CDR Presentation

February 4, 2011

STORM ROBOTICS

CHEROKEE HIGH SCHOOL

LENAPE HIGH SCHOOL

LENAPE

LOCKHEED MARTIN

Introduction

S T O R M

Agenda

- Introduction — Anna Palka, Nicole Joie
- Strategy
- Robot Design
  - Mechanical
    - Chassis
    - Minibot
    - Elevator
  - Software
  - Electrical
- Program Management & Support Functions
- Conclusion

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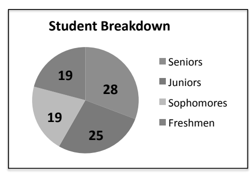
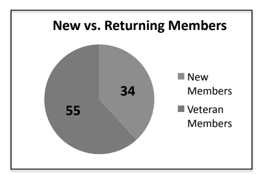
Team Biography

- Team is composed of students from both Lenape & Cherokee High Schools
- Base of operation is Lenape High School
- 89 Student Members





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Team History

- Our Team was established in 2009 – current year (3rd year)
- LMCO sponsorship start in 2009 – current year (3rd year)
- Awards:
  - 2010
    - Miss Daisy Spirit Award
    - Moe Safety Award
  - 2009
    - Highest Rookie Seed Award at Atlanta World Championship
    - Highest Rookie Seed Award at Philadelphia Regional
    - Rookie All-Star at both Washington & Philadelphia Regionals
- Gracious Professionalism
  - Thanks to Red Devils and Iron Devils for exchanging parts with us
  - Organized a fundraiser with Iron Devils to sell stainless steel water bottles
  - Working closely with Iron Devils on design and deployment of Minibot

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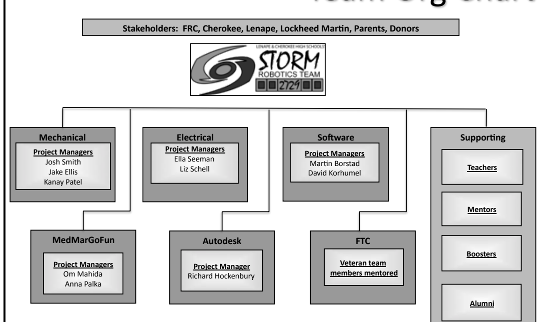
Team Org Chart



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FTC

- Started in the fall of 2010
- FTC team 4390 was created to provide experience to our new members
- Once they move to team FRC 2729, they have already had a hand in robotics
- The team consists of new freshmen and sophomores
- FTC 4390 is the minor league of FRC 2729

Fortunately for us, the FTC game helped us with the FRC game this year!!

Parent Booster Organization

- Our booster organization was founded to help with fundraising and organization.
- Functions:
  - Fundraisers
  - Saturday lunches
  - Jerseys and T-shirts

Team Advisors and Mentors

- Faculty Advisors
  - Nathan Knauss
  - James Hessler
  - James Scott
  - Scott Harris
- Mentors
  - Carrie Ballester (ATLP)
  - Scott Harrison (ATLP)
  - Matthew Smith (ATLP)
  - Vitaliy Aynbinder (ATLP)
  - William McCorkle (ATLP)
  - Leslie Hurff
  - Burt Hurff
  - Maurice Grontkowski
  - Pete Wach
  - Dan Jones
  - Aron Rubin
  - Alex Alm
  - Edward Cohen

Competitions & Award Plans

Competitions:

- Ramp Riot & Duel on the Delaware
  - Pre-season
- New Jersey Regional Competition
  - March 3, 4, and 5
- Philadelphia Regional Competition
  - April 7, 8, and 9
- Saint Louis World Championships
  - April 29, 30, and 31

Awards:

- What awards are we applying for?
  - Chairman's Award
  - Woodie Flowers Award
  - Website Award
  - Entrepreneurship Award

Agenda

- Introduction & Video
- Strategy — Richard Hockenbury
- Robot Design
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    - Mini-Bot
    - Elevator
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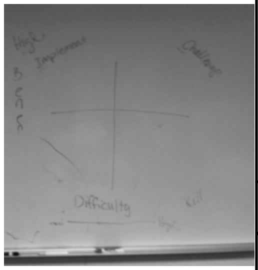
Strategy

- Build Season – Week #1 (Brainstorm & Strategy)
- Day 1
  - Discuss rules
- Day 2
  - Break up into groups to discuss design options
  - Post-it notes
- Day 3
  - Snow Day

