November 13, 2012

CISCOR AGV
Interim Design Selection

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Presentation Overview

- Project Overview
- Steering Design Introduction
- Selection Criteria
- Selection Calculation
- Proposed Concepts
- Design Selected
- Necessary Components
- Summary

PROJECT NEED

- Currently there is no off road vehicle platform for autonomous research and development in CISCOR's inventory

PROJECT GOAL

- Modify an existing all terrain vehicle (ATV) to be capable of full autonomous movement by designing, researching and manufacturing components to allow full unmanned locomotion control

PROJECT OBJECTIVES

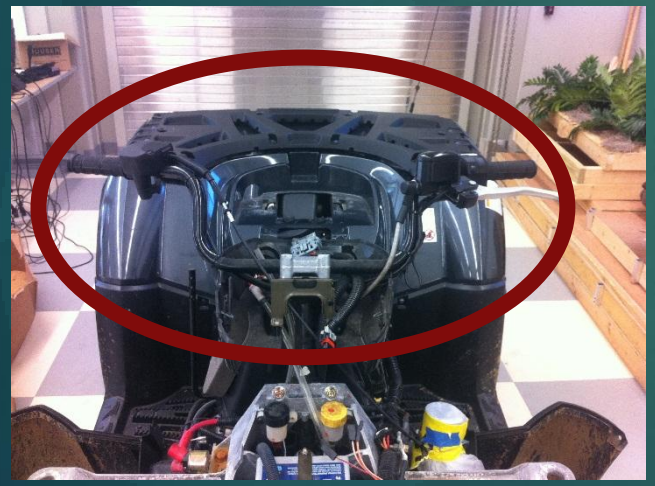
- AGV (Autonomous Ground Vehicle) will be able to turn, accelerate, brake and switch gears without physical user interaction
- AGV locomotion controls, mounts and sensors will be durable and able to withstand off road environments
- AGV will retain the ability to be human operated and driven
- AGV will be able to easily mount multiple sensors
- AGV will be able to easily mount multiple onboard computers

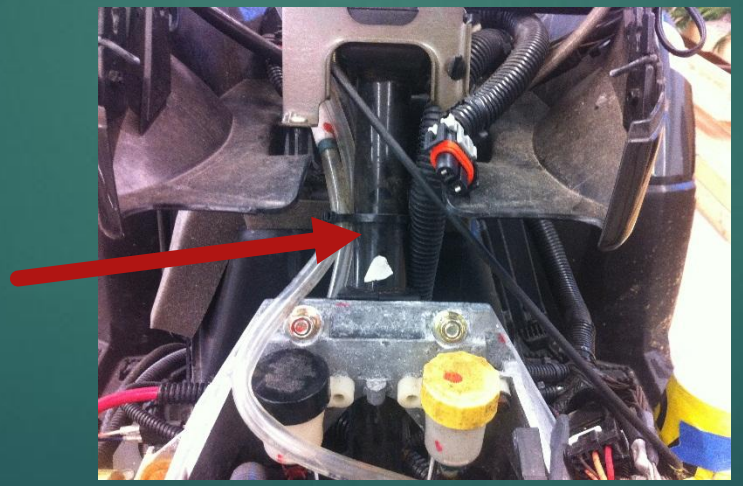
PROJECT CONSTRAINTS

- ATV must retain Autonomous/Human drivability
- AGV must be able to weather off-road conditions
  - Vibration
  - Water and mud
  - Sand and dust
- AGV must be retrofitted with all components in a limited mounting area

