# System Development Review

## Friction Force Explorers

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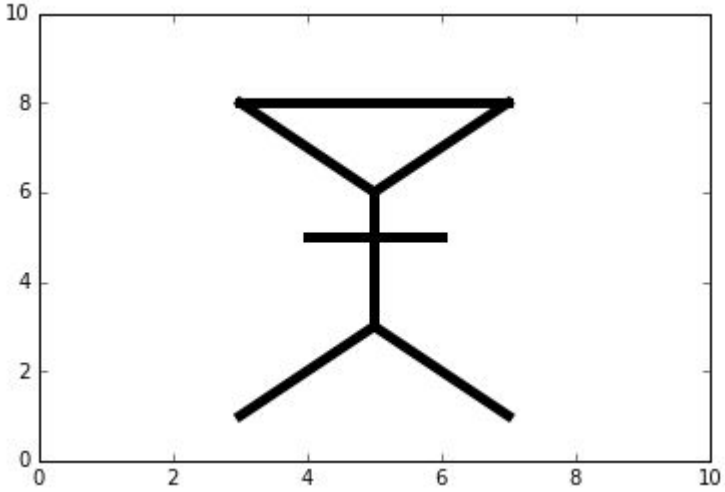
Objective:

To develop a multi-agent system that collaboratively and efficiently draws inputted images at variable scale.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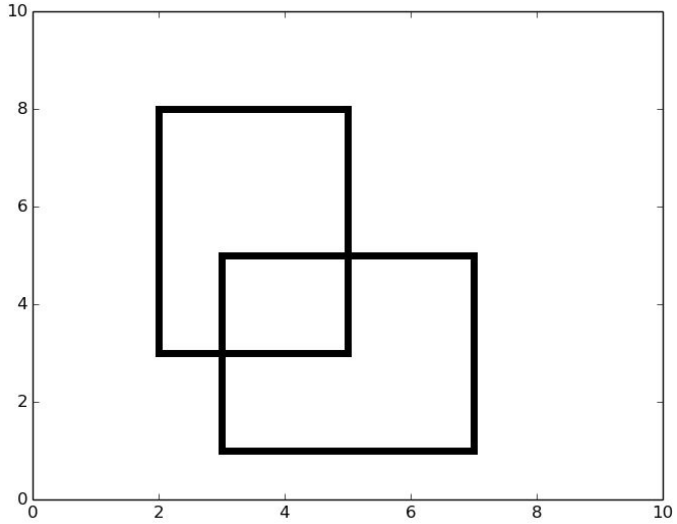
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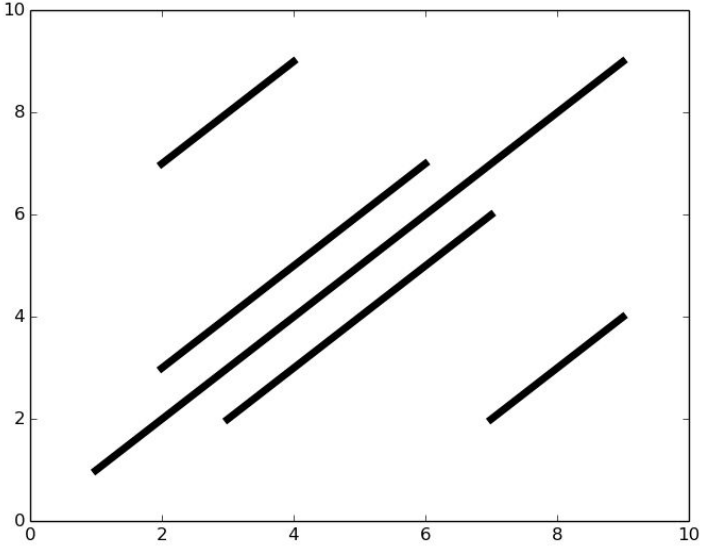
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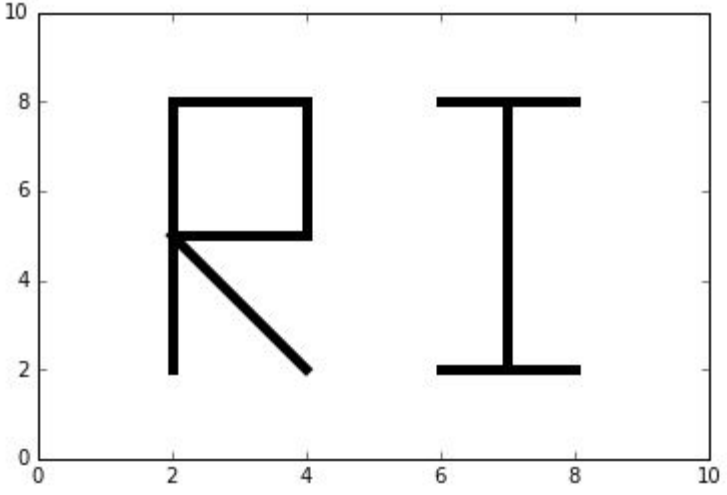
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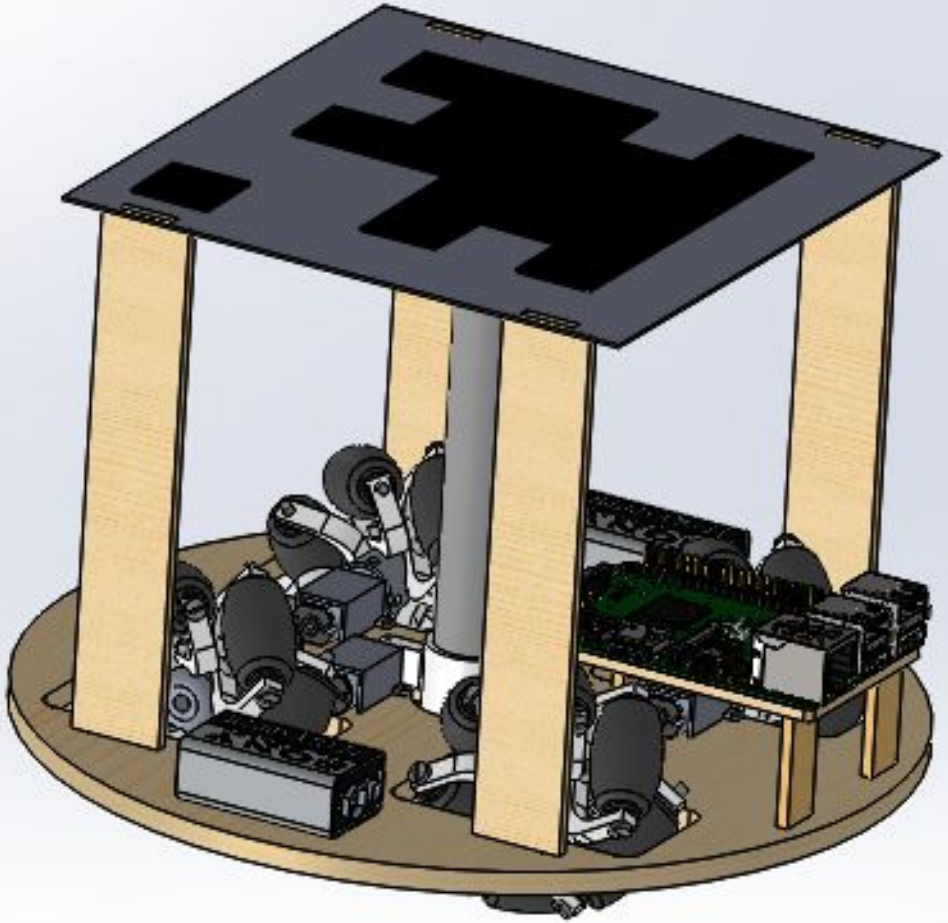

