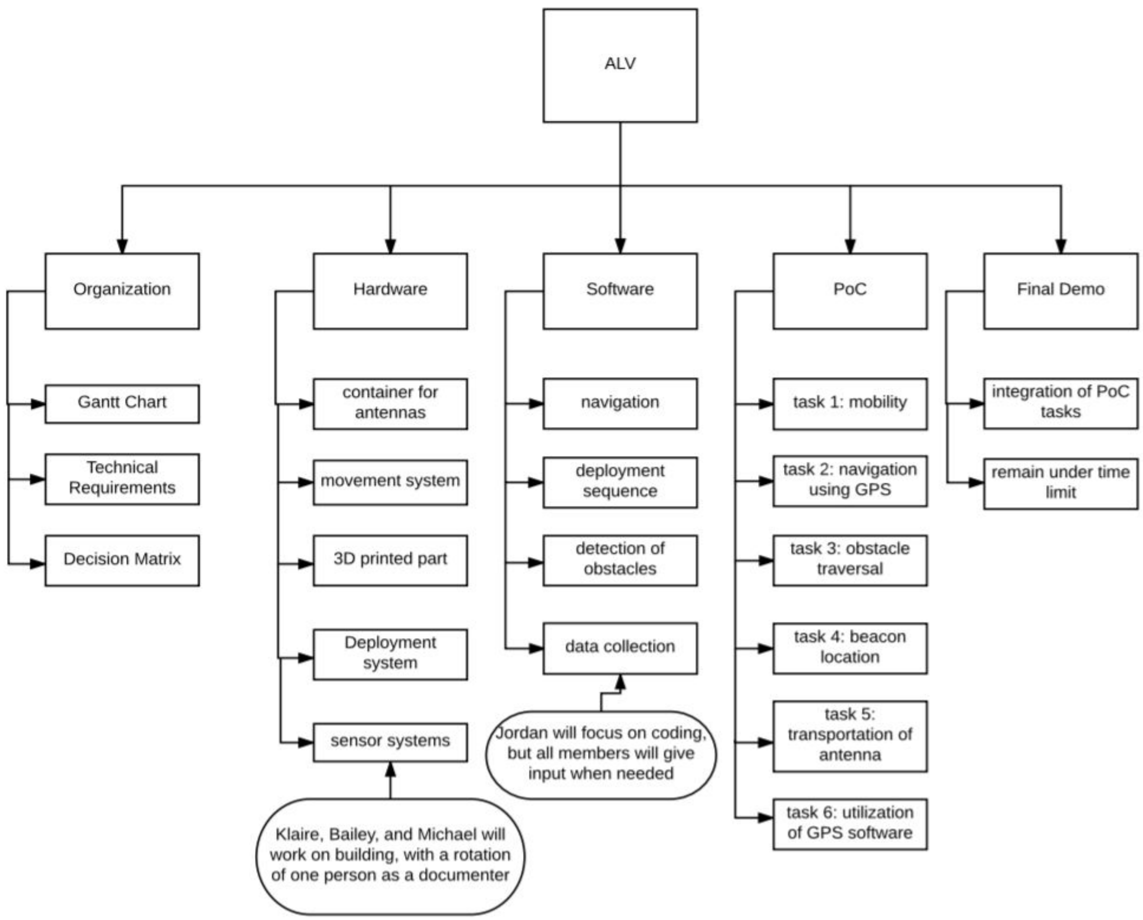
Agenda

Finish the design specification review, continue brainstorming initial designs and RFAI questions.

3:00pm

Finish DSR

The following work breakdown structure was finalized.



Delegation of Tasks:

- Klaire: Software, Organization
- Michael: Hardware, Quantitative Testing/Calculations
- Jordan: Software, Document & Notebook
- Bailey: Hardware, Technical Writing

3:30pm
Possible RFAI Questions:

- How is the damage of the antennae packages measured?

3:30pm
Design brainstorming:

Drive Train:

- Pivoting is extremely important, as both orientation and xy-movement are crucial.
- Think of zero turn lawn mower.
- A three wheel system with lone front wheel turning.

Arm for antenna transportation:

- If there is a handle on case for antenna, arm could slide into place and then lift the antenna.
- Bin could be slanted so antenna would slide down to front position after one is removed.
- Is there any added benefit between unloading the antennas to the side, front, or rear ends of the robot?

4:10pm
Submitted DSR

4:15pm Adjourned
Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

02.14.17

Meeting #3

Agenda

Finish the RFAI questions.

9:00 pm

Possible RFAI Questions:

- What the dimensions of the cargo container drop-off locations?
- What is the maximum incline the ALV will have to surmount on the lunar surface?

Other Brainstorming:

- Possible 3D printed part: plow to move obstacles

PoC Specifications were reviewed. The final copy is below.

Task	Customer Need	Technical Need	Technical Requirement	Target Value	Current Performance
1, 5	Move steadily	Move with a maximum degree of rotation of the chassis	Move with a maximum of 15 degrees of rotation from original setting	Move with less than 10 degrees of rotation	N/A
1	Move far	Move at least a set distance in a set amount of time	Move at least 8 feet in 1 minutes	Move at least 10 feet in 1 minute	N/A
1	Move straight	Move with less than a specified degree of displacement from original path	Move with less than 20 degree displacement	Move with less than 5 degree displacement	N/A
2, 6	Navigate using GPS tracking	Receive set of coordinates	Receive set of coordinates	Receive set of coordinates	N/A

2	Move to correct location	Move to coordinated location with specified precision	Move to coordinated location within 3 inches	Move to coordinated location within 2 inches	N/A
2, 4	Beep thrice when at known location	Beep thrice at location	Beep thrice at location	Beep thrice at location	N/A
2	Return to start	Robot returns to point within the home base	Robot is completely within outline of home base	Robot is completely within outline of home base	N/A
3	Move over small obstacles	Traverse obstacles of a certain height without interfering with structure	Traverse obstacles at least 1/2 inch in height without interfering with structure	Traverse obstacles at least 1 inch in height	N/A
3	Traverse small obstacles quickly	Traverse 1 inch obstacles in a set time	Traverse 1 inch obstacles in less than 30 seconds	Traverse 1 inch obstacles in less than 15 seconds	N/A
4	Stop with paperclip over beacon	Paperclip is within a certain distance of the beacon	Paperclip is within 1 cm of the beacon	Paperclip is 0 cm from beacon (directly over beacon)	N/A
5	Transport antenna	Antennae are transported without being compressed	Compression of antenna is less than 1 cm total	Compression of antenna is less than 0.1 cm total	N/A
5	Deploy antenna	Antennae are deployed within a certain distance of the beacon	Antenna are deployed within 1 cm of beacon (closest part of antenna is within 1 cm of beacon)	Antenna are deployed within 0 cm of beacon (directly over beacon)	N/A

5	Set orientation of antenna	Antennae are deployed a number of degrees from the correct orientation	Antenna are deployed 20 degrees from correct orientation	Antenna are deployed 10 degrees from correct orientation	N/A
	Contains functional 3D part	Contains 3D part that functions as a part of the robot	Contains at least 1 3D part that functions as a part of the robot	Contains at least 1 3D part that functions as a part of the robot	N/A

9:58 pm
Submitted RFAI 1

10:00 pm Adjourned
Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

02.16.17

Meeting #4

Agenda

Begin building drive base and submit POC specs.

8:00 pm

POC submitted.

RobotC Research:

- Will not run on Jordan's mac.
- Can download to Klaire's computer and share using git.

8:20 pm

Robot building:

- Treads vs. Gear Conveyor
    - Inspiration: omni conveyor
- Drive train
    - Zero turn radius lawn mower
    - Three wheel design proved impractical without gear shift

Design of the third wheel. Should have been able to turn a certain angle and then cause the entire robot to turn with it. However, it was impractical to connect the motor to the robot at this angle. The idea was scrapped because the wheel could not swivel.

10:00 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

02.22.17

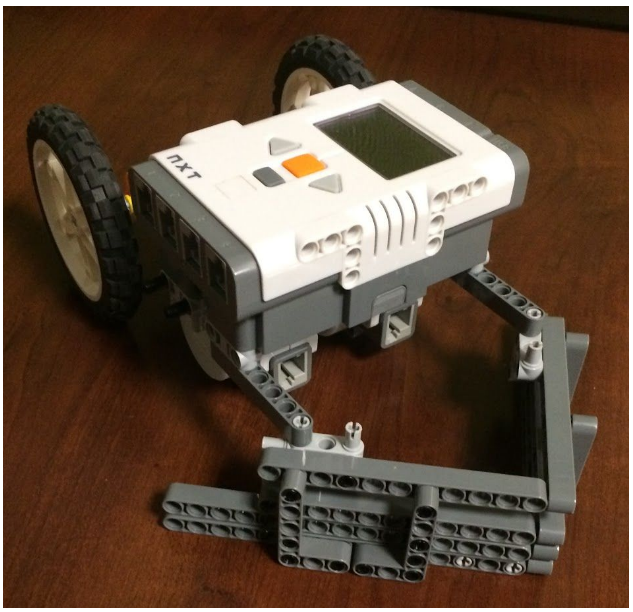
Meeting #5

Agenda

Improve drive base and begin coding. Figure out bluetooth by the end of the meeting. Begin antenna distribution design.

9:15 pm

Began to build plow on front of robot. Ran to third Street Market for batteries.



Plow on the front of the robot. Designed to push small obstacles out of the way.

Attached a conveyor belt to distribute the antenna. This is a preliminary design; later designs should have a transition from the belt to the ground, so that the antenna don't have to drop to get to the ground.

9:50 pm
Paired brick to Klaire's computer through bluetooth. Downloaded firmware.

10:20 pm
Ran sample code that made the robot beep twice. Success!

10:30 pm Adjourned
Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

02.26.17

Meeting #6

Agenda

Improve antenna distribution design. Begin codes for PoC. Revise PoC specifications.

9:15 pm

Began improving structure of conveyor belt that will distribute the antenna. Also began revising PoC specifications.

