Swerve Drive Selection Process

Cyber Blue 234

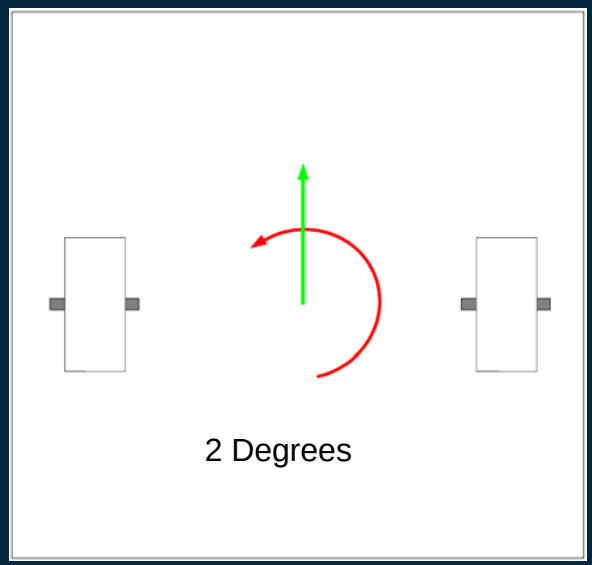
4/15/2010 – CHP Forums

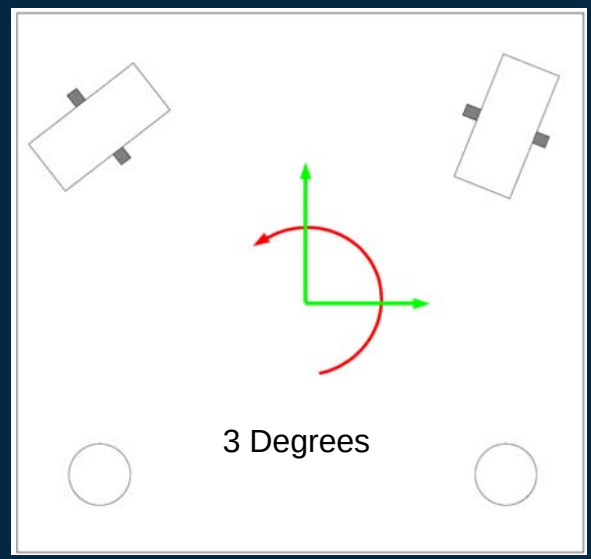
Background

- Cyber Blue had discussed wanting to try an omni-directional drive system for many years
- Recognized need for a lot of work to be done in summer and fall, not starting in January
- Atlanta 2009 – Began the process of developing a “swerve” drive