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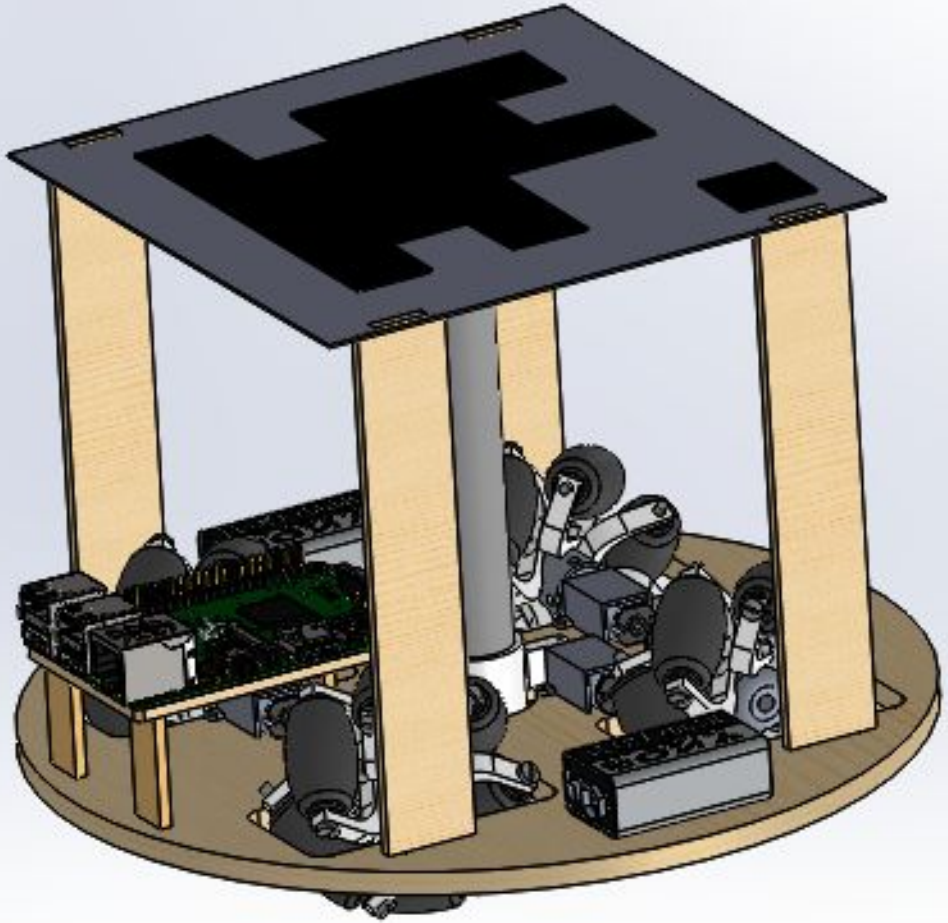
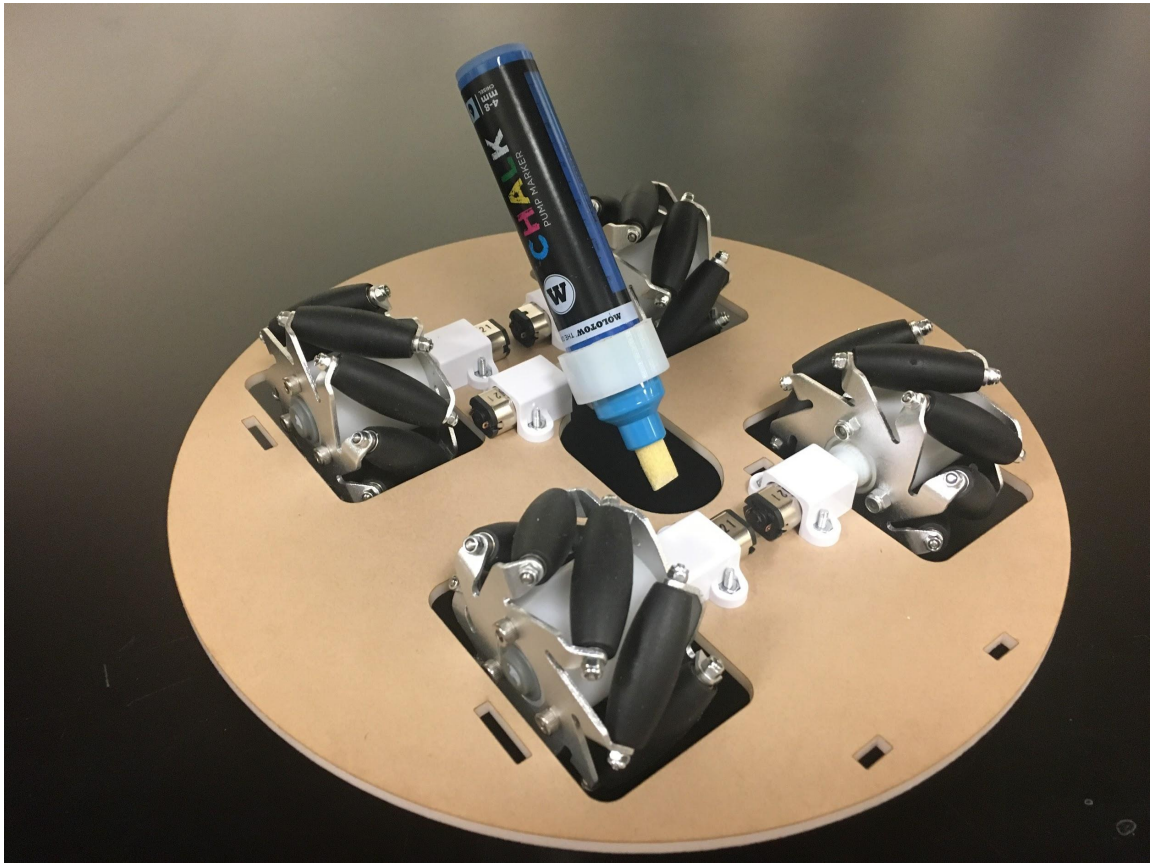