10:00 pm

Finished revising PoC specifications. The new specs are below:

	Klaire Fosnaugh	**Section 1**			
	Bailey Hayes	**Team 9**			
	Jordan Loeser				
	Michael Porter				
Task	**Customer Need**	**Technical Need**	**Technical Requirement**	**Target Value**	**Current Performance**
1, 5	Move steadily	Move with a maximum degree of rotation of the chassis	Move with a maximum of 15 degrees of rotation from original setting	Move with less than 10 degrees of rotation	N/A
1	Move far	Move at least a set distance in a set amount of time	Move at least 8 feet in 1 minutes	Move at least 10 feet in 1 minute	N/A
1	Robot can turn	Robot can turn with less than a certain turn radius	turn radius < 40 degrees	turn radius < 20 degrees	N/A
1	Robot can correct orientation	Robot can correct its orientation within certain degree of desired orientation	Robot can correct its orientation within 10 degrees of desired orientation	Robot can correct its orientation within 5 degrees of desired orientation	N/A

1	Move straight	Move with less than a specified degree of displacement from original path	Move with less than 20 degree displacement	Move with less than 5 degree displacement	N/A
2, 6	Navigate using GPS tracking	Receive set of coordinates	Receive set of coordinates	Receive set of coordinates	N/A
2	Correctly determine location	Can determine current location within a certain distance of actual location	Can determine current location within 5 cm of actual location	Can determine current location within 3 cm of actual location	N/A
2	Move to correct location	Move to coordinated location with specified precision	Move to coordinated location within 3 inches	Move to coordinated location within 2 inches	N/A
2, 4	Beep thrice when at known location	Beep thrice at location	Beep thrice at location	Beep thrice at location	N/A
2	Return to start	Robot returns to point within the home base	center of robot is within 3 inches of center of home base	center of robot is within 1 inch of center of home base	N/A
2	Move around large obstacles	Move around obstacles larger than certain height	Move around obstacles larger than 1 inch	Move around obstacles larger than 1 inch	N/A
3	Move over small obstacles	Traverse obstacles of a certain height without interfering with structure	Traverse obstacles at least 1/2 inch in height without interfering with structure	Traverse obstacles at least 1 inch in height	N/A
3	Traverse small obstacles quickly	Traverse 1 inch obstacles in a set time	Traverse 1 inch obstacles in less than 30 seconds	Traverse 1 inch obstacles in less than 15 seconds	N/A
4	Stop with paperclip over beacon	Paperclip is within a certain distance of the beacon	Paperclip is within 1 cm of the beacon	Paperclip is 0.5 cm from beacon (directly over beacon)	N/A

5	Transport antenna carefully	Antennae are transported without being compressed	Compression of antenna is less than 1 cm total	Compression of antenna is less than 0.1 cm total	N/A
5	Release antenna	Antennae are released within a certain distance of the beacon	Antenna are released within 1 cm of beacon (closest part of antenna is within 1 cm of beacon)	Antenna are released within 0.5 cm of beacon (directly over beacon)	N/A
5	Transport antennae	Transport antennae a certain distance	Transport antennae to within 1 cm of beacon	Transport antennae to within 0.5 cm of beacon	N/A
5	Transport antenna without excessive vibrations	Transport antennae without excessive displacement due to vibrations	Transport antennae with less than 1 cm displacement due to vibration	Transport antennae with less than 0.5 cm displacement due to vibration	N/A
5	Set orientation of antenna	Antennae are deployed a number of degrees from the correct orientation	Antenna are deployed 20 degrees from correct orientation	Antenna are deployed 10 degrees from correct orientation	N/A
6	Receive coordinates and error codes	Correctly display coordinates to screen	Correctly display coordinates to screen	Correctly display coordinates to screen	N/A
6	Move to correct location based on LSTS input	Move to correct location within set distance	Move to correct location within 1 cm	Move to correct location within .5 cm	N/A
	Contains functional 3D part	Contains 3D part that functions as a part of the robot	Contains at least 1 3D part that functions as a part of the robot	Contains at least 1 3D part that functions as a part of the robot	N/A

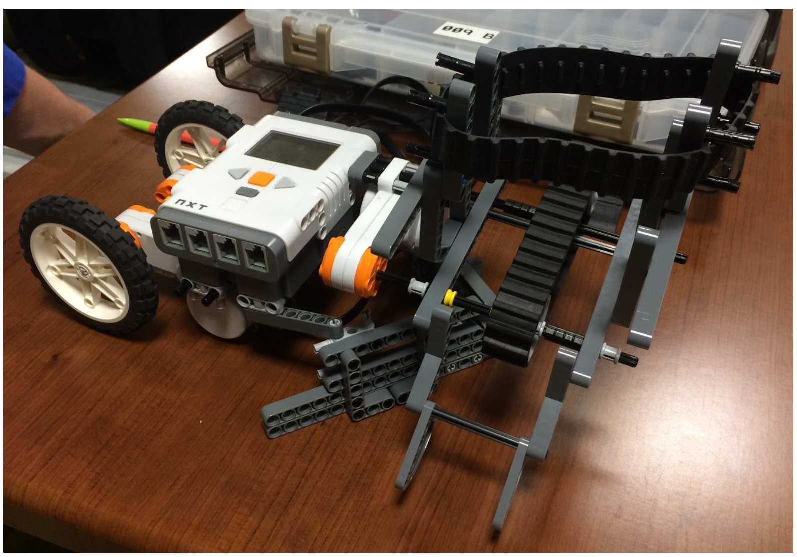
10:15 pm

Improved conveyor belt of robot.

10:30 pm

Tested drivetrain of robot. The robot moves in a straight line and turns. Weight needs to be added towards the back to weigh down the wheels more. They just slip when attempting to turn. **Current turning : 3 in of deviation**

10:55 pm



Another improved design of the conveyor belt. This time another belt is wrapped around the top of the frame to reduce the amount that the frame flexes.

11:00 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

03.02.17

Meeting #7

Agenda

Code and adjust robot to be able to complete more POC tasks. Decide on final wheel design.

8:30 pm

Moved conveyor belt on top of brick. Moved wheels to a more central position to reduce the turn radius.

Rotation Testing: Running on 20 power for 200 encoder ticks, clockwise direction:

Trial #	**Degrees rotated**
1	113
2	113
3	115
4	114

Average rotation: 113.75

Design Considerations:

Design	Deviation from central point on 90 degree turn (cm)
Conveyor belt in front, wheels behind	7 cm
Conveyor belt on top, wheels behind	4 cm
Conveyor belt on top, wheels underneath brick (but are narrower)	3 cm
Conveyor belt on top, wheels underneath brick (as wide as possible)	1 cm
Conveyor belt behind brick, wheels underneath brick (as wide as possible)	2 cm

Moving the conveyor belt decreased the deviation to 1 inch. Moving the wheels underneath the brick as well as putting the conveyor belt on top of the brick caused the deviation from a central point while turning to 1 cm. When looking at weighted values, ability to accurately navigate (small error in turning on central point) is the most important, so this was focused on to start. Optimal level is reached, so the team is moving on from the drive chain.

11:00 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

03.05.17

Meeting #8

Agenda

Come up with RFAI questions and prepare for PoC 1 by testing robot and debugging code.

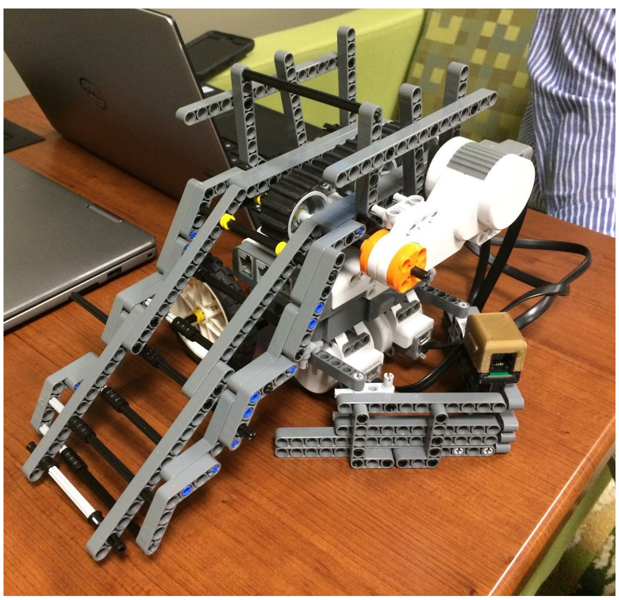
9:15 pm

RFAI Questions:

1. What will be the color of the special marker?
2. What is the altitude of the satellite above the lunar surface?
3. What are the dimensions of the specified drop off zone?
4. What amount of vibration is acceptable?
5. Is the beacon in the center of the drop-off zone?

10:00 pm

Tested new code for POC Task 2. Robot corrects orientation then moves to new point. Cannot figure out how to incorporate user input so current code has hardcoded values.



Added a slide to the antenna distribution system.