Strategy

- Day 4
  - Project Managers look through post-it notes and rate on a PICK chart
  - Discuss which post-its remained met our strategy requirements
  - Based our final design on this method



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Strategy

- Day 5
  - Break up into teams:
    - MedMarGoFun
    - Autodesk
    - Chassis
    - Elevator
    - Arm/Grabber
    - Electrical
    - Software

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Agenda

- Introduction & Video
- Strategy
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  - Mechanical
    - Chassis — Jacob Ellis
    - Mini-Bot
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Goals

What our purpose is on this team:

- To design and construct the best possible chassis and drive train system for this years game based off of our level of expertise.
  - Compiled from multiple Team members within this department.

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Ideas Considered

Chassis Structures	Plate	T-slot
Strength	Extremely Strong	Bolts loosen
Weight	Very Light Weight	Heavier than the alternative
Ease of Modification	Extremely Difficult to Impossible	Relatively easy
Aesthetics	Professional	Butcher Job
Level of Experience	Our first year	Used Last Year
Time constraints	Pressured during the design phase; Lax during end of construction	Lax during the design phase; Pressure during construction
Durability	First years chassis still in one piece	Last years chassis being held together with zip-ties and duct- tape
Complexity	Clean and Simple	Multiple fail points
Team Decision	X	

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Ideas Considered

Drive Trains	Tank Drive	Mecanum	Swerve Drive
Ease to Troubleshoot	Relatively easy few components	More in depth; Multiple Components	More in depth; Multiple Components
Aesthetics	Bland	Cool looking Wheels!!!	Awesome wheel Housings
Level of Experience	Our first year	This past Pre-Season	NONE
Durability	Depends on the alignment being Perfect	Depends on accessibility of wheels and transmissions	Depends on the way the modules are mounted for access
Complexity	Low	Medium	High
Team Decision		X	

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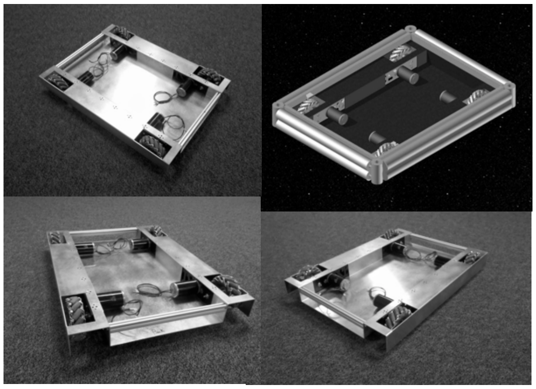
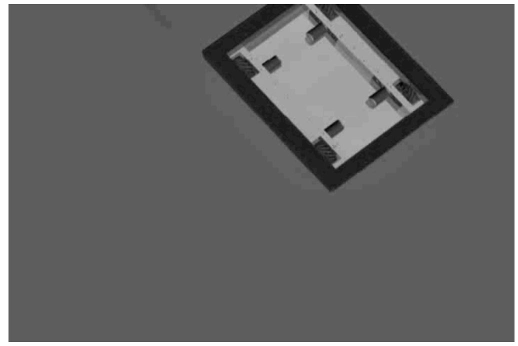
Pictures of the Chassis



Animation



Final Design

Mecanum Drive Train & Plate Chassis

Why?

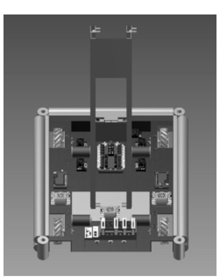
- Our experience with Mecanum in the preseason
- The benefits outweigh the draw backs of the Mecanum drive train.
- We are confident in our design and are willing to give up the ability to drastically modify it.

Build Status

- Plate Chassis is in!!!!!! WOO!!!
- Nanotube Gearboxes have been integrated.