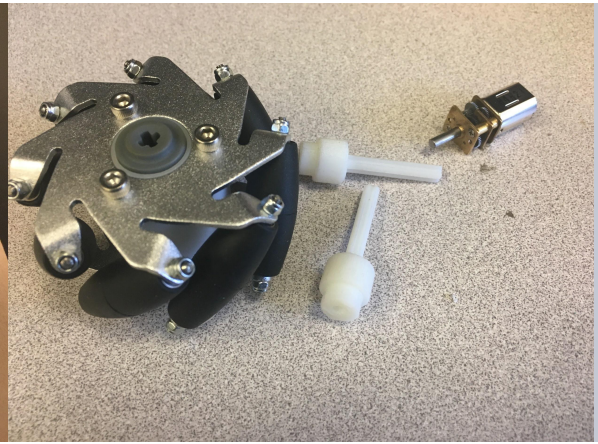
Bad

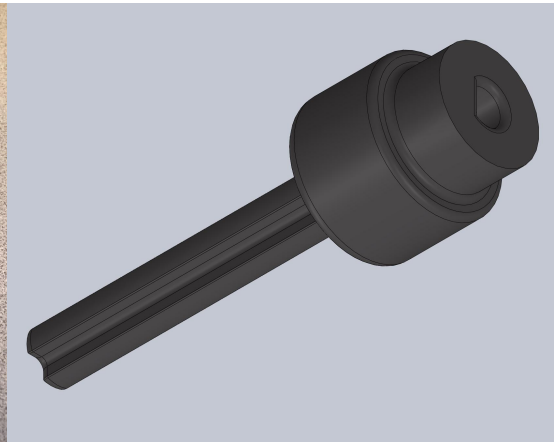
# Build Updates

# Mechanical Updates - Full System



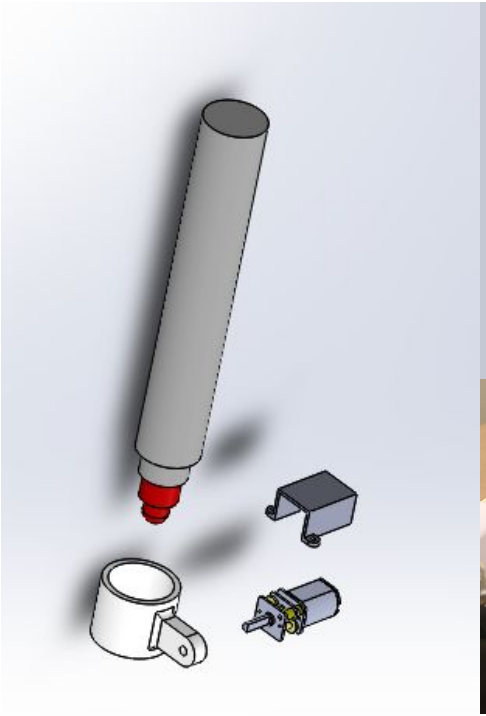
# Mechanical Updates - Locomotion System

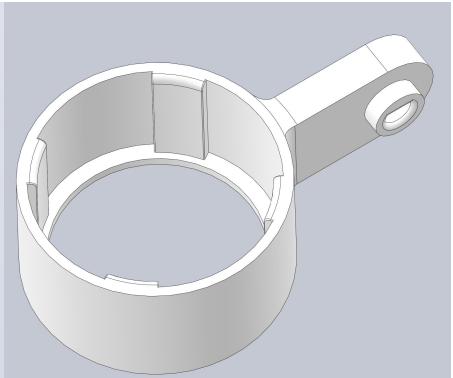




- 3D printed wheel adapter
- Motor holes need to be a little bigger
- No significant bending observed in static test
    - No supports necessary on opposite side of wheels

# Mechanical Updates - Painting Mechanism





- 3D printed chalk holder
- Internal ribs to hold the chalk in place, while allowing easy chalk exchange
- Added small cap to prevent slippage during drawing
- Motor hole designed too small, resulting in fracture during assembling

# Mechanical Updates - Camera Rig

## Pivots for Single Rails


Inline and Inline/Perpendicular

**Pivots** provide smooth, consistent motion at the junction between two rails.

| For Rail Ht. | Lg. | Color | Material | Mounting Fasteners Included | | Each |
|---|---|---|---|---|---|---|
| **Inline** | | | | | | |
| 1" | 3" | Silver | Anodized Aluminum | Yes | 47065T191 | $16.33 |
| 1 1/2" | 4 1/2" | Silver | Anodized Aluminum | Yes | 47065T13 | 18.43 |
| **Inline/Perpendicular** | | | | | | |
| 20mm | 2 3/8" | Silver | Anodized Aluminum | Yes | 5537T219 | 17.73 |
| 30mm | 3 5/8" | Silver | Anodized Aluminum | Yes | 5537T865 | 20.17 |
| 40mm | 4 3/4" | Silver | Anodized Aluminum | Yes | 5537T221 | 21.07 |
| 45mm | 5 1/2" | Silver | Anodized Aluminum | Yes | 5537T222 | 21.70 |