11:00 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

03.23.17

Meeting #9

Agenda

Work on revising POC specs, incorporate LSTS, discuss magnetic sensors

8:00 pm

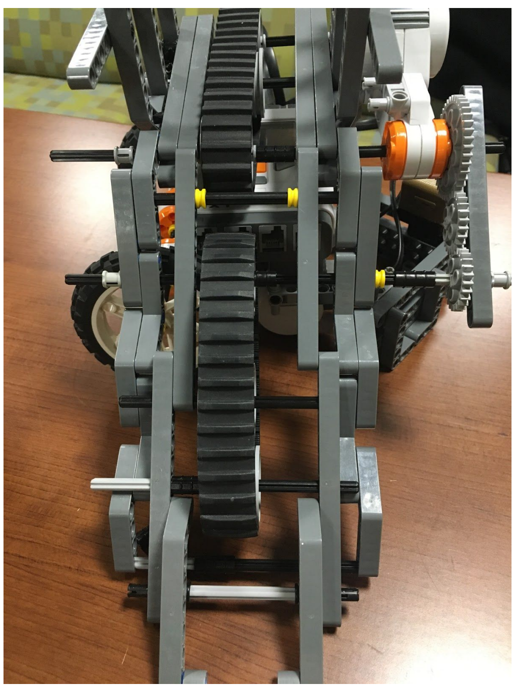
Possible RFAI Questions:

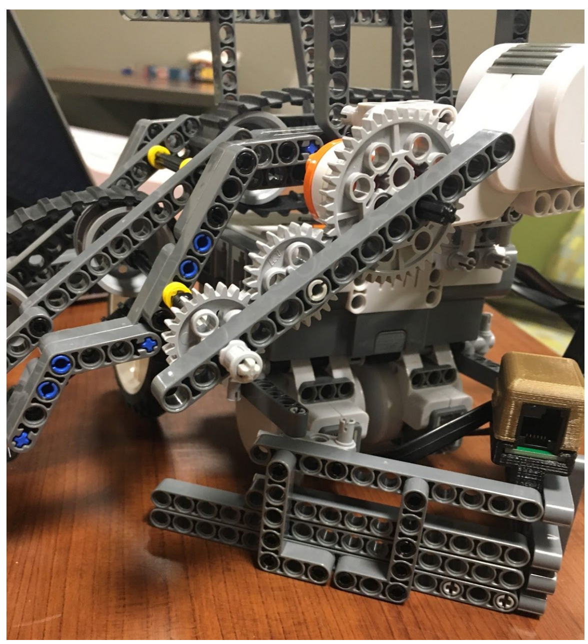
1. Will the altitude map be provided before the final demo?
    a. If we have to enter it as input for the final demo, then we will have to create an additional algorithm to determine the best path.

Updated conveyor belt system:

During initial testing, the antenna package was dropped with too much force, so a second treadmill was added to try and slow the speed of the package while it descends. The new frame slows the descent, but still needs a frame to keep packages from falling off the sides.

Next step: attempting to lower the treadmill so it is horizontal and barely off the ground





9:00 pm

Revise PoC Specs

	Klaire Fosnaugh	**Section 1**			

	Bailey Hayes	Team 9			
	Jordan Loeser				
	Michael Porter				
Task	Customer Need	Technical Need	Technical Requirement	Target Value	Current Performance
1, 5	Move steadily	Move with a maximum degree of rotation of the chassis	Move with a maximum of 15 degrees of rotation from original setting	Move with less than 10 degrees of rotation	N/A
1	Move far	Move at least a set distance in a set amount of time	Move at least 8 feet in 1 minutes	Move at least 10 feet in 1 minute	N/A
1	Robot can turn	Robot can turn 90 degrees while deviating a max of x inches from the center point	turn 90 degrees with a max deviation of the central point of the robot not deviating by more than 2 cm	turn 90 degrees with a max deviation of 1cm	N/A
1	Robot can accurately rotate its orientation	Robot can rotate its orientation within certain degree of desired orientation	Robot can rotate its orientation within 10 degrees of desired orientation	Robot can rotate its orientation within 5 degrees of desired orientation	N/A
1	Move straight	Move with less than a specified degree of displacement from original path	Move with less than 20 degree displacement	Move with less than 5 degree displacement	N/A
2	Correctly determine location	Can determine current location within a certain distance of actual location	Can determine current location within 5 cm of actual location	Can determine current location within 3 cm of actual location	N/A
2	Move to correct location	Move to coordinated location with specified precision	Move to coordinated location within 3 inches	Move to coordinated location within 2 inches	N/A

2, 4	Beep thrice when at known location	Beep thrice at location specified % of times	Beep thrice at location 95% of the time	Beep thrice at location 100% of the time	N/A
2	Return to start	Robot returns to point within the home base	center of robot is within 3 inches of center of home base	center of robot is within 1 inch of center of home base	N/A
2	Move around large obstacles	Robot does not come within x inches of the obstacle	Robot does not come within one inch of the obstacle	Robot does not come within two inches of the obstacle	N/A
3	Move over small obstacles	Traverse obstacles of a certain height without interfering with structure	Traverse obstacles at least 1/2 inch in height without interfering with structure	Traverse obstacles at least 1 inch in height	N/A
3	Traverse small obstacles quickly	Traverse 1 inch obstacles in a set time	Traverse 1 inch obstacles in less than 30 seconds	Traverse 1 inch obstacles in less than 15 seconds	N/A
4	Stop with paperclip over beacon	Paperclip is within a certain distance of the beacon	Paperclip is within 1 cm of the beacon	Paperclip is 0.5 cm from beacon (directly over beacon)	N/A
4	Detect beacon	ALV needs to detect beacon from certain distance away from it	Detect beacon more than 3 inches away	Detect beacon more than 5 inches away	N/A
4	Stop at beacon	ALV must stop within specified distance of beacon	ALV stops within 1 cm of beacon	ALV stops within .5 cm of beacon	N/A
5	Release antenna	Antennae are released within a certain distance of the beacon	Antenna are released within 1 cm of beacon (closest part of antenna is within 1 cm of beacon)	Antenna are released within 0.5 cm of beacon (directly over beacon)	N/A
5	Transport antennae	Transport antennae a certain distance	Transport antennae within 1 cm of beacon	Transport antennae within	N/A

				0.5 cm of beacon	
5	Transport antenna without excessive vibrations	Transport antennae without exceeding appropriate g force	Transport antennae without exceeding vibrations of 1 g (as measured by accelerometer inside of antennae)	Transport antennae without exceeding vibrations of 0.5 g (as measured by accelerometer inside of antennae)	N/A
5	Set orientation of antenna	Antennae are deployed a number of degrees from the correct orientation	Antenna are deployed 20 degrees from correct orientation	Antenna are deployed 10 degrees from correct orientation	N/A
6	Recieve coordinates and error codes	Correctly display coordinates to screen with specified % accuracy	Correctly display coordinates to screen with 95% accuracy	Correctly display coordinates to screen with 99% accuracy	N/A
6	Move to correct location based on LSTS input	Move to correct location within set distance	Move to correct location within 1 cm	Move to correct location within .5 cm	N/A
6	Recognize error code from LSTS system	Identifies error codes from LSTS system x percentage of time	identifies error codes from LSTS 80 percent of the time	identifies error codes from LSTS 95 percent of the time	N/A
6	Recognize error in human entered coordinates	detects when coordinates entered are not on the map or are in crevices x percent of time	detects error entered coordinates 80 percent of the time	detects error entered coordinates 95 percent of the time	N/A

11:00 pm Adjourned

Klaire Fosnaugh, Jordan Loeser, Michael Porter

03.27.17

Meeting #10

RFAI Questions:

1. Will the altitude map be provided before the final demo?
2. How close must the antenna containers be placed in relation to the drop-off zone to be considered passing?

11:15 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

04.06.17

Meeting #11

Revised Specs for POC 2:

Task	Customer Need	Technical Need	Technical Requirement	Target Value	Current Performance
1, 5	Move steadily	Move with a maximum degree of rotation of the chassis	Move with a maximum of 15 degrees of rotation from original setting	Move with less than 10 degrees of rotation	N/A
1	Move far	Move at least a set distance in a set amount of time	Move at least 8 feet in 1 minutes	Move at least 10 feet in 1 minute	N/A
1	Robot can turn	Robot can turn 90 degrees while deviating a max of x inches from the center point	turn 90 degrees with a max deviation of the central point of the robot not deviating by more than 2 cm	turn 90 degrees with a max deviation of 1cm	N/A
1	Robot can accurately rotate its orientation	Robot can rotate its orientation within certain degree of desired orientation	Robot can rotate its orientation within 10 degrees of desired orientation	Robot can rotate its orientation within 5 degrees of desired orientation	N/A
1	Move straight	Move with less than a specified degree of displacement from original path	Move with less than 20 degree displacement	Move with less than 5 degree displacement	N/A
2	Correctly determine location	Can determine current location within a certain distance of actual location	Can determine current location within 5 cm of actual location	Can determine current location within 3 cm of actual location	N/A
2	Move to correct location	Move to coordinated	Move to coordinated	Move to coordinated	N/A

		location with specified precision	location within 3 inches	location within 2 inches	
2, 4	Beep thrice when at known location	Beep thrice at location specified % of times	Beep thrice at location 95% of the time	Beep thrice at location 100% of the time	N/A
2	Return to start	Robot returns to point within the home base	center of robot is within 3 inches of center of home base	center of robot is within 1 inch of center of home base	N/A
2	Move around large obstacles	Robot does not come within x inches of the obstacle	Robot does not come within one inch of the obstacle	Robot does not come within two inches of the obstacle	N/A
3	Move over small obstacles	Traverse obstacles of a certain height without interfering with structure	Traverse obstacles at least 1/2 inch in height without interfering with structure	Traverse obstacles at least 1 inch in height	N/A
3	Traverse small obstacles quickly	Traverse 1 inch obstacles in a set time	Traverse 1 inch obstacles in less than 30 seconds	Traverse 1 inch obstacles in less than 15 seconds	N/A
4	Stop with paperclip over beacon	Paperclip is within a certain distance of the beacon	Paperclip is within 1 cm of the beacon	Paperclip is 0.5 cm from beacon (directly over beacon)	N/A
4	Detect beacon	ALV needs to detect beacon from certain distance away from it	Detect beacon more than 3 inches away	Detect beacon more than 5 inches away	N/A
4	Stop at beacon	ALV must stop within specified distance of beacon	ALV stops within 1 cm of beacon	ALV stops within .5 cm of beacon	N/A
5	Release antenna	Antennae are released within a certain distance of the beacon	Antenna are released within 1 cm of beacon (closest part of antenna is within 1 cm of beacon)	Antenna are released within 0.5 cm of beacon (directly over beacon)	N/A