Omni-Drive History

- What is Omni-Drive?
  - Ability to control robot in 3 degrees of freedom



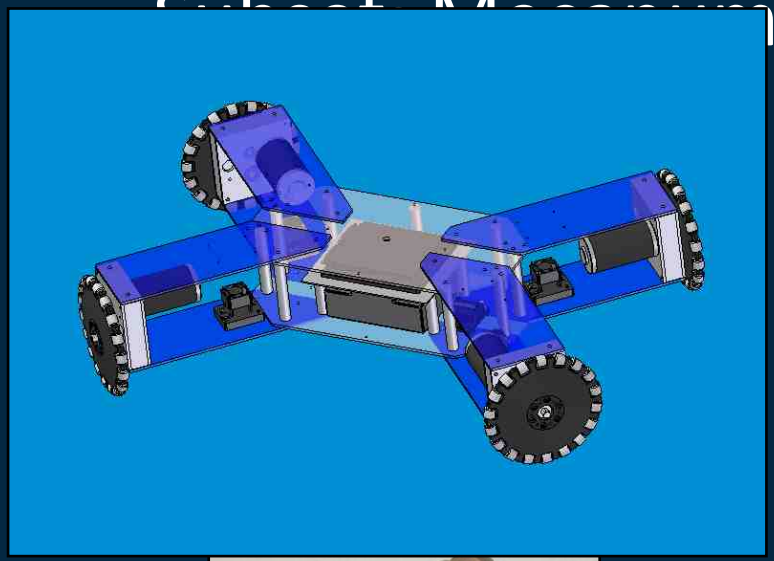


Omni-Drive History

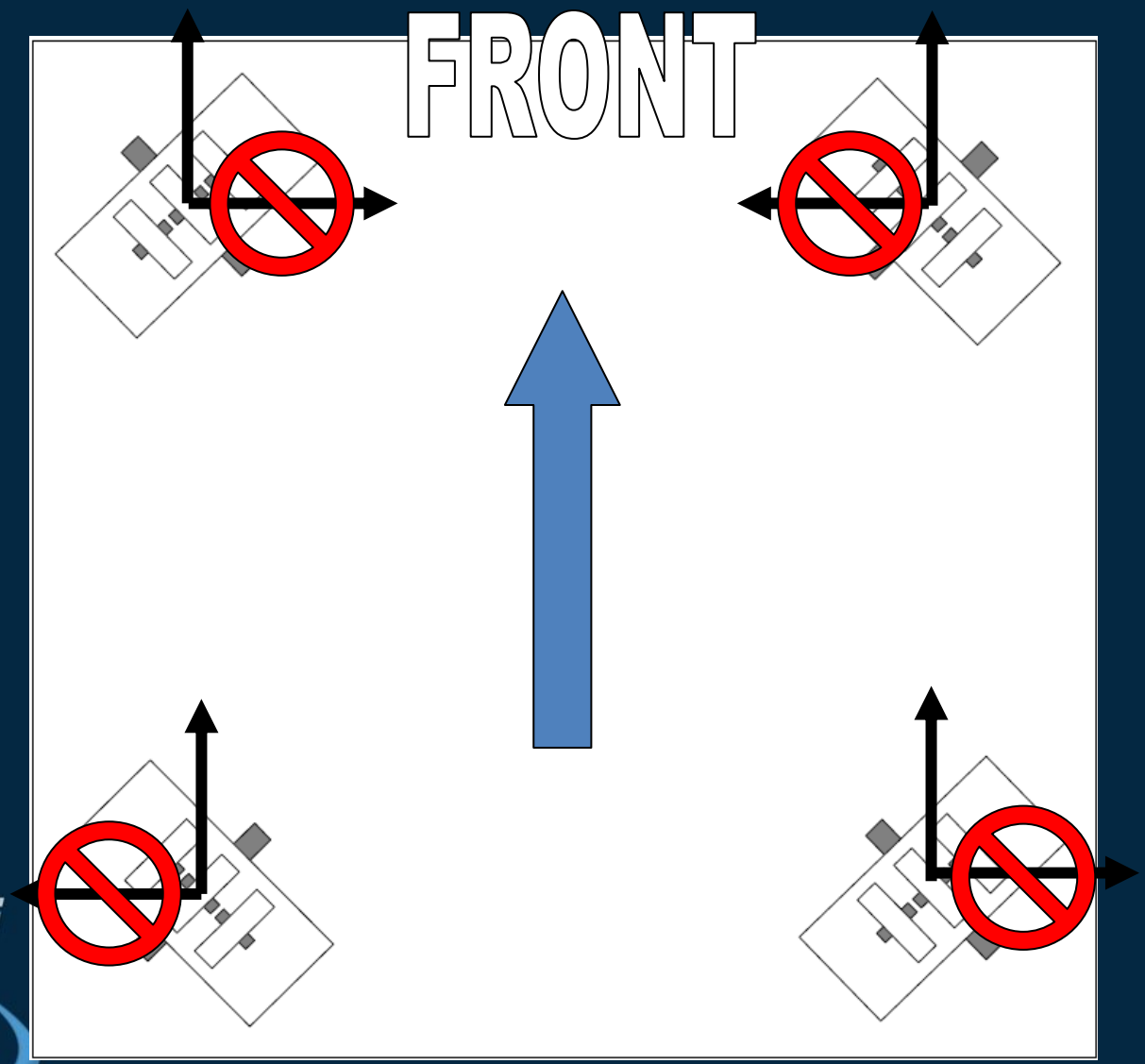
- Origins
  - 1998: crab steering, FRC 47
  - 1998: Omni wheels, FRC 67, 45
  - 2002: 3-wheel Killough drive, FRC 857
  - 2003: Ball Drive, FRC 45
  - 2003: Four-wheel crab, FRC 111
  - 2005: Mecanum-style “Jester Drive”, FRC 357
  - 2008: Three-wheel crab, FRC 148
  - 2010: Commercially available omni-drives