## Single Standard Rails—Aluminum

Hollow


Profile

**Hollow rails** are lighter and more economical than solid rails.

| Rail Ht. | Rail Wd. | Rail Construction | T-Slot Wd. | Center Hole Dia. | | Lengths 1 ft. | 2 ft. | 3 ft. | 4 ft. | 5 ft. | 6 ft. | 8 ft. | 10 ft. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Silver Anodized** | | | | | | | | | | | | | |
| 1 1/2" | 1 1/2" | Hollow | 0.32" | 0.26" | 47065T102 | $7.76 | $15.04 | $21.78 | $26.90 | $33.33 | $39.31 | $51.36 | $61.94 |
| 30mm | 30mm | Hollow | 8mm | 7mm | 5537T97 | 5.84 | 9.47 | 13.09 | 16.73 | 20.36 | 23.98 | 31.24 | 38.49 |
| 45mm | 45mm | Hollow | 10mm | 10mm | 5537T103 | 8.44 | 14.03 | 19.98 | 25.80 | 30.50 | 35.96 | 48.22 | 59.02 |

## Corner Brackets for Single Rails

Three-Way Outside Corner

**Outside corner** and **three-way outside corner brackets** require tapped holes to connect rails.

| For Rail Ht. | Color | Material | Lg. | Mounting Fasteners Included | | Each |
|---|---|---|---|---|---|---|
| **Three-Way Outside Corner** | | | | | | |
| 1" | Silver | Anodized Aluminum | 1" | Yes | 47065T244 | $9.86 |
| 1 1/2" | Silver | Anodized Aluminum | 1 1/2" | Yes | 47065T245 | 10.78 |

Use 8020 to construct the camera rig.

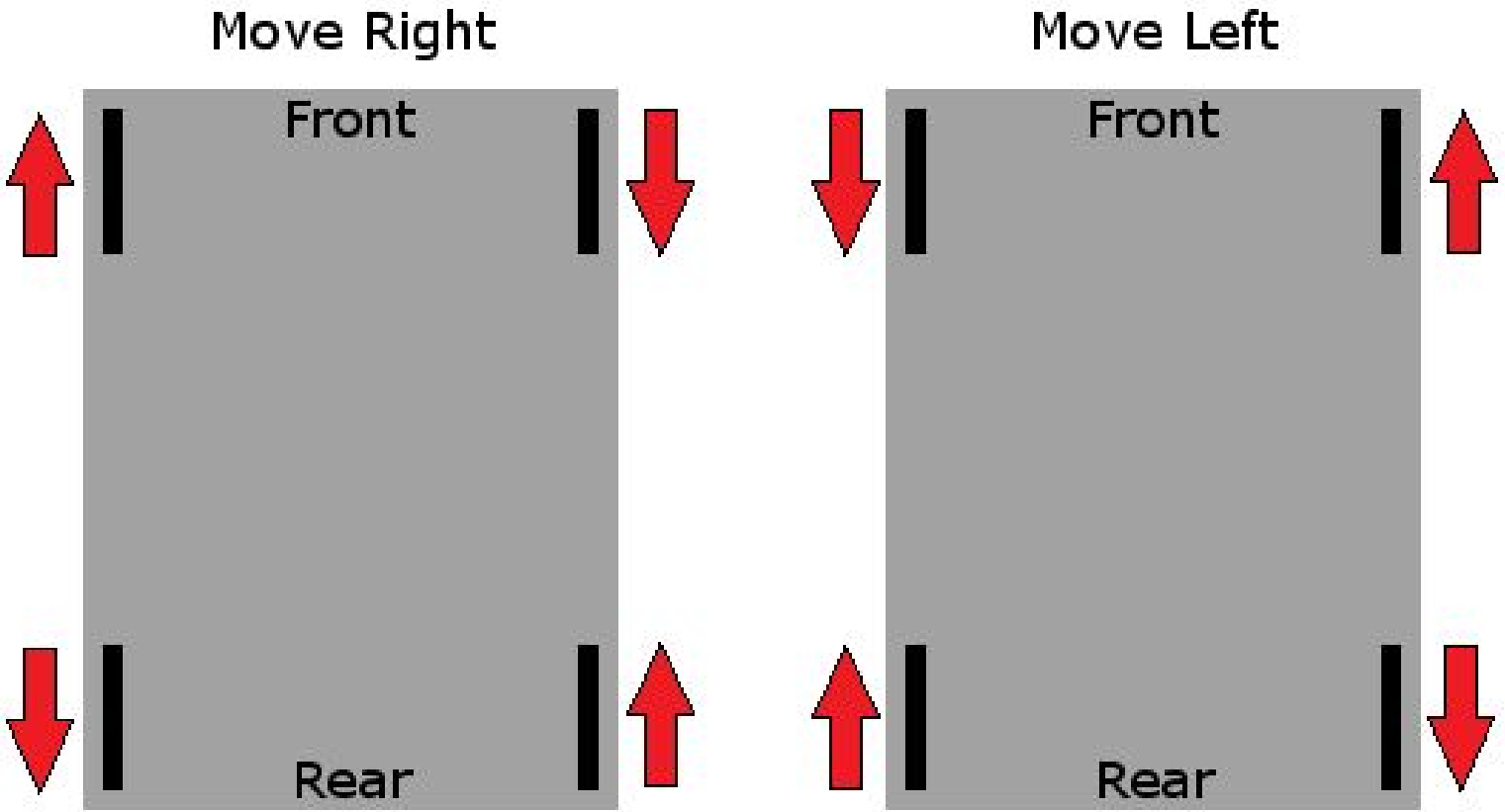
More expensive, but easier to work with.

Currently working on CAD and finding optimal camera height.