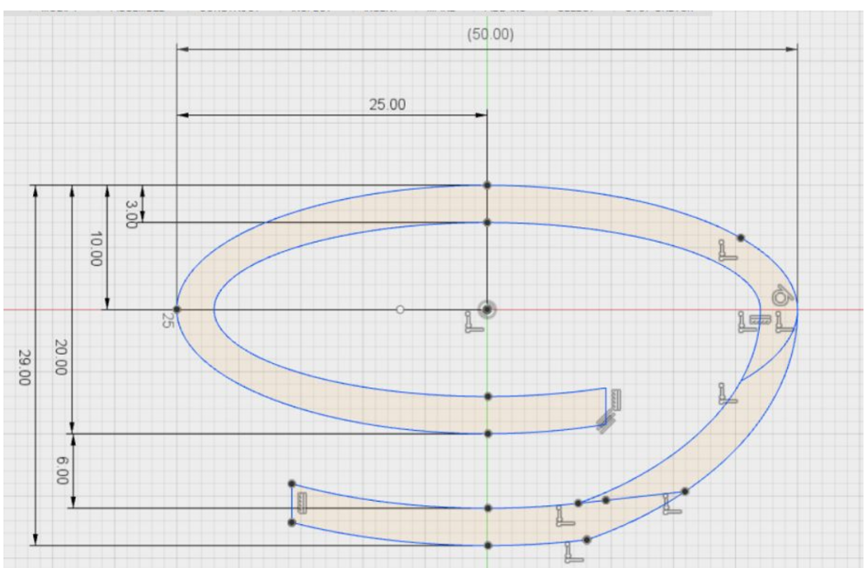
5	Antenna detachment	From the time the antenna touches the ground to the robot completely releasing the antenna, the antenna does not move more than a certain number of millimeters	The antenna moves less than 3 mm	The antenna moves less than 1 mm	N/A
5	Transport antennae	Transport antennae a certain distance	Transport antennae 5 meters	Transport antennae 7 meters	N/A
5	Transport antenna without exceeding average vibration level	Transport antennae without exceeding average vibration level	Transport antennae without exceeding average vibrations of 1.3m/s^2 (as measured by accelerometer inside of antennae)	Transport antennae without exceeding average vibrations of 1.0 m/s^2 (as measured by accelerometer inside of antennae)	N/A
5	Transport antenna without exceeding a peak vibration level	Transport antennae without exceeding specified level at any time	Transport antennae without exceeding 1.6 m/s^2 at any time	Transport antennae without exceeding 1.3 m/s^2 at any time	N/A
5	Set orientation of antenna	Antennae are deployed a number of degrees from the correct orientation	Antenna are deployed less than 20 degrees from correct orientation	Antenna are deployed less than 10 degrees from correct orientation	N/A
6	Recieve coordinates and error codes	Correctly display coordinates to screen with specified % accuracy	Correctly display coordinates to screen with 99% accuracy	Correctly display coordinates to screen with 100% accuracy	N/A

6	Move to correct location based on LSTS input	Move to correct location within set distance	Move to correct location within 1 cm	Move to correct location within .5 cm	N/A
6	Recognize error code from LSTS system	Identifies error codes from LSTS system x percentage of time	identifies error codes from LSTS 99 percent of the time	identifies error codes from LSTS 100 percent of the time	N/A
6	Recognize error in human entered coordinates	detects when coordinates entered are not on the map or are in crevices x percent of time	detects error entered coordinates 99 percent of the time	detects error entered coordinates 100 percent of the time	N/A

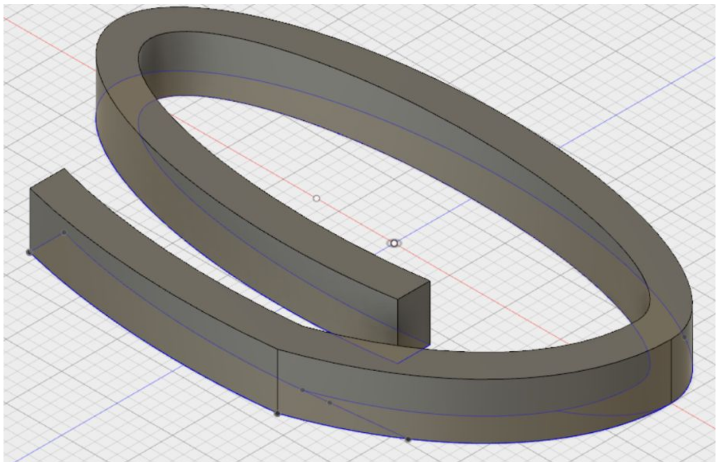
3D printed part:

Bailey began to design the initial part. The team brainstormed creating a slide for the antenna box or making a clip to hold all the wires so they stay out of the way of the motors and treadmill. The wire clip was chosen. Issues with the slide consisted of difficulty of fitting it into design and concerns of the surface being rough and causing excess vibrations. The clip designed is approximately 50 mm wide, 20 mm long, and 3 mm thick. It was extruded 5 mm.

Dimensioned sketch of 3D part:

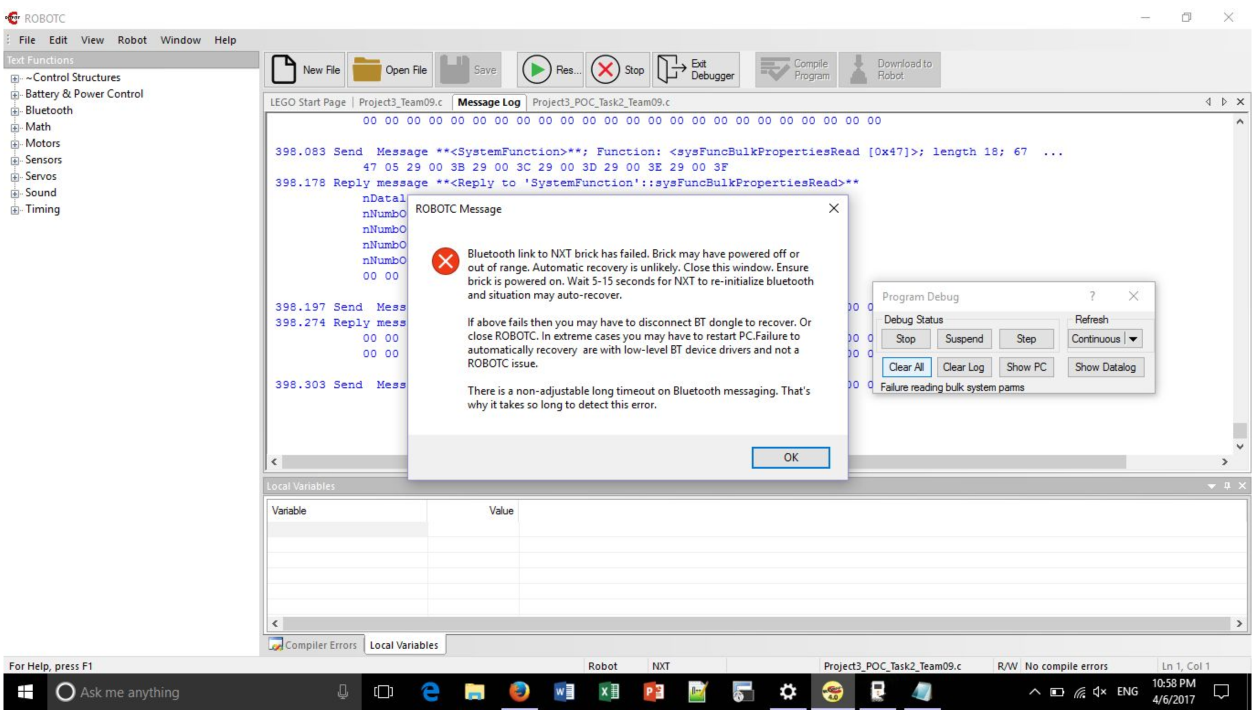


Final model of 3D part:



Coding:
Klaire and Jordan worked on the code and tried to get the computer to connect to the NXT brick via bluetooth.

Error Code:



Decision Matrix:

Since PoC specs were done being revised, a full decision matrix was created for both the hardware and software. They can be seen as follows:

Hardware

Rank	Customer Need	Technical Need	Technical Requirement	Target Value	Current Performance
4	Move steadily	Move with a maximum degree of rotation of the chassis	Move with a maximum of 15 degrees of rotation from original setting	Move with less than 10 degrees of rotation	N/A
2	Move far	Move at least a set distance in a set amount of time	Move at least 8 feet in 1 minutes	Move at least 10 feet in 1 minute	N/A
5	Robot can turn	Robot can turn 90 degrees while deviating a max of x inches from the center point	turn 90 degrees with a max deviation of the central point of the robot not deviating by more than 2 cm	turn 90 degrees with a max deviation of 1cm	N/A
5	Robot can accurately rotate its orientation	Robot can rotate its orientation within certain degree of desired orientation	Robot can rotate its orientation within 10 degrees of desired orientation	Robot can rotate its orientation within 5 degrees of desired orientation	N/A
5	Move straight	Move with less than a specified degree of displacement from original path	Move with less than 20 degree displacement	Move with less than 5 degree displacement	N/A
5	Move over small obstacles	Traverse obstacles of a certain height without interfering with structure	Traverse obstacles at least 1/2 inch in height without interfering with structure	Traverse obstacles at least 1 inch in height	N/A
1	Traverse small obstacles quickly	Traverse 1 inch obstacles in a set time	Traverse 1 inch obstacles in less than 30 seconds	Traverse 1 inch obstacles in less than 15 seconds	N/A