Omni-Drive Types

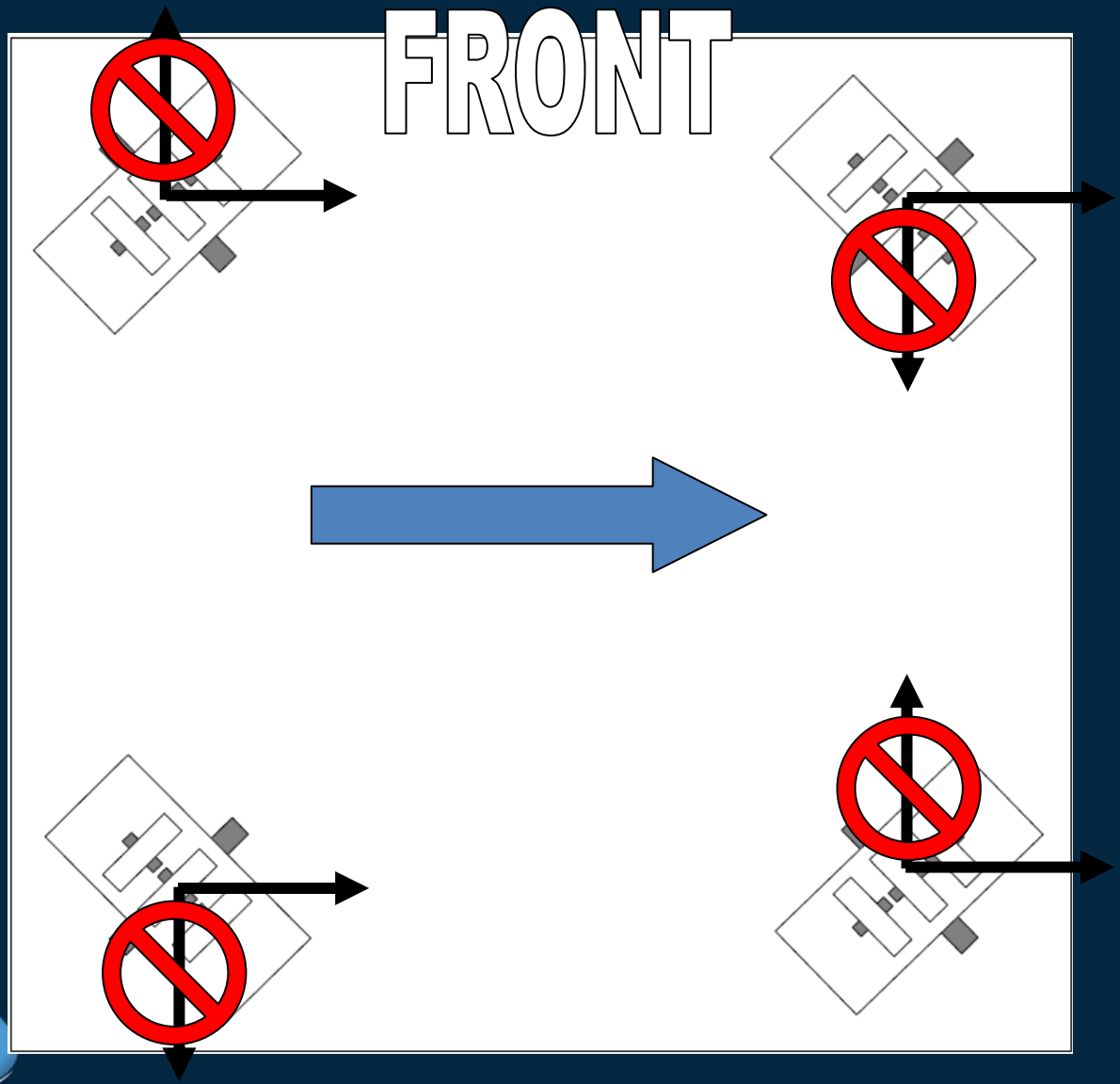
- Holonomic Drive
- Mecanum Drive



Holonomic Drive