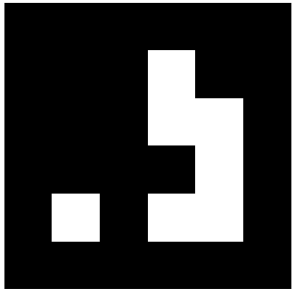
# Risks are real

# Software Updates - Communication

# Software Updates - Locomotion



# Software Updates - Localization



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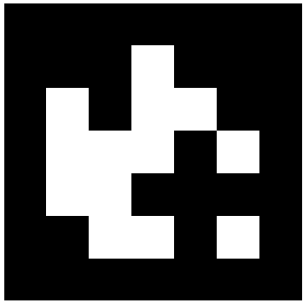

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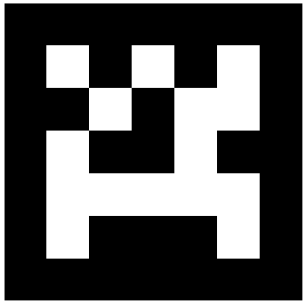

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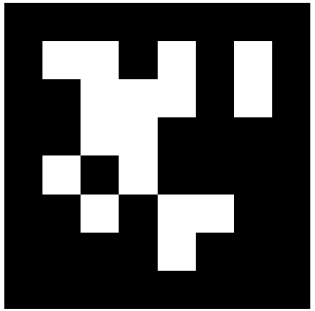

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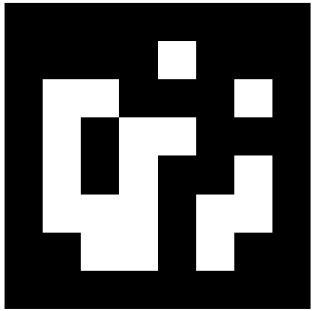

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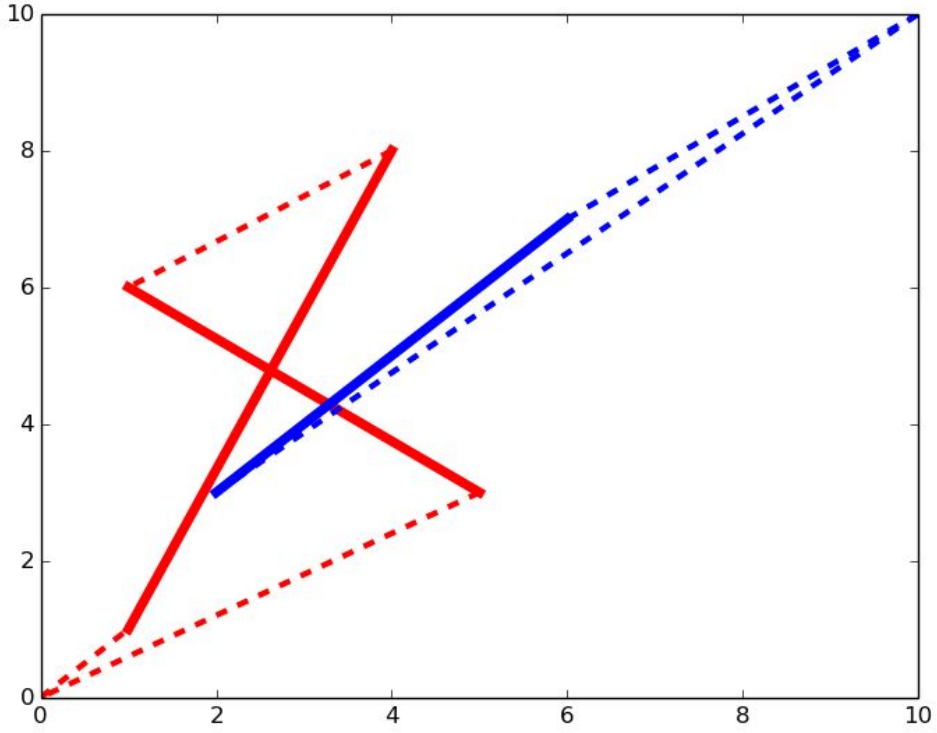
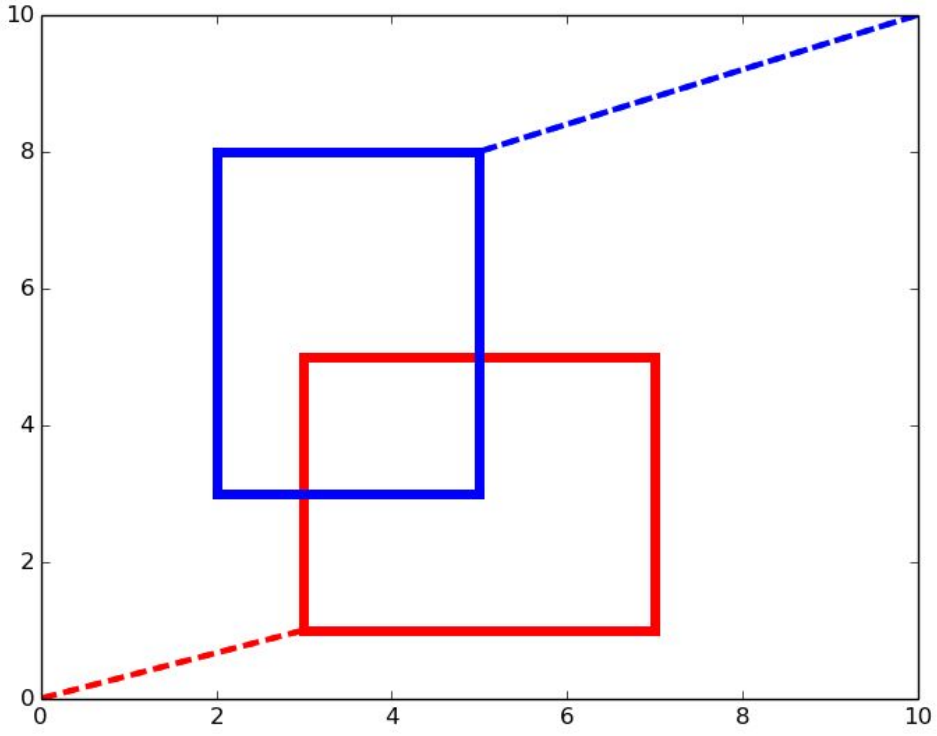
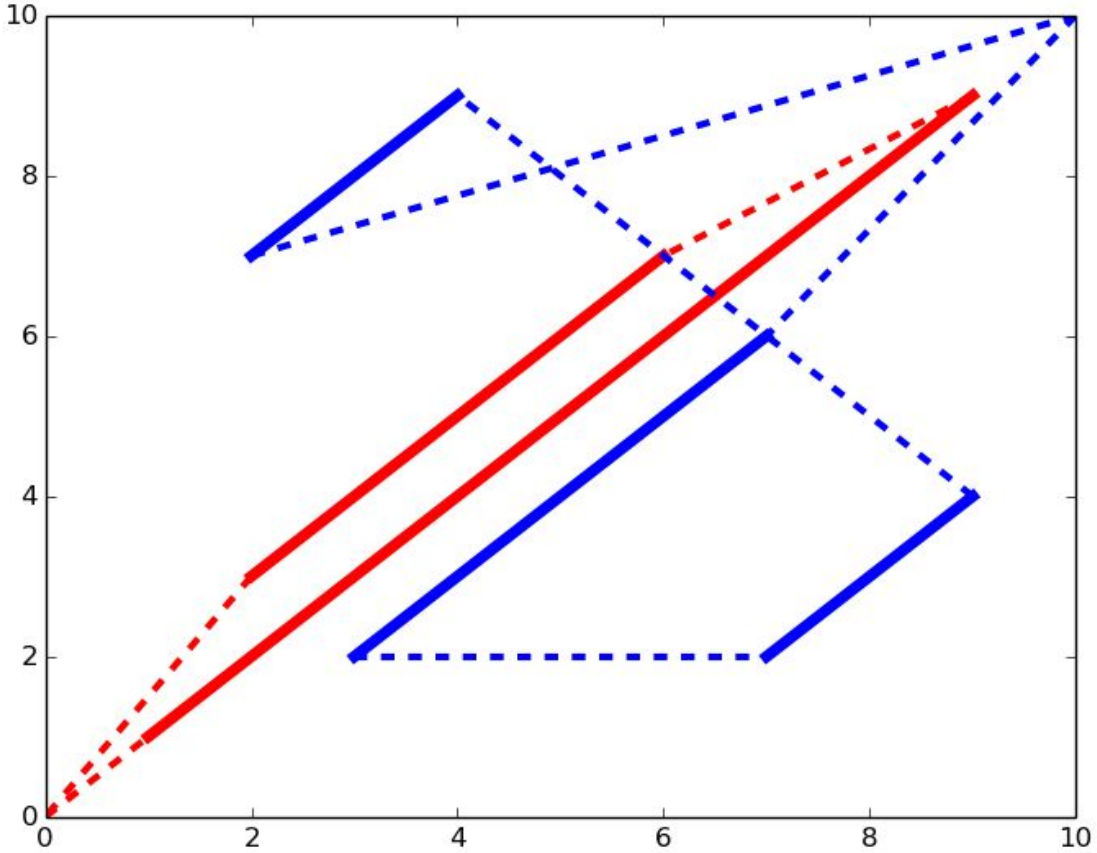
# Software Updates - SDP and UI