Plans

- Integrate the lift system by Tuesday
- Electrical components mounted Saturday



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    - Minibot — Matthew Schwartz, Andrew Trachtman
    - Elevator
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Minibot goals

- Get to the top in a timely manner
- No software, only electrical switches
- Be able to go up and down pole
- Small as possible

Deployment Goals

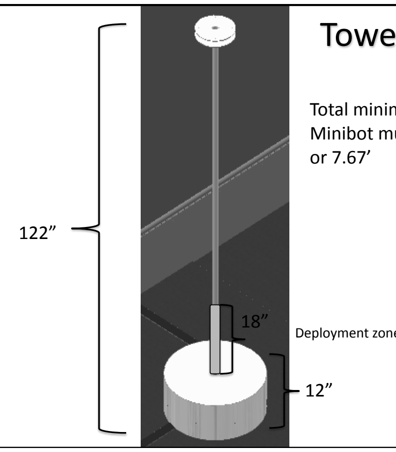
- Accurate
  - Front of main robot will contour to the base of pole, allowing for consistency in starting location
- Consistent
  - Have a range of deployment area where Minibot will function, regardless of placement
- Softwareless
  - Electrical switches cause activation rather than software

Early Designs

- Separate group brainstorming

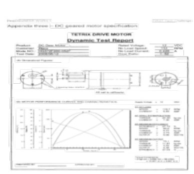
	Design #1	Design #2
Minibot	1 drive wheel, 1 frictionless wheel, latches on with own weight	2 drive wheels, T shaped with battery, holds onto pole using tension
Deployment	2 pin pullout, gravity swivels to lock onto pole, auto switch on	Forced onto pole. Dado groove as holster to allow only upward movement. Auto switch on

Tower Specs

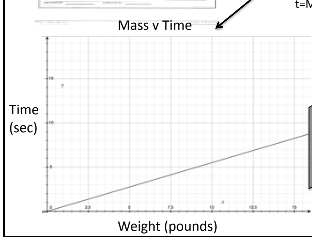


Total minimum distance Minibot must travel: 92” or 7.67’

Calculations



Maximum output: 9.36 watts=Power
Minimum height to travel: 7.67 ft or 2.34 meters
Gravitational potential energy at top= Mgh
Power that must be used to get to top=Mgh/t
P_{motor}=Mgh/t
t=Mgh/P_{motor}
using 2 motors: t=Mgh/(2P_{motor})
(gh)/(2P_{motor})=(9.8*2.34)/(2*9.36)=1.22
Using substitution
t=M(1.22) where t is seconds and M is kg



Fast to top means <u>30</u> points!

1st Design

Note: the jutting bar is a counterbalance and is replaced by relocation of the battery

Deployment Design 1

- Pins & drop
  - 2 pins are propelled toward pole
  - first pin is removed, causes robot to swivel down, latch onto pole
  - Second pin's removal activates robot by pulling a tab that blocks the circuit's connection to battery

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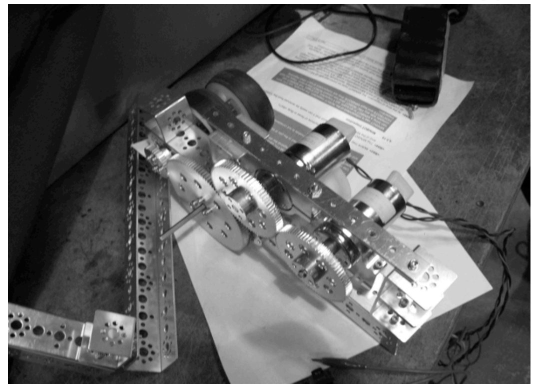
Prototype



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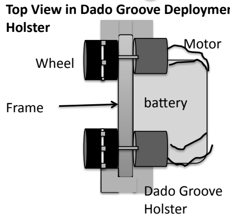
Design Idea 2

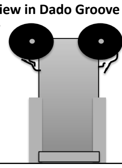
- 2 Drive wheels
- Maximum size efficiency
- Minimum weight
- 2 Motors
- Tension design

- Ultimately winning design

Top View in Dado Groove Deployment Holster



Front view in Dado Groove Deployment Holster



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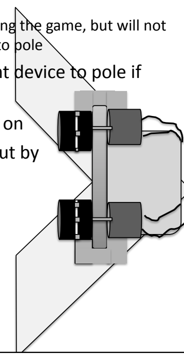
Deployment Design 2

- Dado groove holster
  - Will stop the mini-bot from moving during the game, but will not restrict upward motion when attached to pole
- V shaped plate will guide deployment device to pole if slightly off center
- Upon attachment, mini-bot will turn on
- Deployment device will be pushed out by pre-tensioned surgical tubing



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1st design

Pro	Con
•Besides motors and wheels, no moving parts •Gives range for deployment area (space between wheels) •Deployment can rely on weight instead of a mechanical or electrical mechanism	•If unbalanced for any reason, can fall •Difficult to get down

2nd design

Pro	Con
• Able to hold on to the pole • Can bring itself down • Wheels have excellent grip • Easy to deploy • Sharable	•Hard to put on pole

Winning Design!