STEERING LOCOMOTION

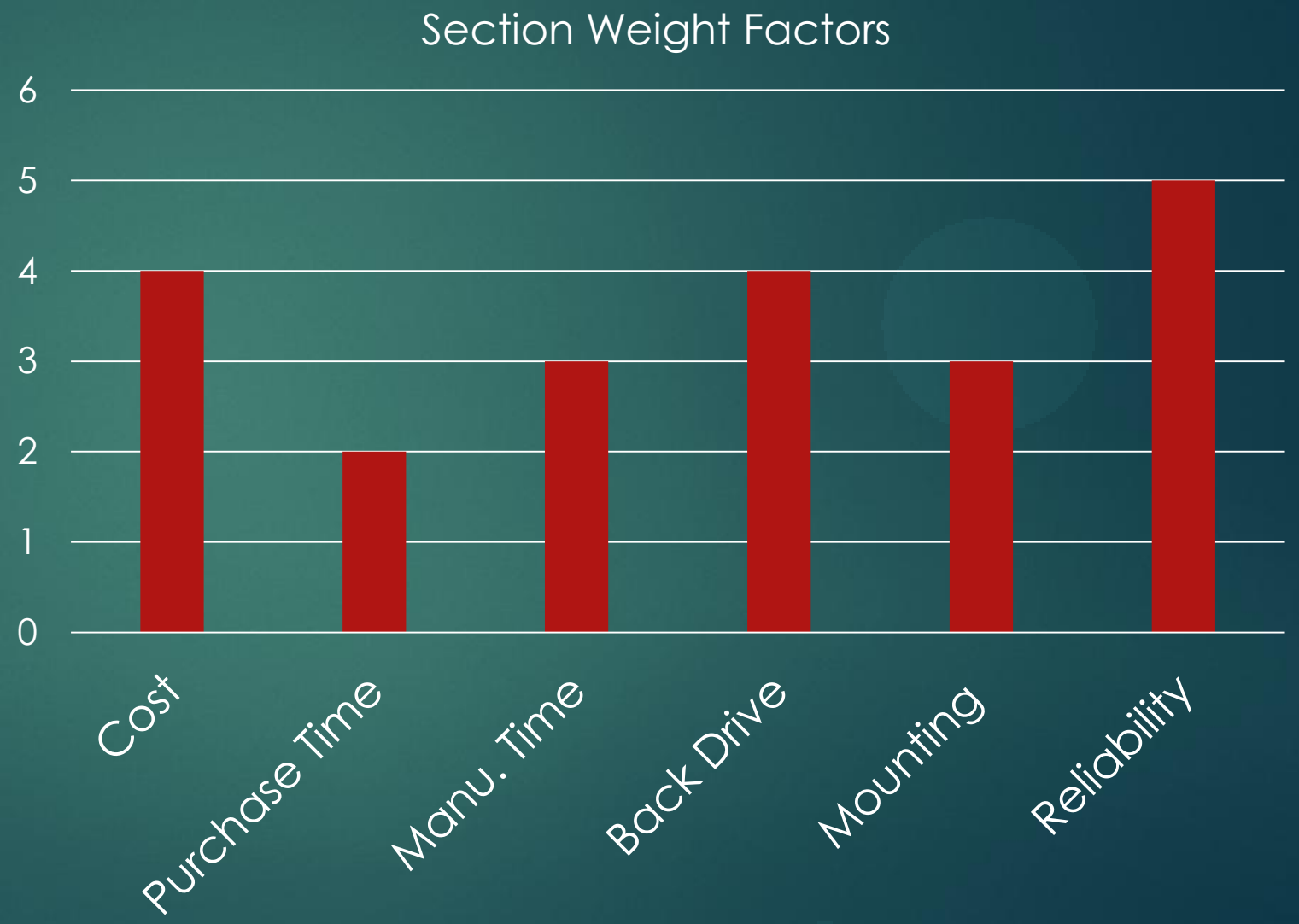
- System will be able to operate with full range of motion
- System will be able to withstand feedback from terrain
- Motor will provide enough output for any terrain and speed