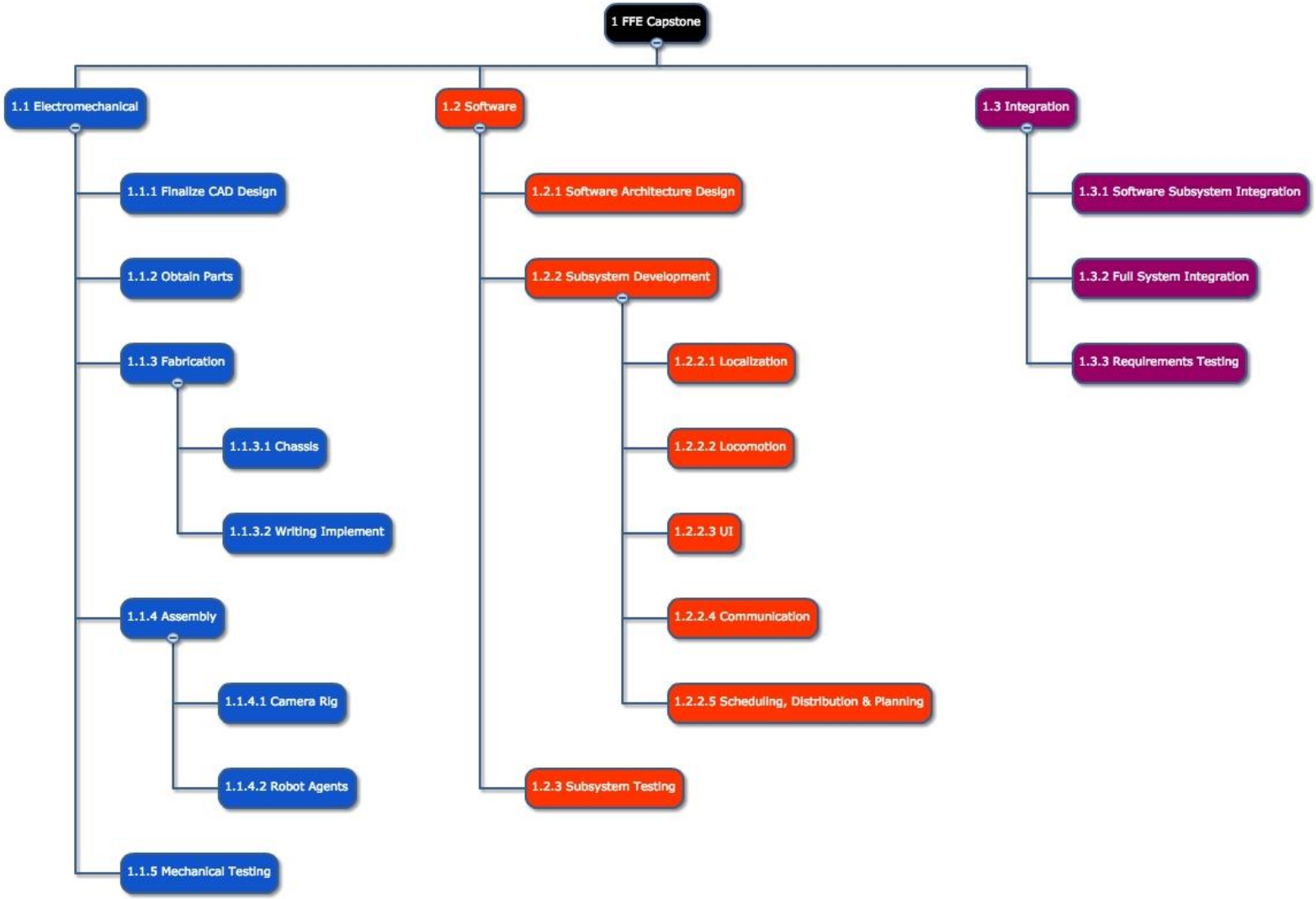


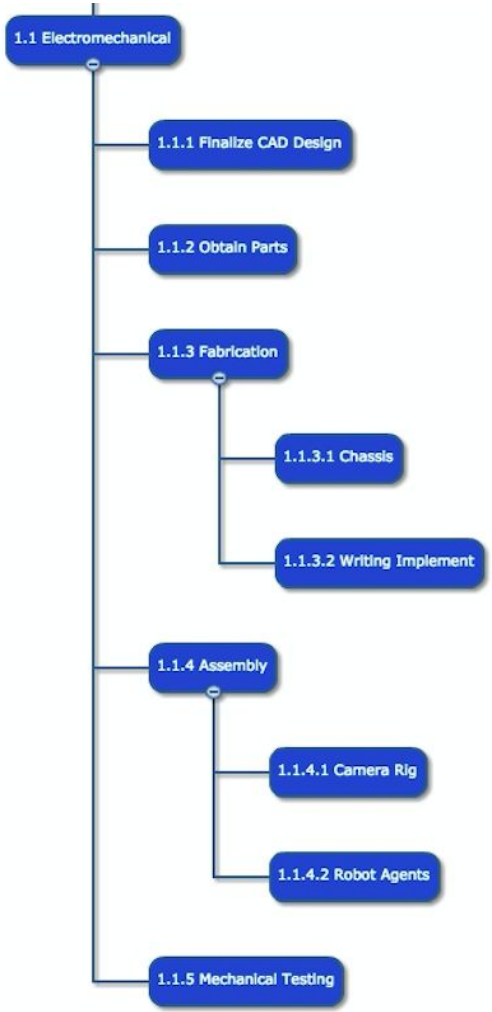
# Software Updates - SDP and UI



# Future Software Development: Collision Avoidance




1 FFE Capstone
1.1 Electromechanical
1.1.1 Finalize CAD Design
1.1.2 Obtain Parts
1.1.3 Fabrication
1.1.3.1 Chassis
1.1.3.2 Writing Implement
1.1.4 Assembly
1.1.4.1 Camera Rig
1.1.4.2 Robot Agents
1.1.5 Mechanical Testing
1.2 Software
1.2.1 Software Architecture Design
1.2.2 Subsystem Development
1.2.2.1 Localization
1.2.2.2 Locomotion
1.2.2.3 UI
1.2.2.4 Communication
1.2.2.5 Scheduling, Distribution & Planning
1.2.3 Subsystem Testing
1.3 Integration
1.3.1 Software Subsystem Integration
1.3.2 Full System Integration
1.3.3 Requirements Testing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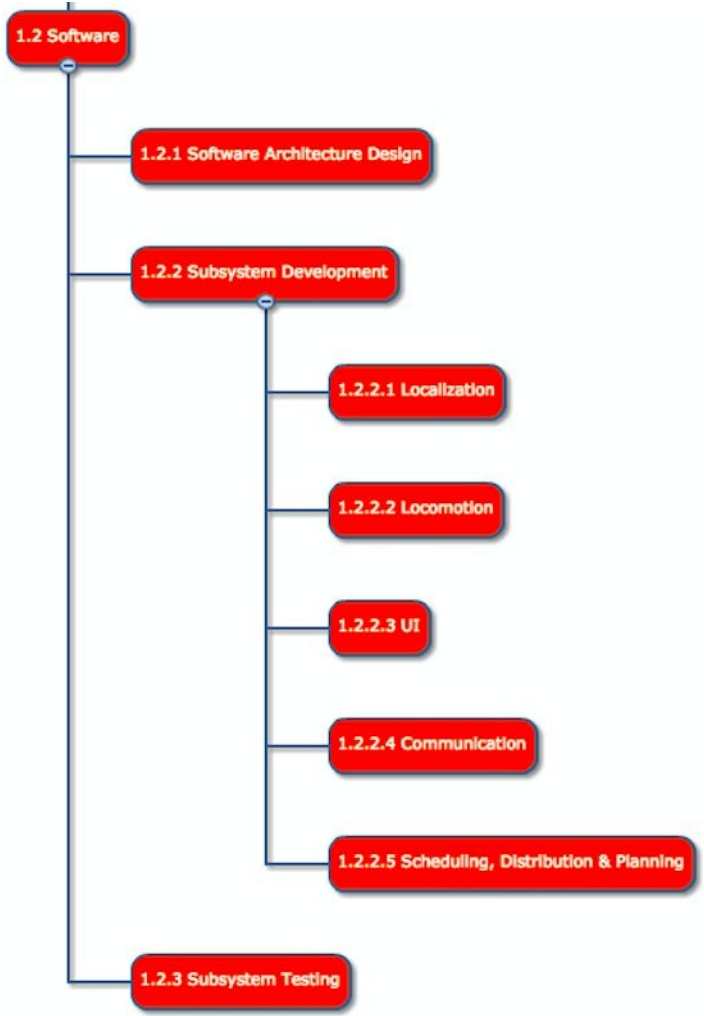
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1.2.2.3 UI
1.2.2.4 Communication
1.2.2.5 Scheduling, Distribution & Planning
1.2.3 Subsystem Testing