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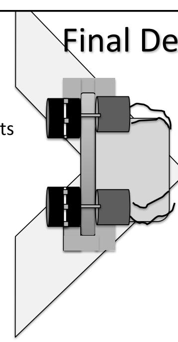
Final Design



- Final choice is Design #2
- Why this design will get 30 points
  - Extremely lightweight
  - Short deployment time

Don't forget about coopertition

- This design is easily modified to fit other teams robots!

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    - Elevator — Richard Hockenbury, Kanay Patel, Josh Smith
  - Software
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Goals

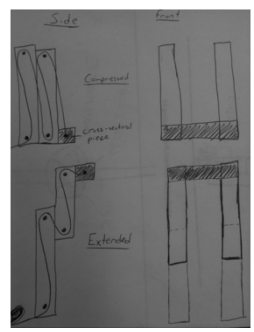
- Reaching top peg
- Maintain grip on tubes at all times
- Ability to pick up tube off ground
- Maintain a balanced robot

Elevator Ideas Considered:

- Ladder Lift
- Scissor Lift
- Telescopic Arm

Ladder Lift

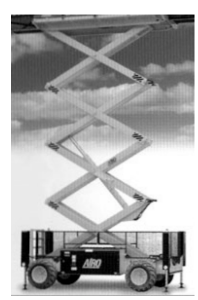
- Pros
  - Simple Design
  - Operates off single motor
  - Easy to program
  - Very Reliable
- Cons
  - Raises center of gravity
  - Heavy
  - Tilts mass towards front of robot



Elevator Prototype

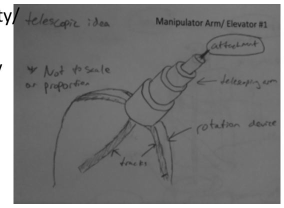
Scissor Lift

- Pros
  - Shortest relative elevator height when retracted
  - Requires minimum horizontal room to extend
- Cons
  - Heavy
  - Must be precisely built
  - Unstable as height increases
  - Complicated to implement



Telescopic Arm

- Pros
  - High control if built properly
- Cons
  - Needs room to swing
  - As height increases, more articulation and difficulty/ complexity
  - Offsets center of gravity



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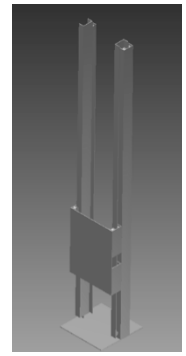
Final Chosen Elevator Design

- Ladder Lift
  - Extending ladder chosen over firemen's ladder design in order to reduce tendency to tilt forward; more stability
- Tower Height: 57"
- Base Width: 17"
- Total Extended Height: 8' 9"
- Aluminum C-Channel



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Elevator Build Status/Plans

Week 1:	Week 2:	Week 3:
•Brainstorm goals •Weigh out options	•Design models •Construct prototype	•Finish prototype •Begin final design
Week 4: (Current Week)	**Week 5:**	**Week 6:**
•Finishing up final elevator design •Communicating with chassis/grabber teams to locate connection possibilities	•Troubleshoot any defects with electrical	•Troubleshoot any defects with software

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Potential Grabber Ideas

- Scooping Claw "Dustpan"
- Fork Lift
- Claw
- Vacuum Grabber

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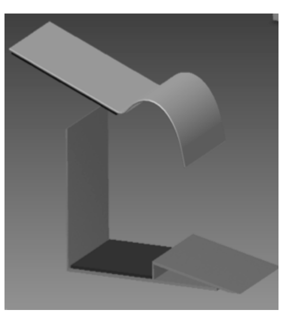
Scooping claw "Dustpan"

- <u>Pros</u>
- Easy to make
- Relatively simple
- Easy to grab while moving

- <u>Cons</u>
- Might push tube away
- Can't Reach highest peg



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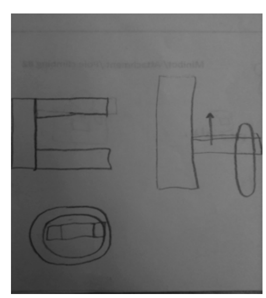
Fork lift