3	Release antenna	Antennae are released within a certain distance of the beacon	Antenna are released within 1 cm of beacon (closest part of antenna is within 1 cm of beacon)	Antenna are released within 0.5 cm of beacon (directly over beacon)	N/A
3	Antenna detachment	From the time the antenna touches the ground to the robot completely releasing the antenna, the antenna does not move more than a certain number of millimeters	The antenna moves less than 3 mm	The antenna moves less than 1 mm	N/A
2	Transport antennae	Transport antennae a certain distance	Transport antennae 5 meters	Transport antennae 7 meters	N/A
5	Transport antenna without exceeding average vibration level	Transport antennae without exceeding average vibration level	Transport antennae without exceeding average vibrations of 1.3m/s^2 (as measured by accelerometer inside of antennae)	Transport antennae without exceeding average vibrations of 1.0 m/s^2 (as measured by accelerometer inside of antennae)	N/A
3	Transport antenna without exceeding a peak vibration level	Transport antennae without exceeding specified level at any time	Transport antennae without exceeding 1.6 m/s^2 at any time	Transport antennae without exceeding 1.3 m/s^2 at any time	N/A
1	Set orientation of antenna	Antennae are deployed a number of degrees from	Antenna are deployed less than 20 degrees from	Antenna are deployed less than 10 degrees from	N/A

		the correct orientation	correct orientation	correct orientation	

Software

Rank	Customer Need	Technical Need	Technical Requirement	Target Value	Current Performance
2	Correctly determine location	Can determine current location within a certain distance of actual location	Can determine current location within 5 cm of actual location	Can determine current location within 3 cm of actual location	N/A
5	Move to correct location	Move to coordinated location with specified precision	Move to coordinated location within 3 inches	Move to coordinated location within 2 inches	N/A
1	Return to start	Robot returns to point within the home base	center of robot is within 3 inches of center of home base	center of robot is within 1 inch of center of home base	N/A
3	Move around large obstacles	Robot does not come within x inches of the obstacle	Robot does not come within one inch of the obstacle	Robot does not come within two inches of the obstacle	N/A
3	Stop with paperclip over beacon	Paperclip is within a certain distance of the beacon	Paperclip is within 1 cm of the beacon	Paperclip is 0.5 cm from beacon (directly over beacon)	N/A
4	Detect beacon	ALV needs to detect beacon from certain distance away from it	Detect beacon more than 3 inches away	Detect beacon more than 5 inches away	N/A
4	Stop at beacon	ALV must stop within specified distance of beacon	ALV stops within 1 cm of beacon	ALV stops within .5 cm of beacon	N/A
2	Release antenna	Antennae are released within a certain	Antenna are released within 1 cm of beacon	Antenna are released within 0.5 cm of	N/A

		distance of the beacon	(closest part of antenna is within 1 cm of beacon)	beacon (directly over beacon)	
5	Recieve coordinates and error codes	Correctly display coordinates to screen with specified % accuracy	Correctly display coordinates to screen with 99% accuracy	Correctly display coordinates to screen with 100% accuracy	N/A
4	Move to correct location based on LSTS input	Move to correct location within set distance	Move to correct location within 1 cm	Move to correct location within .5 cm	N/A
5	Recognize error code from LSTS system	Identifies error codes from LSTS system x percentage of time	identifies error codes from LSTS 99 percent of the time	identifies error codes from LSTS 100 percent of the time	N/A
5	Recognize error in human entered coordinates	detects when coordinates entered are not on the map or are in crevices x percent of time	detects error entered coordinates 99 percent of the time	detects error entered coordinates 100 percent of the time	N/A

Michael worked on the antenna distribution system. He completely redesigned the system to allow the robot to release the antenna closer to the ground and prevent the antenna from flipping over on the way to the ground.

11:15 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

04.07.17

Meeting #12

Code Updates

- LSTS still gave error
- Focused on tasks without LSTS

Task 2

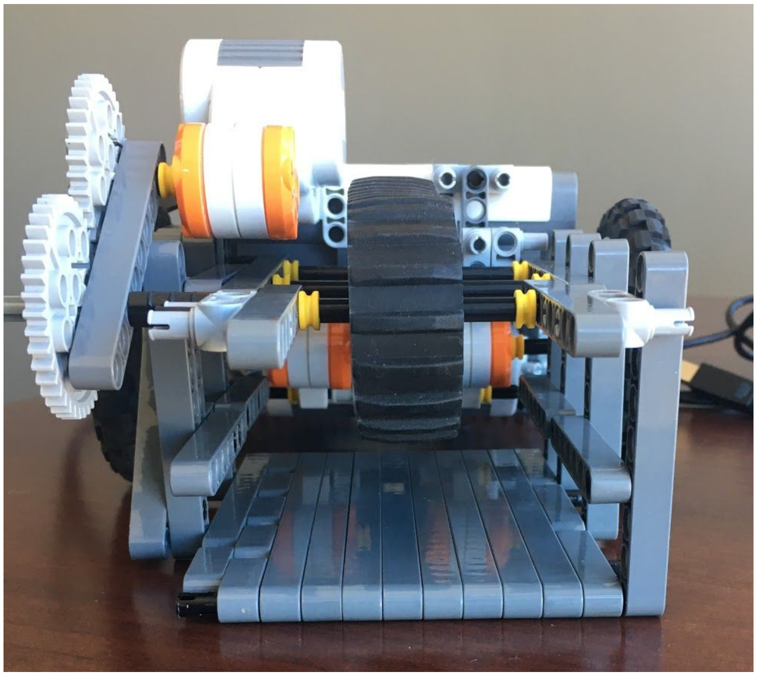
- Paper texture greatly impacted turn accuracy
- Added variable textureGainFactor to amp up number of ticks and make turns more accurate.

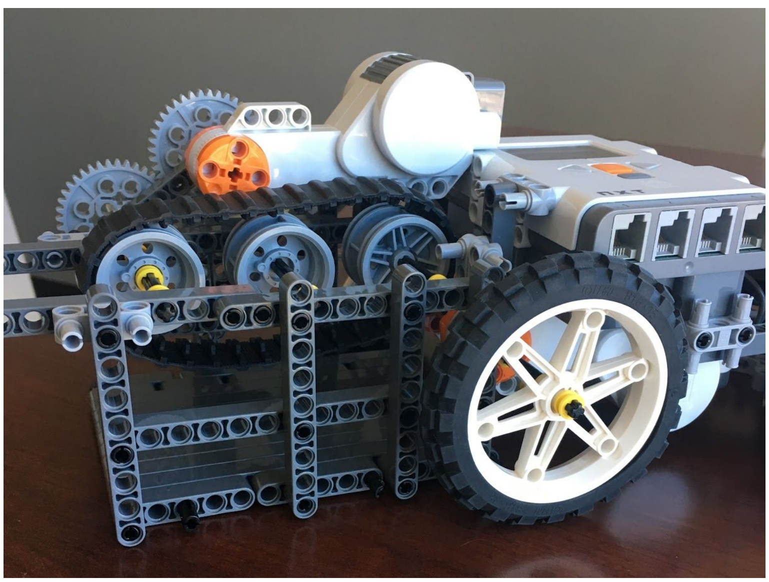
Task 4

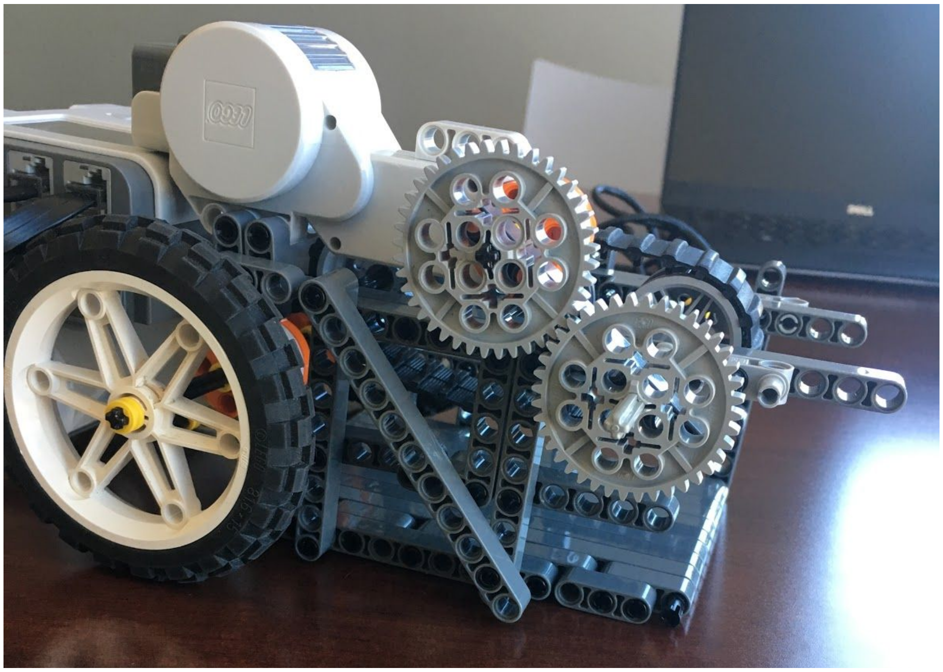
- Conceptualized sweeping algorithm to point ALV towards magnet.
- Sweep in angles of 20deg and find a max magnet reading and corresponding angle
  - If the values are below a threshold (no magnet), keep moving straight
  - If any detects a magnet, move forward 10 cm
  - Repeat again until reading is high enough

Bailey downloaded robotC because Klaire’s laptop doesn’t connect to the robot via bluetooth. The team is trying another computer so that we can connect to the robot with bluetooth.

Michael further improved the antenna distribution system. He added a horizontal bar so that the antenna wouldn’t get caught on the vertical bars on the frame. He also added a diagonal bar to stabilize the frame. The antenna distribution system is attached to the back of the robot, which allows the wheels to be centered and keeps the turn radius as close to zero as possible.







Complete data from testing antenna dropoff:

Design	Is force at a passing level (determined from office hours tests)
Conveyor belt on top with two piece slide	No
Conveyor belt on top with zig-zag (less steep) slide	No
Double conveyor belt slide	No
Bed on ground with conveyor belt above bed	Yes, four tests resulted in Average average - 0.3 m/s^2 (max = 1.3) Average peak - 8.66 m/s^2 (max = 12)

The team began the rough draft of the final report. The paper was formatted and outlined.