# Project Management & Schedule

| | Week Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WBS | Task | 1/30 | 2/6 | 2/13 | 2/20 | **2/27** | 3/6 | 3/20 | 3/27 | 4/3 | 4/10 | 4/16 | 4/24 | 5/1 |
| 1.1 | Electromechanical | | | | | | | | | | | | | |
| 1.1.1 | Finalize CAD Design | | | | | | | | | | | | | |
| 1.1.2 | Obtain Parts | | | | | | | | | | | | | |
| 1.1.3.1 | Chassis Fabrication | | | | | | | | | | | | | |
| 1.1.3.2 | Writing Implement Fabrication | | | | | | | | | | | | | |
| 1.1.4.1 | Camera Rig Assembly | | | | | | | | | | | | | |
| 1.1.4.2 | Robot Agent Assembly | | | | | | | | | | | | | |
| 1.1.5 | Mechanical Testing | | | | | | | | | | | | | |
| 1.2 | Software Implementation | | | | | | | | | | | | | |
| 1.2.1 | Softare Architecture Design | | | | | | | | | | | | | |
| 1.2.2.1 | Localization Subsystem Development | | | | | | | | | | | | | |
| 1.2.2.2 | Locomotion Subsystem Development | | | | | | | | | | | | | |
| 1.2.2.3 | UI Subsystem Development | | | | | | | | | | | | | |
| 1.2.2.4 | Communication Subsystem Development | | | | | | | | | | | | | |
| 1.2.2.5 | SDP Subsystem Development | | | | | | | | | | | | | |
| 1.2.3 | Software Subsystem Testing | | | | | | | | | | | | | |
| 1.3 | Integration | | | | | | | | | | | | | |
| 1.3.1 | Software Subsystem Integration | | | | | | | | | | | | | |
| 1.3.2 | Full System Integration | | | | | | | | | | | | | |
| 1.3.3 | Requirements Testing | | | | | | | | | | | | | |
| | Demo Preparation | | | | | | | | | | | | | |

| Risk ID: | Risk Title: | Risk Owner: |
|---|---|---|
| 1 | Defective Parts | Don |

| Description: |
|---|
| Parts that we ordered arrived defective or do not perform to specifications |

| Consequences: | Risk Type: |
|---|---|
| We need to reorder parts, expending extra time and budget | Parts |

| Risk Reduction Plan: | Expected Outcome |
|---|---|
| We will order only parts that have been extensively reviewed, or we have experience with, and order extra parts | We will be able to properly deal with any parts that break during the development process |

| | 1 | 2 | 3 | 4 | 5 | Likelihood Consequence |
|---|---|---|---|---|---|---|
| | | | | | | 5 |
| | | | | | | 4 |
| | | | | | | 3 |
| | | | | X | | 2 |
| | | | | | | 1 |

| Risk ID: | Risk Title: | Risk Owner: |
|---|---|---|
| 2 | Unvavailable Group Member | All |

| Description: |
|---|
| A group member becomes unavailable for work due to travel, sickness, or other emergencies |

| Consequences: | Risk Type: |
|---|---|
| Work that would have been distributed to that group member needs to be reassigned | Logistical |

| Risk Reduction Plan: | Expected Outcome |
|---|---|
| We will ensure that every group member is always on the same page about progress so we don't lose too much progress | If a member becomes unavailable, it will only be for a short time and can be easily dealt with |

| | 1 | 2 | 3 | 4 | 5 | Likelihood Consequence |
|---|---|---|---|---|---|---|
| | | | | | | 5 |
| | | X | | | | 4 |
| | | | | | | 3 |
| | | | | | | 2 |
| | | | | | | 1 |

| Risk ID: | Risk Title: | Risk Owner: |
|---|---|---|
| 3 | Breaking parts | Eric |

| Description: |
|---|
| Parts unexpectedly break as a result of accidents or improper use |

| Consequences: | Risk Type: |
|---|---|
| We need to reorder parts, expending extra time and budget | Parts |

| Risk Reduction Plan: | Expected Outcome |
|---|---|
| We will practice safe procedures when working with parts and order extras in case | Few parts will break, and even if they do we will have extras on hand |

| | 1 | 2 | 3 | 4 | 5 | Likelihood Consequence |
|---|---|---|---|---|---|---|
| | | | | | | 5 |
| | | | | | | 4 |
| | | | | | | 3 |
| | | | X | | | 2 |
| | | | | | | 1 |

| Risk ID: | Risk Title: | Risk Owner: |
|---|---|---|
| 4 | Mecanum Drive Too Unstable | Eric |

| Description: |
|---|
| The drive mechanism for the robot proves too be too unstable or unreliable for our purposes |

| Consequences: | Risk Type: |
|---|---|
| We will need to redesign the drive mechanism, expending considerable time and effort | Design flaw |

| Risk Reduction Plan: | Expected Outcome |
|---|---|
| We will build enough time in our schedule to deal with it if necessary, and will use suspension | The instability resulting from the wheels will be manageable |

| | 1 | 2 | 3 | 4 | 5 | Likelihood Consequence |
|---|---|---|---|---|---|---|
| | | | X | | | 5 |
| | | | | | | 4 |
| | | | | | | 3 |
| | | | | | | 2 |
| | | | | | | 1 |

| Risk ID: | Risk Title: | Risk Owner: |
|---|---|---|
| 5 | Localization not precise enough | Neil |

| Description: |
|---|
| Our localization system is not precise enough to ensure that the drawings are accurate representations of input |

| Consequences: | Risk Type: |
|---|---|
| We will need to redesign the localization system or redefine drawing requirements | Design flaw |
| Risk Reduction Plan: | Expected Outcome |
| We will test the localization system early on in order to catch any design flaws within the system | Localization will work well enough for our purposes |

| | 1 | 2 | 3 | 4 | 5 | Likelihood Consequence |
|---|---|---|---|---|---|---|
| | | | | | | 5 |
| | X | | | | | 4 |
| | | | | | | 3 |
| | | | | | | 2 |
| | | | | | | 1 |

| Risk ID: | Risk Title: | Risk Owner: |
|---|---|---|
| 6 | Unexpected Budget Overruns | Rachel |

| Description: |
|---|
| We unexpectedly run out of budget, because parts cost more than expected or other parties reduce our budget |

| Consequences: | Risk Type: |
|---|---|
| We need to scale down our project, or possibly even acquire funds through other means | Logicstical |

| Risk Reduction Plan: | Expected Outcome |
|---|---|
| We will leave a significant buffer in our budget in case unexpected situations occur | We will have a large enough buffer that essential components will be acquired |

| | 1 | 2 | 3 | 4 | 5 | Likelihood Consequence |
|---|---|---|---|---|---|---|
| | | | | | | 5 |
| | | | | | | 4 |
| | X | | | | | 3 |
| | | | | | | 2 |
| | | | | | | 1 |

# Friction Force Explorers

Neil Jassal
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