- <u>Pros</u>
- Very Simple
- Quick at grabbing and moving tube

- <u>Cons</u>
- Limited range
- Unbalanced



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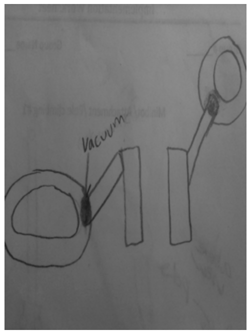
Vacuum

- Pro’s
- Strong grip
- Grab at any angle
- Light at arm

- Con’s
- No prior knowledge or experience
- Vacuum itself heavy
- Excess part not on arm



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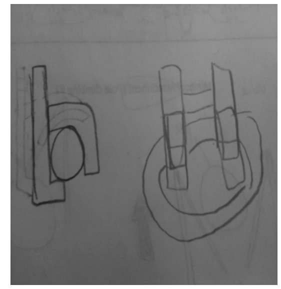
3-prong Claw

- Pros
- Strongest grip
- Quick Grab
- Reliable
- Light

- Cons
- Takes up a lot of space
- Requires arm to be longest
- Weak if hit



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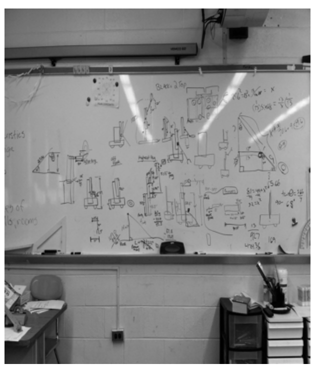
Analysis

- Arm Length
- Claw Length
- Claw Height
- Angle of approach
- “reach” of Arm



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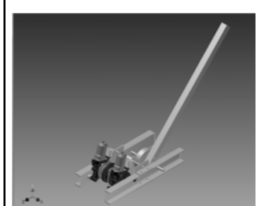
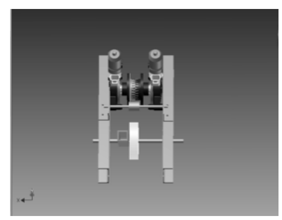
Arm





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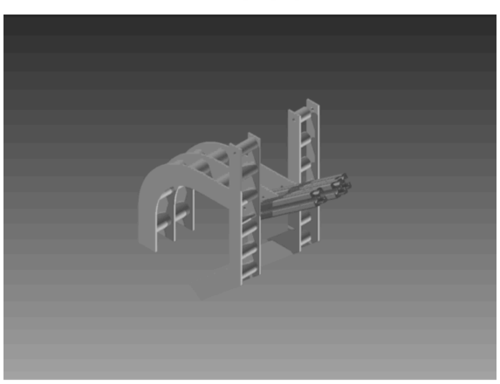
The Claw



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Grabber

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Grabber Animation

Build Status and plans

Week 1	Week 2	Week 3
•Got design together •Begin wooden prototypes	•Tested concept of wooden prototype •Began construction of metal prototype	•Finished metal prototype and tested • ordered parts for final project

Week 4 (current)	Week 5	Week 6
•Finish final project • begin integration into robot •Finish integration •Trouble shooting	•Finalize claw and arm •Finish with robot hand over to electrical and software	Assist electrical and software with any mounting of wires or software

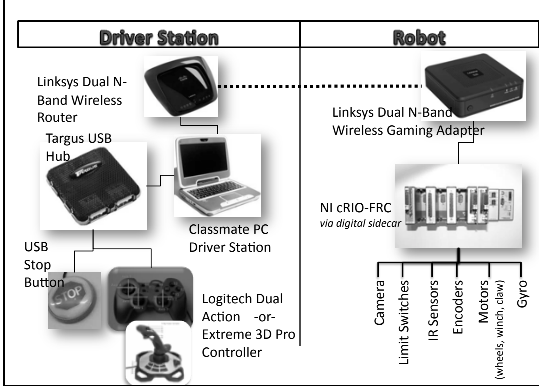
Agenda

- Introduction & Video
- Strategy
- Robot Design
  - Mechanical
    - Chassis
    - Mini-Bot
    - Elevator
  - Software — Martin Borstad, David Korhumel
  - Electrical
- Program Management & Support Functions
- Conclusion

Goals

- **C++ Proof of Concept**
  - Program previous year's autonomous mode in C++
  - Program current year's autonomous mode in LabVIEW and then translate to C++
- **Server and Development Computers**
  - Setup Development Computers
  - FTP Server
- **New Hardware**
  - IR sensors
  - Mecanum drive
- **Website**
  - New look
  - Mentor pages