4:00 pm Adjourned
Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

04.07.17

Meeting #12

Agenda: Finalize code for PoC Task 2

Testing of task 2 new design

Trial (start location)	Travel to location and back home(distance from original cm)	Beeps at correct location (distance from cm)	Comments
1 (0,0)	10 cm off	0 cm (after one correction)	The turn was thrown off due to a divot in the tile tested on. Code made to only turn before moving initially to decrease chance of error in turns. Also, varied some while going forwards
2 (0,0)	Divots caused to be off target so test avoided	Ran into box	The three beeps were made easier to hear, but robot still doesn't stop while beeping
3(0,0)	Ran off course	0 cm off	Correctly stopped, waited, and beeped but went too far down on way back
			It was discovered a wire touching a wheel was causing the direction to veer slightly. A piece was added to hold the wire out of the way.
4 (0,0)	20 cm off	10 cm off	The robot was short of the initial location
5 (0,0)	5 cm	10 cm off	
6 (0,0)	2 cm	8 cm	
7 (20,50)	13 cm	35 cm	One of the turns was off by a large amount, affecting the wanted location, but it was accurate at returning to the needed location

8 (20,50)	17 cm	15 cm	Has trouble on turns still, so a slight delay is added before turning (it turns well from stopped in previous testing)
9 (20,50)	N/A		Batteries were running low. The pause before turns greatly improved turning accuracy, but the batteries were low, so the straight line portion ran slow and not straight

Coding Update:
Due to the different friction factor of different surfaces, a factor to multiply the turning functions and a factor for travelling large distances were added as coefficients in the two different functions. Now, when a new environment is tested on, a test function for travelling one foot and turning are run separately, changing the coefficient values until the correct distance is reached.

A delay is added before turning to try and avoid some slight slipping while going into the turns.

A poster board with the same material as the track is discussed being bought. This will allow a full grid system with the track to be drawn on. It will assist in measuring error and save time on setup for each meeting.

11:15 pm Adjourned
Bailey Hayes, Jordan Loeser, Michael Porter

04.10.17

Meeting #13

Agenda: calibrate the magnetic sensor to detect a beacon, test antennae drop-off

RFAI Questions:

1. What is the peak acceleration the antennae boxes can withstand before being damaged?
2. Is the beacon held against the ground, or is it just laid on top of the surface?
3. Does the team manually load the antennae boxes before beginning the demonstration?

Code:

We calibrated the magnetic sensor during office hours, and then wrote the code for the fourth PoC task. The code for PoC Task 4 doesn't have the readings from the magnetic sensor hardcoded into it. Instead, the code measures the difference between the initial value and all the other values. Once this difference reaches 10 the robot moves forward another 5 cm and then stops and beeps because it is above the magnet.

Antenna Box Acceleration Table

Trial	Average Acceleration (m/s^2)	Max Acceleration (m/s^2)	Notes
1	0.25	7.75	Box didn't fall completely onto the table; the corner stayed on the platform.
2	0.32	9.50	Used a second box behind the first to push the first box fully onto the table.
3	0.28	9.79	Used a rod to decrease the distance from the platform to the table.
4	0.36	7.61	Same conditions as Trial 3.

Maximum acceleration cannot exceed 12 m/s^2 in order to pass PoC.
Average acceleration cannot exceed 1.3 m/s^2 in order to pass PoC.

8:30 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

04.11.17

Meeting #14

Agenda: Test robot for PoC Tasks

Testing Tasks:

Task	*Predicted to Pass?
1	Yes
2	Yes
3	Passed at last PoC
4	Yes
5	Yes
6	No

*Predictions are based on the requirements for the PoC Tasks listed on Blackboard Learn.

We discovered that our right motor gets a faster start than our left motor, which led to the robot being unable to move in a straight line. We adjusted our code accordingly and fixed the problem.

11:00 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

04.12.17

Meeting #15

Agenda: PoC 2

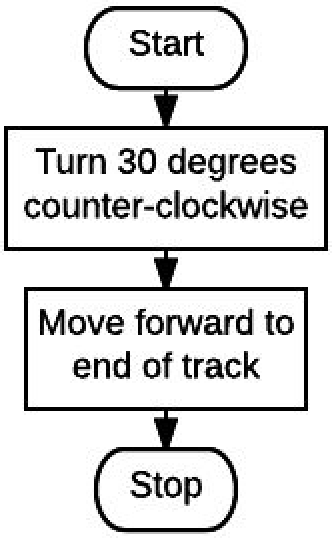
PoC 2 Results:

Task	Passed?
1	Yes
2	No
3	Yes
4	Yes
5	No
6	No

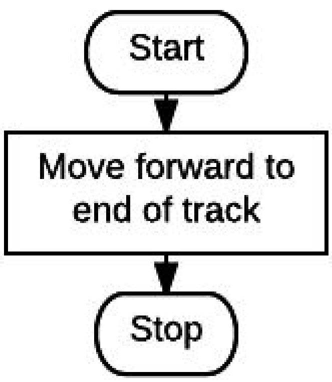
Total Points: 4 (1,3,4 and integration of 1 and 3)

Tasks 1 & 3 were passed easily earning the team 3 points.
Task 4 was passed after the team realized the reference point needed to be the center of the brick, not the tip of the plow.
Task 5 was close, but there was too much error in navigation because of the friction factor accounted for in the turning and movement functions. Task 2 was unsuccessful for the same reason. Task 5 was close in terms of dropping of the antennae though. The team managed to drop the box within the circle with successful peak and average vibration levels. The team ran out of time, which is why it was not passed.
Task 6 works sometimes. The team is going to try using the MATLAB version of LSTS to see if it is a bluetooth compatibility issue.

Code Flowcharts:



Task 1



Task 3

10:30 pm Adjourned
Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

04.13.17

Meeting #16

Agenda: Finish Report Draft for Friday 4/14 deadline.

We updated the draft with the results from PoC 2 and added in more information about the software.

10:30 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

04.17.17

Meeting #17

Agenda: Work on connecting to the LSTS system and find a friction factor for the paper used at the demo.

LSTS is initially tested with Klaire's laptop to see if the ALV can connect with the interface.

Coordinate entered	Should there be an error	Output
(750,550)	No	No error X:750 Y: 550
(350,350)	No	Error in Coordinates
Manual override	Yes	Error in coordinates
**(950,550)		No Error X:950 Y:550
(650, 750)	No	No error X:650 Y;750
Manual Override	Yes	Error Manual Override
Coordinates out of bounds	Yes	Error Out of Bounds
No ALV marker seen	Yes	Did not correctly display message
Busy	Yes	Did not correctly display message

After testing, the issue was determined to be the receiving of the message. The entire message was printed in multiple different tests with the different options.

(**) brick and LSTS are restarted at this point

After restarting, correct coordinates and manual overrides could be detected

Testing with the friction factors (robot turns left 90 degrees, then right 90 degrees)

Friction Factor	Degrees Turned	Desired Degrees Turned
Left - 1.9 Right 1.6	100	90
Left - 1.5 Right - 1.2	50	90
Left - 1.7 Right - 1.2	75	Deviated 3 cm
Left - 1.8 Right - 1.2	45	Deviated 5 cm
Left - 2.1 Right - 1.5	90	Deviated 4 cm
Left - 2.0 Right - 1.5	98	Deviated 3 cm
Left - 2.05 Right - 1.05	92	Deviated 3 cm
Left - 2.05 Right - 1.45	89	Deviated 3 cm
Left - 1.7 Right - 1.7	1st turn - 80 2nd - turn 95	Deviated 4 cm
Left - 2.05 Right - 1.43	90	Deviated 3 cm

Changing motor speed to try and lower deviation (Left - 2.05, Right - 1.45)

Motor Speed	Degrees turned	Deviation
40	95	4 cm
20	90	3 cm
25	85	4 cm
30	80	3 cm

8:00 pm Adjourned

Klaire Fosnaugh, Michael Porter

04.19.17

Meeting #18

Agenda: Write team reflection for programming homework #2; test bin drop off and LSTS system.

We changed the batteries again. They were changed on Monday, and they are already dead.

The LSTS system works again!

Data for testing the bin deployment (goal is to drop all three bins, one at a time)

Bin width	Bin 1	Bin 2	Bin 3
36	Dropped correctly	Dropped correctly	Didn’t drop
38	Dropped correctly	Dropped after second rotation	Dropped correctly
40	Dropped correctly	Dropped after second rotation	Dropped after second rotation
39	Dropped correctly	Dropped after second rotation	Didn’t drop
39	Dropped correctly	Dropped after second rotation	Dropped after second rotation, but was crooked
41	Dropped correctly	Dropped after second rotation	Dropped correctly
40	Dropped correctly	Dropped after second rotation	Dropped after first rotation, but bin started partially off of the end
40	Dropped correctly	Dropped after second rotation	Dropped correctly
40	Dropped correctly	Dropped after first rotation, but bin started partially off of the end	Dropped correctly
40.5	Dropped correctly	Dropped correctly	Dropped after

			second rotation
36	Dropped correctly	Dropped after second rotation	Dropped after second rotation
40.5	Dropped after second rotation	Dropped after second rotation	Didn't drop
40.5	Dropped correctly	Dropped after second rotation	Didn't drop
40.5	Dropped correctly	Dropped after second rotation	Dropped correctly
40.5	Dropped correctly	Dropped after second rotation	Dropped correctly
40.5	Dropped correctly	Dropped after second rotation	Dropped correctly