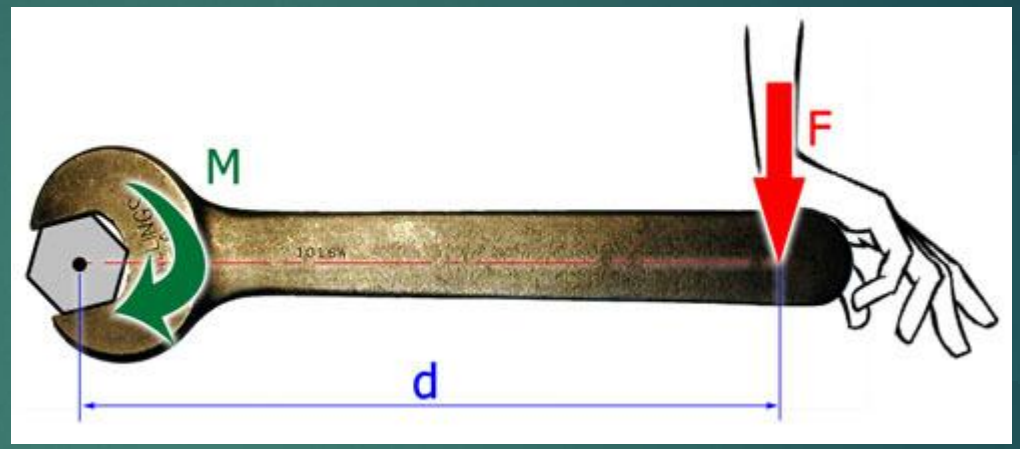
Selection Criteria

- Cost
- Purchase lead time
- Reliability
- Manufacturing time
- Ease of back-drivability
- Mounting option



Selection Calculations

- Force required to turn steering column



$$\overrightarrow{M_o} = \overrightarrow{r_{oF}} \times \overrightarrow{F}$$

$$\left|\overrightarrow{M_O}\right| = (\text{Force}) \cdot (\text{Perpendicular distance})$$

Selection Calculations Cont.

- Required Torque:

  14.00 N*m

Moment arm length: 16in

Spring mass force: 8 lb

Torque = 16in * 8lbf

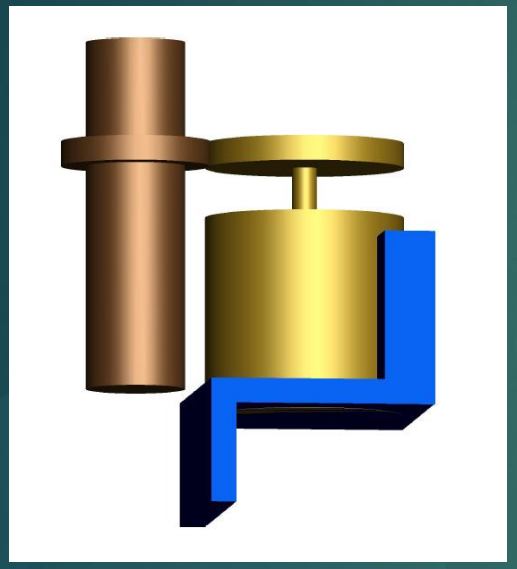
Torque = 128.00 in*lbf

Torque = ~14.00 N*m

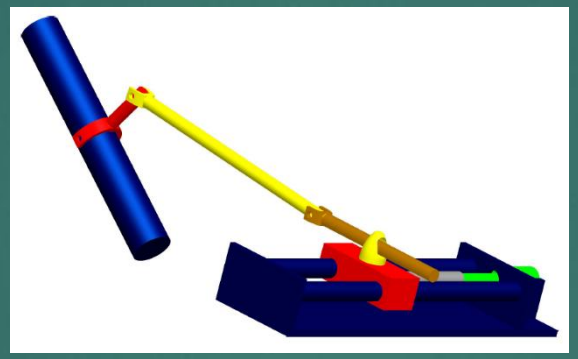
Mass spring pull direction

Mass spring scale

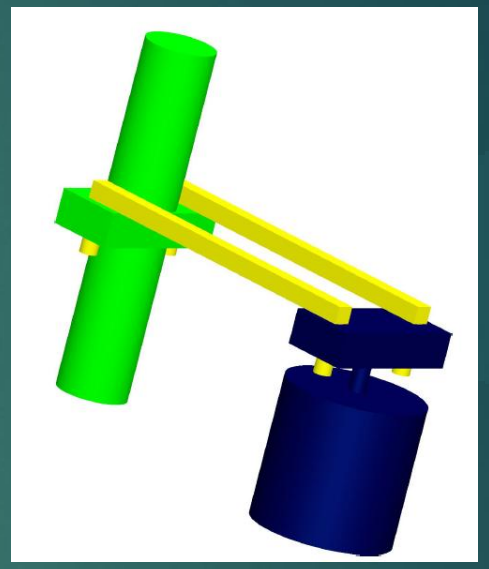
Proposed Concepts



Concept I

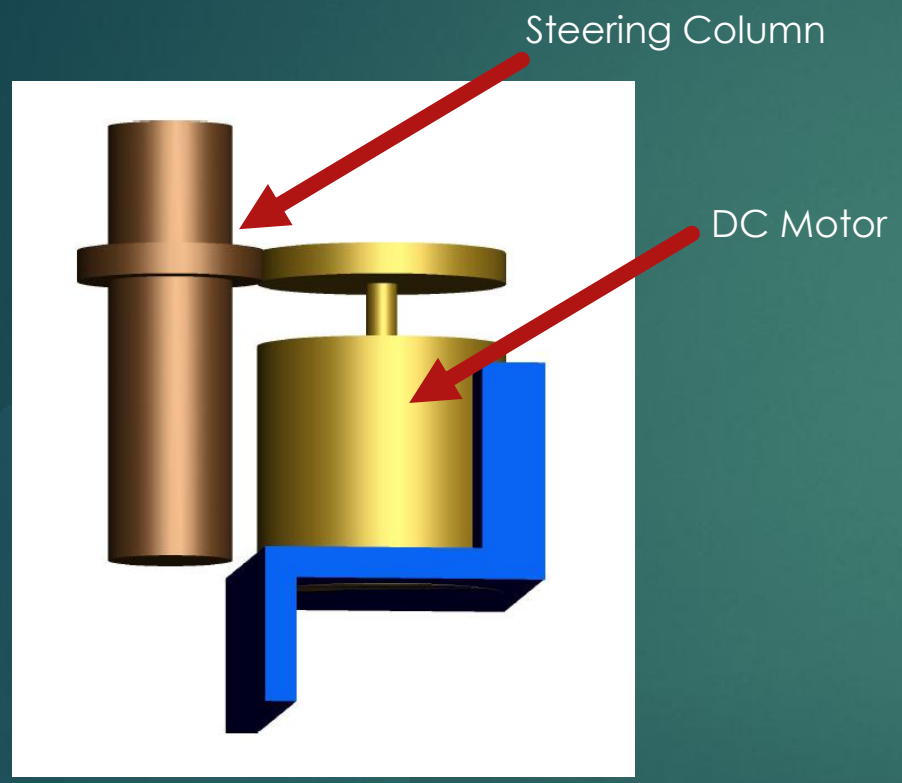


Concept II



Concept III

Concept I Selected



Favorable Design Parameters:

- Cost is relatively cheap (>$1,000)
- Little manufacturing time (>5 Shop Hours)
- Simple mounting (No body modifications)
- Back Drivable

Negative Design Parameters:

- Belt Drive Reliability

Motor Selection

- Max torque required to turn steering column = 14 N*m

- Motor Selected: Maxon 150W DC Motor 24V
- Max Stall Torque: 2420 mN*m
- Max continuous Torque: 177 mN*m

Complimentary Gearbox

- Gear ratio 100:1
- Planetary Gearing GP 40

Actual Motor Output

Max Stall Torque: 242 N*m
Max continuous Torque: 17.7 N*m

Additional Part Selection

Drive Belt

Goodyear Engineering Products
GY 2UVN9

Failure Force: 214 lb

Tensioner

Lovejoy Rosetta
LR 1L834

Failure Force: 198 lb

Design Constraints and Solutions

Constraints:

- Purchase lead time
- Machine shop availability
- Prototype limitations

Solutions:

- Purchase products from approved vendors
- Place machine shop work orders early
- Prototype often and with cheap material

Summary

- Product need is being attended
- Design selected exceeds measureable objectives
- Motor and additional parts are robust and satisfactory
- Team is on track according to original Gantt chart

Questions?