Communication Diagram



Modes of Operation

Goals of Autonomous
- Track lines
- Place Uber-tube

Goals of Teleoperated
- Intuitive Controls
- Deploy mini-bot

Systems of the Robot: Navigation

- Steering
  - Mecanum Drive
- Positioning
  - IR sensors
  - Gyros
    - Track rotation along X/Y plane (Field Oriented Driving)
- Controller
  - Logitech Extreme 3D Pro Joystick
  - Logitech Dual Action

Systems of the Robot: Vision

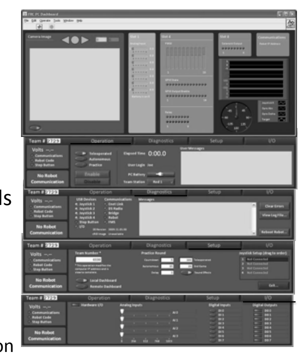
- **Camera**
  - Camera image on dashboard
  - Indicator for when robot is on target
  - Auto tracking of target and placement of tube during autonomous

Systems of the Robot: Lifting

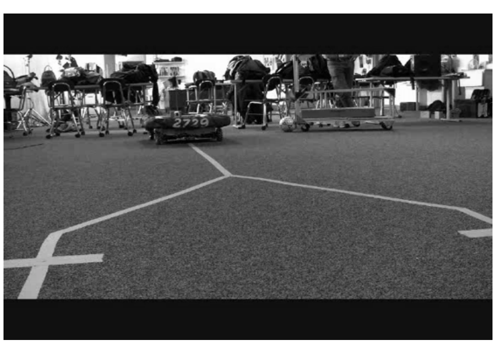
- **Claw**
  - Detecting Tube / Tube Possession
    - Limit Switch to detect contact with tube and provide indication to operator
  - Opening/Closing
    - Open/Close Claw using button on controller
    - Use Encoders and a Limit Switch to prevent Claw from closing/opening too far
- **Elevator**
  - Lifting Tubes
    - Have Tele-Op control of tube delivery mechanism
    - Control winch motor to lift elevator with claw

Dashboard

- Indicators
  - Tube in Possession
  - Elevator Seated
  - Claw Seated
  - Target Aligned
- Driver Station Controls
  - Robot drive
  - Deploy Claw
  - Open/Close claw
  - Elevator Up/Down
  - Emergency Stop Button



Software Demo



Goal Status

- C++ Proof of Concept
  - Previous year's autonomous mode has been reprogrammed in C++ and undergoing integration testing
  - Current year's line tracing has been programmed in LabVIEW and is currently being translated to C++
- Server and Development Computers
  - All computers have been finished
- Website
  - Everything has been completed except for the server and content delivery system

Build Status

- **Navigation** – almost complete based on field testing with prior year's robot
- **Vision** – Half way done - able to receive image in LabVIEW, needs calibration
- **Lifting**
  - **Elevator** – Half way done - basic motor control coded, pending testing when new robot is available
  - **Claw** – Almost complete - coding and some testing achieved, awaiting additional integration testing when new robot is available

Future Plans

- C++
  - Finish programming current year's autonomous mode in C++
  - Finish programming the robot
- New Hardware
  - Finish incorporating the encoders and gyro
- Website
  - Continue changing the look
  - Adding mentor pages

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  - Electrical — Ella Seeman, Liz Schell
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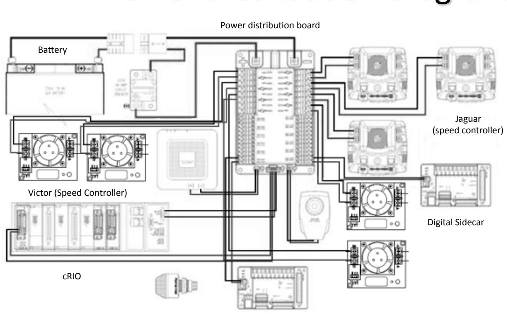
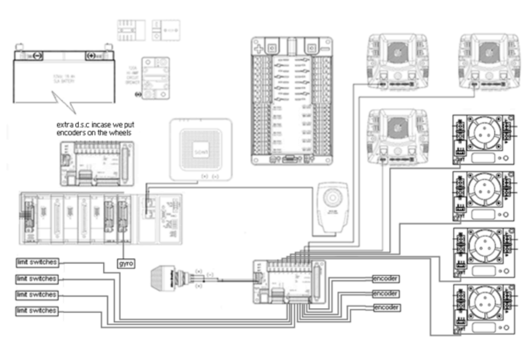
Goals for this Season