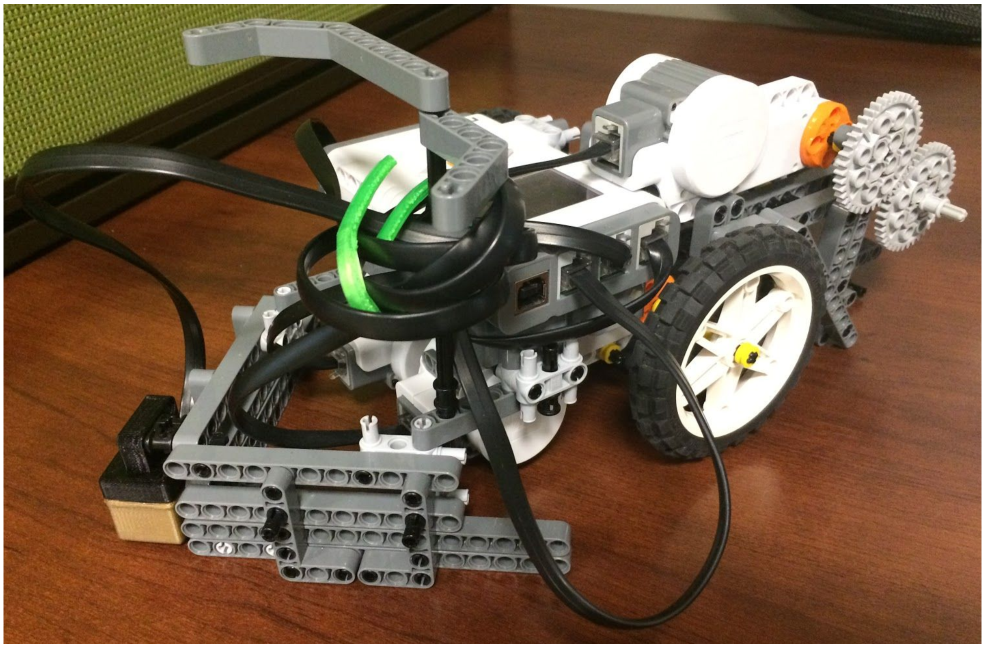
There was a lot more resistance than there was initially, so the team tried changing some parts to see if there was a difference. The team switched out the motor that turns the conveyor belt, and there was no noticeable change.

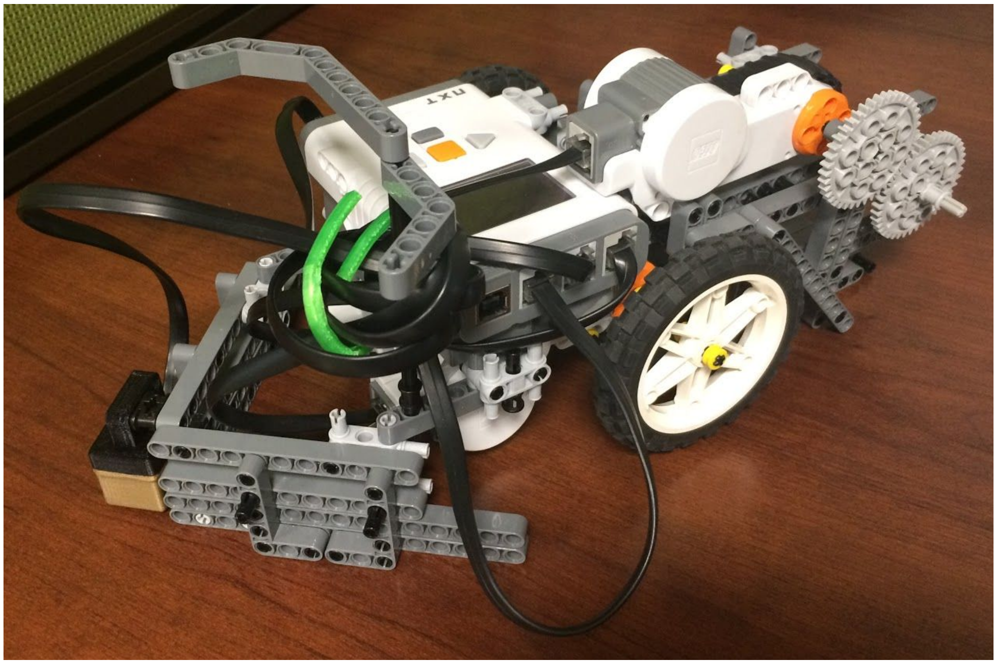
The team decided to use a bin width of 40.5 mm to calibrate the bin distribution. This width worked consistently, and the code can easily be modified to rotate twice for each bin after the first one is dropped off.

Combined codes for POC tasks 2 and 6 meaning the ALV took input data from LSTS the specified its current location and then moved to that location and beeped thrice.

-This worked for the most part other than the fact the testing surface had a different friction factor than the POC paper.

The team also added the 3D printed wire clip to the robot along with a piece that the beacon for the LSTS will attach to.