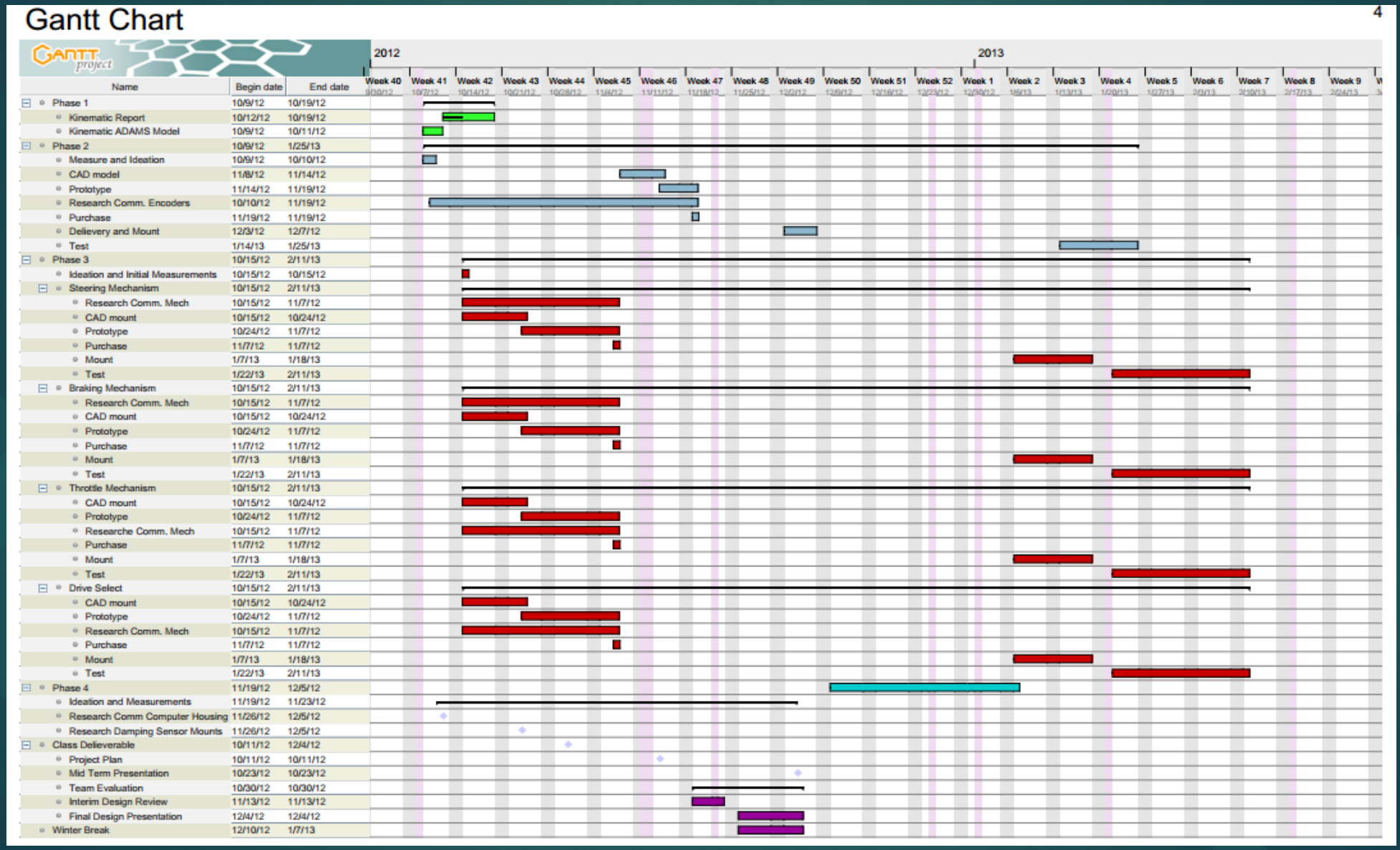
Resources

- "Grainger Industrial Supply." Grainger Industrial Supply - MRO Supplies, MRO Equipment, Tools & Solutions. N.p., n.d. Web. 08 Nov. 2012. <http://www.grainger.com/Grainger/wwg/start.shtml>."
- "Introduction to Statics: Moments. N.p., n.d. Web. 07 Nov. 2012. <http://www.engin.brown.edu/courses/en3/notes/Statics/moments/moments.htm>."
- "Maxon DC Motors." DC Motors. N.p., n.d. Web. 09 Nov. 2012. <http://www.maxonmotorusa.com/maxon/view/content/index>."
- "McMaster-Carr." McMaster-Carr. N.p., n.d. Web. 08 Nov. 2012. <http://www.mcmaster.com/>."

Additional Slides

Decision Matrix							
	Mounting Time	Cost	Lead Time	Back Drive	Reliability	Mounting	Weighted Total
Weight	2	4	2	4	5	3	
Concept 1	3	2	3	2	2	3	47
Concept 2	2	2	1	2	1	1	30
Concept 3	2	1	1	3	3	1	40

Gantt Chart



Name	Begin date	End date
Phase 1	10/9/12	10/19/12
Kinematic Report	10/12/12	10/19/12
Kinematic ADAMS Model	10/9/12	10/11/12
Phase 2	10/9/12	1/25/13
Measure and Ideation	10/9/12	10/10/12
CAD model	11/8/12	11/14/12
Prototype	11/14/12	11/19/12
Research Comm. Encoders	10/10/12	11/19/12
Purchase	11/19/12	11/19/12
Delievery and Mount	12/3/12	12/7/12
Test	1/14/13	1/25/13
Phase 3	10/15/12	2/11/13