- Autonomous Mode
  - Follow tracking lines (optical sensors)
  - Track Reflexite tape on pegs
  - Hang tube on pegs
- Organize Electrical Components and Wiring
- Integrate Motors and Sensors
  - Elevator (1 Motor, 1 encoder, 2 Limit Switches)
  - Arm (2 Motors, 2 Limit Switches, 1 Encoder)
  - Claw (1 Motor, 1 Limit Switch, 1 Encoder)
  - Mecanum Chassis (4 Motors, 1 Gyro, 3 Optical Sensors)
    - with Motor Current Sensing Circuit
  - Minibot Deployment (TBD)

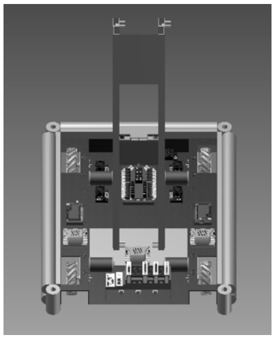
Power Distribution Diagram



Signal Diagram



CAD of the electrical components



Bumpers have been suppressed to better view the internal components.

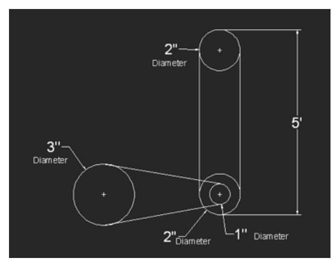
Arm

- Current Status
  - Functional (with Jaguars and software)
- Problems and Solutions
  - Window motors kept stalling
    - Dismantled the structure and removed the locking pins
  - Overly fast
    - Used 2:1 gear ratio to reduce speed
  - Belt on motors kept slipping
    - Added tensioner

Elevator

- Fisher Price Motor (more torque)
- Belt Driven
  - Theoretical speed of Belt : 5ft/sec

System of Elevator Gears



Speed and Gears of Belt

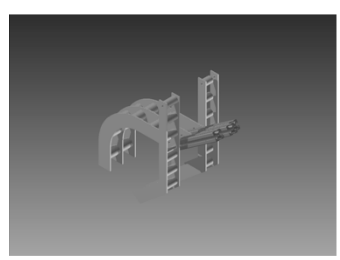
- Counted revolutions per 30 seconds(89 revolutions) multiplied by 2 to get rpm(178)

$$\frac{5ft}{sec} * \frac{12in}{ft} * \frac{60s}{min} * \frac{1}{2\pi r} = 178\,RPM$$

- Solve for radius of the pulley: 6 inches
  - Impractical, too big
- Achieve same reduction with gear ratio 3:1 (with a 2 inch gear on the same axis as the 1 inch)

Claw

- Worm Drive (Bane Bot Motor)
- Motor turns the screw moving the bottom of the claw forward or backwards.



Optical Sensors

- Autonomous period
- 3 in a line (side by side)
- Track Gaffer's tape on the playing field
- Senses contrast between floor and tape

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Gyro

- Tele-operated period
- Tracks rotation
- Recalibrates the robot

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Amperage of the Motors

Item	Part Number	Quantity	Consumption (Amps)	Consumption Factor	Total Consumption (Amps)	
Speed Controller (Jaguar)	MDL-BDC	5	0.156	100%	0.78	
Digital I/O	A003333	2	3.75	100%	7.500	
Computer (cRIO)	NI cRIO-FRC	1	1.67	100%	1.670	
Speed Controller (Victor)	FR-VIC884	4	0.156	100%	0.624	
Bridge (Dual-Band Wireless-N Gaming Adapter)	WGA600N	1	1.000	100%	1.000	
Camera (Axis 206)	288635	1	0.4	100%	0.400	
Camera Servo	HS-322HD	2	1.5	100%	3.000	
Drive (CIM Motor)	FP801-005	4	28.75	90%	103.500	
Fisher-Price	00801-0673	1	10	50%	5.000	
Robot Signal Light (RSL)	855PB-B12ME	1	0.06	70%	0.042	
Turret Motor (Window Motor)	262100-3029	1	1.83	5%	0.092	
Turret Motor (Window Motor)	262100-3030	3	1.83	50%	2.745	
					126.353	Amps
				Battery Life at 80% Discharge (Hours)*	Battery Life at 80% Discharge (Minutes)*	
Peukert's Factor (Great Battery)			1.100000000000	0.0702	4.21	
Calculated Peukert's Factor (FIRST Battery)			1.231495035980	0.0372	2.23	
Peukert's Factor (Average Battery)			1.300000000000	0.0267	1.60	
* Formula: Time = Capacity / (Current)^Peukert's Factor						
Battery Capacity: 18Ah						