11:00 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Michael Porter

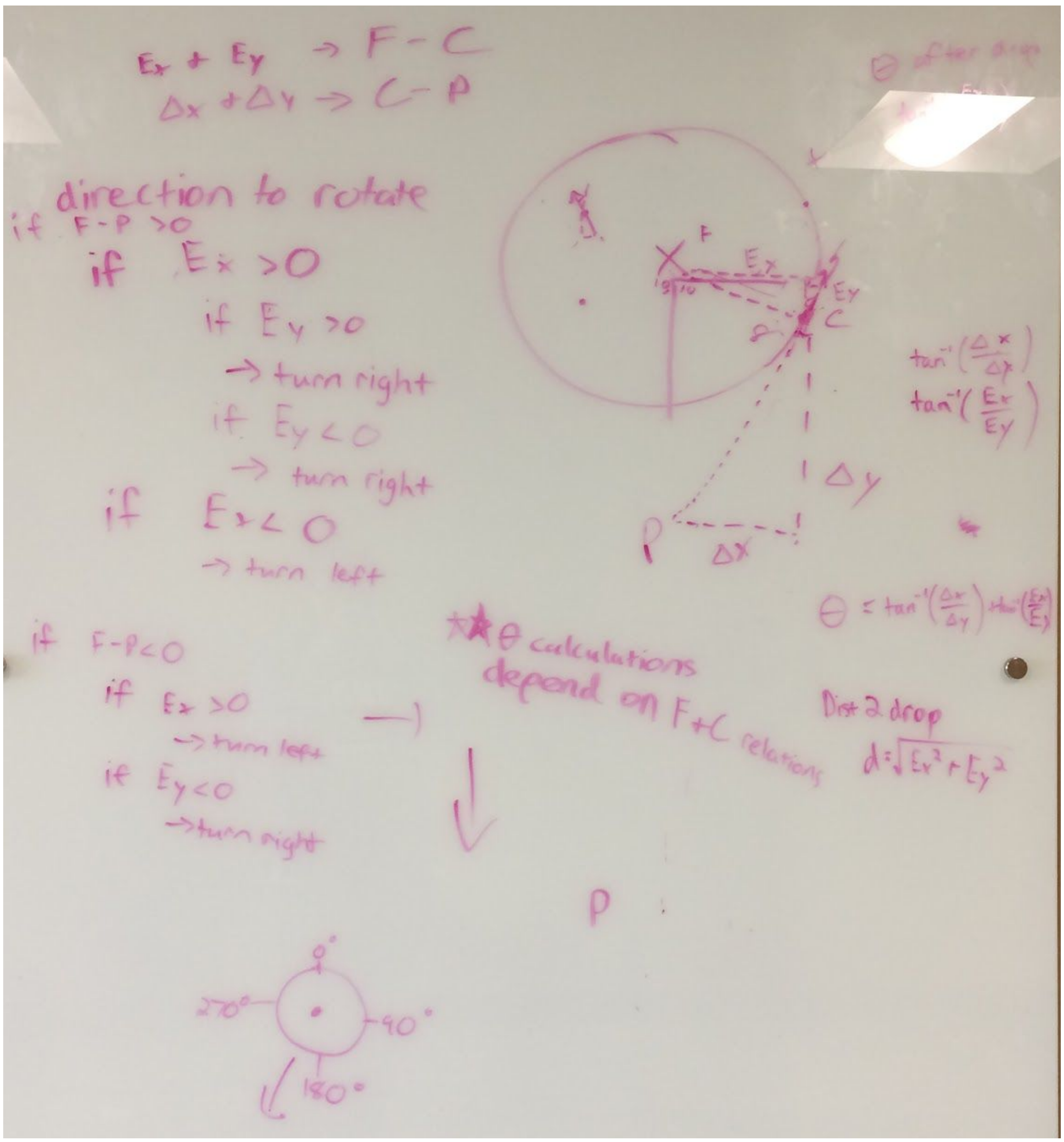
04.22.17

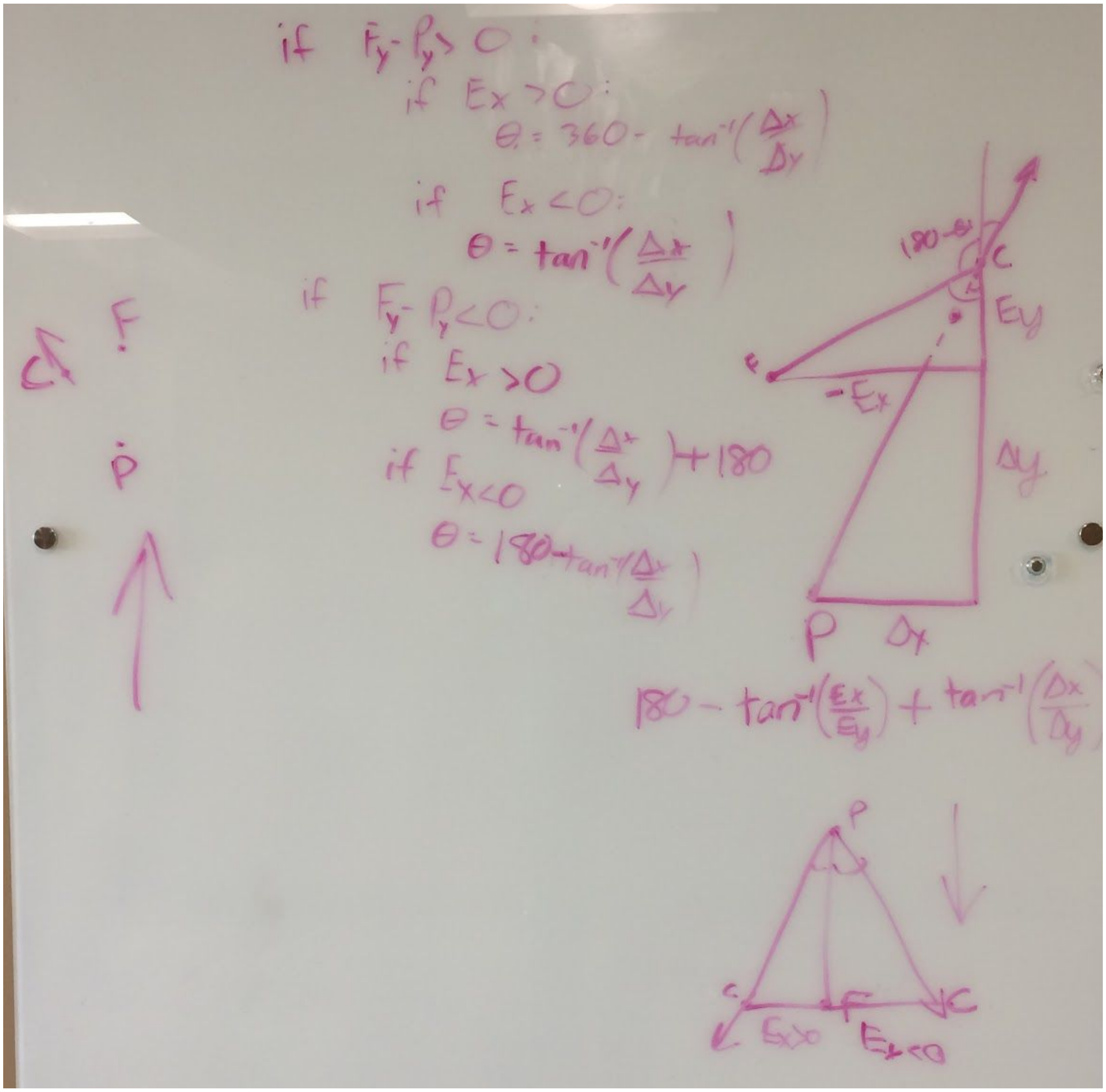
Meeting #19

Agenda: Test the integrated code. Add functions to account for differing orientations in the beginning

Jordan and Klaire wrote and debugged the function that determines the difference between the robot's location and the location the robot wants to be at.

Bailey and Michael worked out the math and the logic to update the orientation of the robot based on how far off course the robot is. The results are shown in the images below.





6:00 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

04.23.17

Meeting #20

Agenda: Test the code on a track and make any adjustments necessary.

An error was found in the turning function. The orientation was not correctly updated with each turn. This was fixed.

Prioritizing Method to Find Location and Drop off Bin

Consideration	Weight	LSTS	Magnetic Sensor	Mathematical Estimation
Consistency	4	3	4	4
Ease of Implementation	3	2	5	4
Accuracy	5	5	4	2
	Totals:	43	51	38

***Values assigned on a scale of 1-5.

3:00 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

04.24.17

Meeting #21

Agenda: Final testing and final adjustments. Start the presentation.

Bailey and Michael worked on the presentation while Klaire and Jordan tested the robot and made final adjustments to the code.

Shortened Decision matrices created for poster presentation.
Hardware:

Consideration	Weight	Deployment System behind brick, wide-wheeled drive train	Deployment System above brick, wide-wheeled drive train	Deployment System above plow, narrow-wheeled drive train
Turns 90 degrees accurately	5	4	5	2
Minimal deviation from origin	5	4	5	2
Deploy bins with minimal vibration	3	5	1	3
	Totals	55	51	29

11:30 am Adjourned
Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter

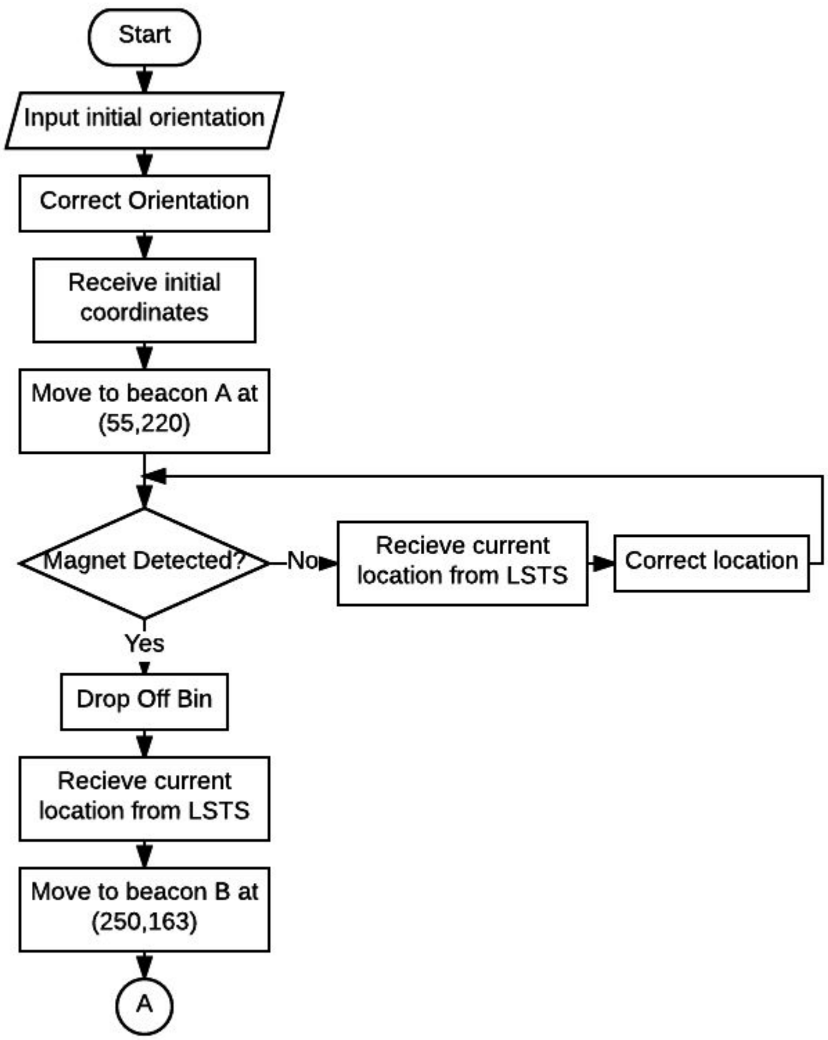
04.25.17

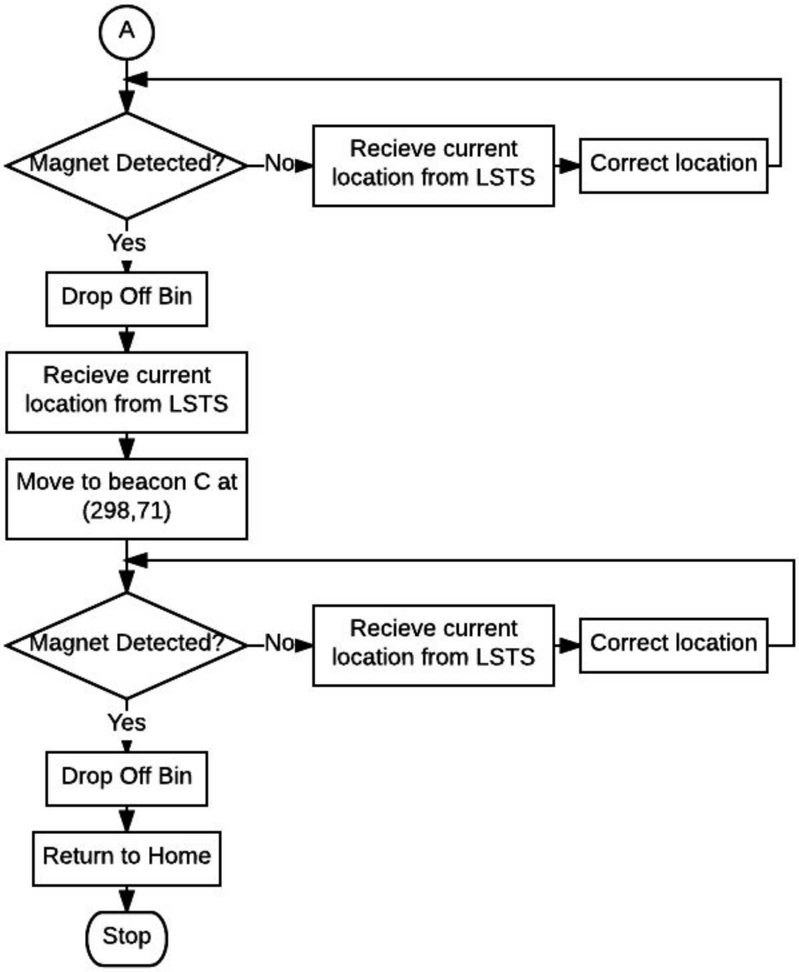
Meeting #22

Agenda: Finish the presentation.

The team worked in finishing the presentation, specifically the software and conclusion sections.

High Level Flowchart of Final Code:





Customer Need	Target Goal	Performance	Ratio of Performance to Goal
Move over small obstacles	Traverse obstacles <= 1 inch in height	All small obstacles <= 3 inches pushed out of way	300 %
Move Straight	< 5-degree deviation	< 10-degree deviation	50 %
Turn precisely	< 10 degrees	< 5 degrees	200 %
Turn accurately	< 1 cm	2 cm	50 %

Safely deploy bins	· Peak < 10 m/s^2 · Average < 1 m/s^2	· Peak 8.66 m/s^2 · Average 0.3 m/s^2	· 115 % · 333 %
Correctly detect current location	· < 3 cm error	· < 1 cm error	300 %
Can move to target location using LSTS	< 5 cm	Average on first try ~ 15 cm	33 %
Can detect a sensor	< 1 cm	0 cm (reference point was directly above sensor)	∞ %

11:15 pm Adjourned

Klaire Fosnaugh, Bailey Hayes, Jordan Loeser, Michael Porter