Ideation and Initial Measurements	10/15/12	10/15/12
Steering Mechanism	10/15/12	2/11/13
Research Comm. Mech	10/15/12	11/7/12
CAD mount	10/15/12	10/24/12
Prototype	10/24/12	11/7/12
Purchase	11/7/12	11/7/12
Mount	1/7/13	1/18/13
Test	1/22/13	2/11/13
Braking Mechanism	10/15/12	2/11/13
Research Comm. Mech	10/15/12	11/7/12
CAD mount	10/15/12	10/24/12
Prototype	10/24/12	11/7/12
Purchase	11/7/12	11/7/12
Mount	1/7/13	1/18/13
Test	1/22/13	2/11/13
Throttle Mechanism	10/15/12	2/11/13
CAD mount	10/15/12	10/24/12
Prototype	10/24/12	11/7/12
Researche Comm. Mech	10/15/12	11/7/12
Purchase	11/7/12	11/7/12
Mount	1/7/13	1/18/13
Test	1/22/13	2/11/13
Drive Select	10/15/12	2/11/13
CAD mount	10/15/12	10/24/12
Prototype	10/24/12	11/7/12
Research Comm. Mech	10/15/12	11/7/12
Purchase	11/7/12	11/7/12
Mount	1/7/13	1/18/13
Test	1/22/13	2/11/13
Phase 4	11/19/12	12/5/12
Ideation and Measurements	11/19/12	11/23/12
Research Comm Computer Housing	11/26/12	12/5/12
Research Damping Sensor Mounts	11/26/12	12/5/12
Class Delieverable	10/11/12	12/4/12
Project Plan	10/11/12	10/11/12
Mid Term Presentation	10/23/12	10/23/12
Team Evaluation	10/30/12	10/30/12
Interim Design Review	11/13/12	11/13/12
Final Design Presentation	12/4/12	12/4/12
Winter Break	12/10/12	1/7/13