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$T = C/(I/(C/R))^n$ X (R/C) or or $T=R(C/R)^n/I^n$						
Where:						
I = the discharge current	0.069509557	4.170573	I:	126.353		
T = the time	0.101639961	6.098398	T:	0.09	5.21	in Minutes
C = capacity of the battery	0.025856888	1.551413	C:	18		
n = Peukert's exponent for that particular battery type			n:	1.1		
R = the battery hour rating, i.e. 100 hour rating, 20 hour r			R:	20		
The modifed equation is $T=C(C/R)^{n-1}/I^n$ or $T=R(C/R)^n/I^n$ = peukert capacity/I^n						
Where:				1.55	minutes @ 126.3525 Amps for 80% discharge	
24h*((100ah/24h)^1.1) = 115.339 ah				0.97	minutes @ 126.3525 Amps to 50% discharge	
T = time in hours		0.03	or in minutes:	1.94	minutes @ 126.3525 Amps for 100% discharge	
C = (Ah) the specified capacity of the battery (at		18	peukert capacity	17.44	(capacity of the battery when discharged at 1 Amp)	
I = (A) the discharge current		126.353				
n = Peukert's exponent		1.3				
R = (h) the hour rating (ie 20 hours, or 10 hours e		20				
Alternatively, do this:						
$R(C/R)^n$ = the "Peukert Capacity".						
So in the case of a battery specified as being 100Ahrs@20 hours with a Peukert's exponent of 1.25 we get:						
$20(100/20)^{1.25}$ = 149.5Ahrs. This is the "peukert capacity". ie the capacity of the battery when discharged at 1 amp.						

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Plan of Attack

Next Two Weeks

- Install motor for elevator
- Implement Electrical Systems
  - Installing all sensors and speed controllers
  - cRIO
  - Motors
  - Power Distribution System
  - Digital Sidecars

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Agenda

- Introduction & Video
- Strategy
- Robot Design
  - Mechanical
    - Chassis
    - Mini-Bot
    - Elevator
  - Software
  - Electrical
- Program Management & Support Functions Anna Palka, Nicole Joie
- Conclusion

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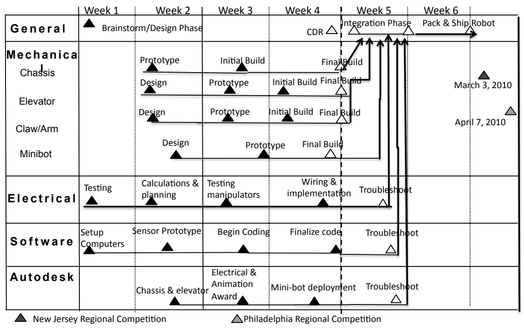
Team Schedule



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Marketing

Giveaways for Competitions

- NJ Goodie Bags
- Alliance Flags
- Storm Awards

Flyers

- Go Green
- Safety Cards
- Tri-fold Brochures

Team Uniforms

- Team jersey
- Redesigned team shirts
- Team Sweatshirts

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Budget

	Budget	Spent to Date
Drive train	$1500	$1159
Elevator	$500	$340
Electronics	$500	$50
Arm & Grabber	$300	$120
Total	$2800	$1779

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Going Green

We are making a large effort to go green by:

- Selling Stainless Steel Water bottles & FIRST LED light bulbs
- Making awards out of recycled materials
- Printing handouts on 100% recycled compostable paper
- Collecting bottle caps to reuse for artwork in the PIT
- Conserving energy in an efficient manner by using lights, computers, and tools only when necessary
- Recycling all scrap metal and wood.
- Exploring Solar Panel uses (ex: charging robot batteries)
- Educating other teams on going green at Robotics Competitions

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Thank You to the Following:

LOCKHEED MARTIN

LENAPE RHS DISTRICT

SCHOTT solar

Medium

Morris Energy Group

DR PEPPER SNAPPLE GROUP

Merchant & Evans, Inc.	Runway Cafe
Victor DeLuca	Buzz Cortese
Steve's Auto Body	Barretta Tile and Stone, Inc

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Final Montage

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The End

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Questions?