Holonomic Drive



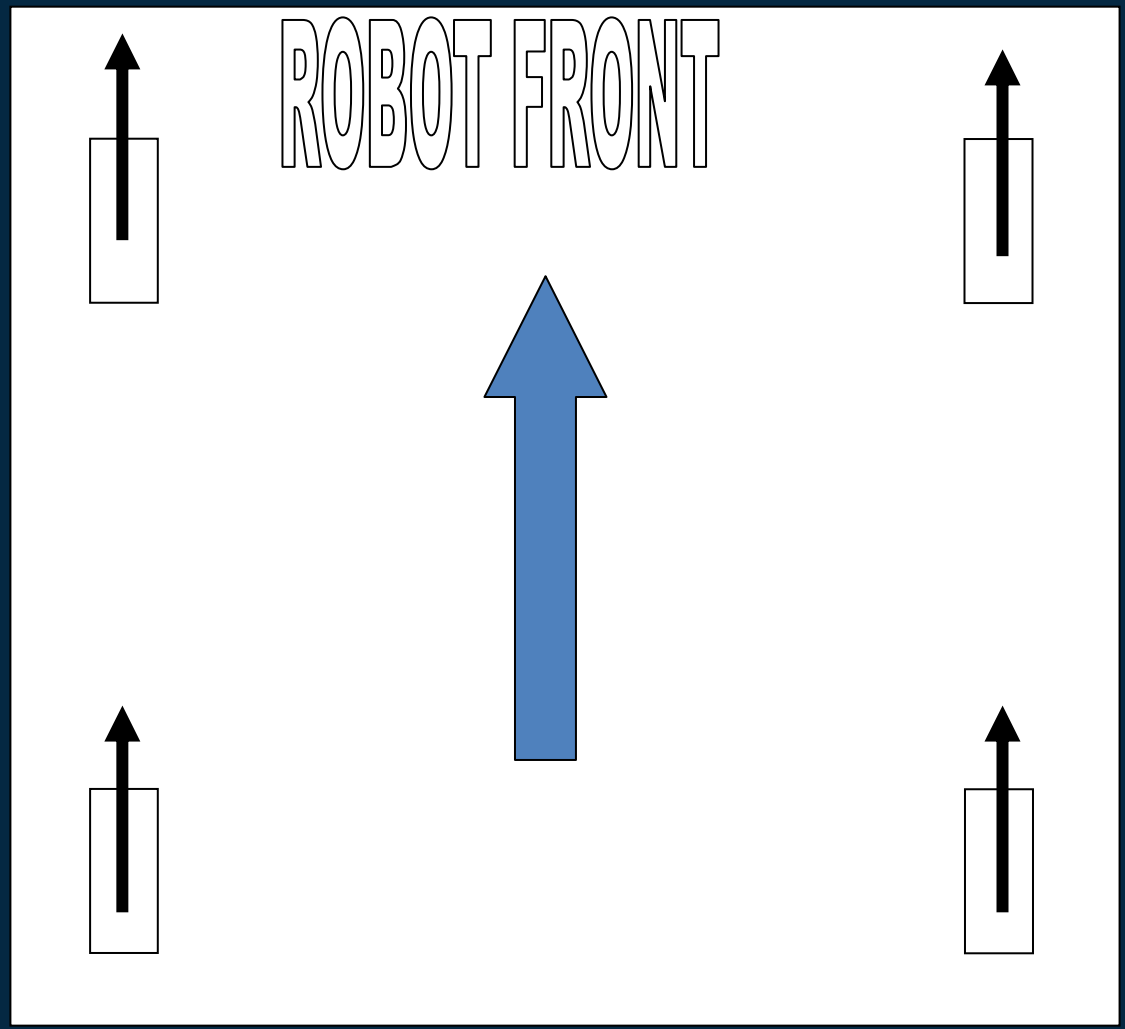
Omni-Drive Types

- Swerve/Crab Drive

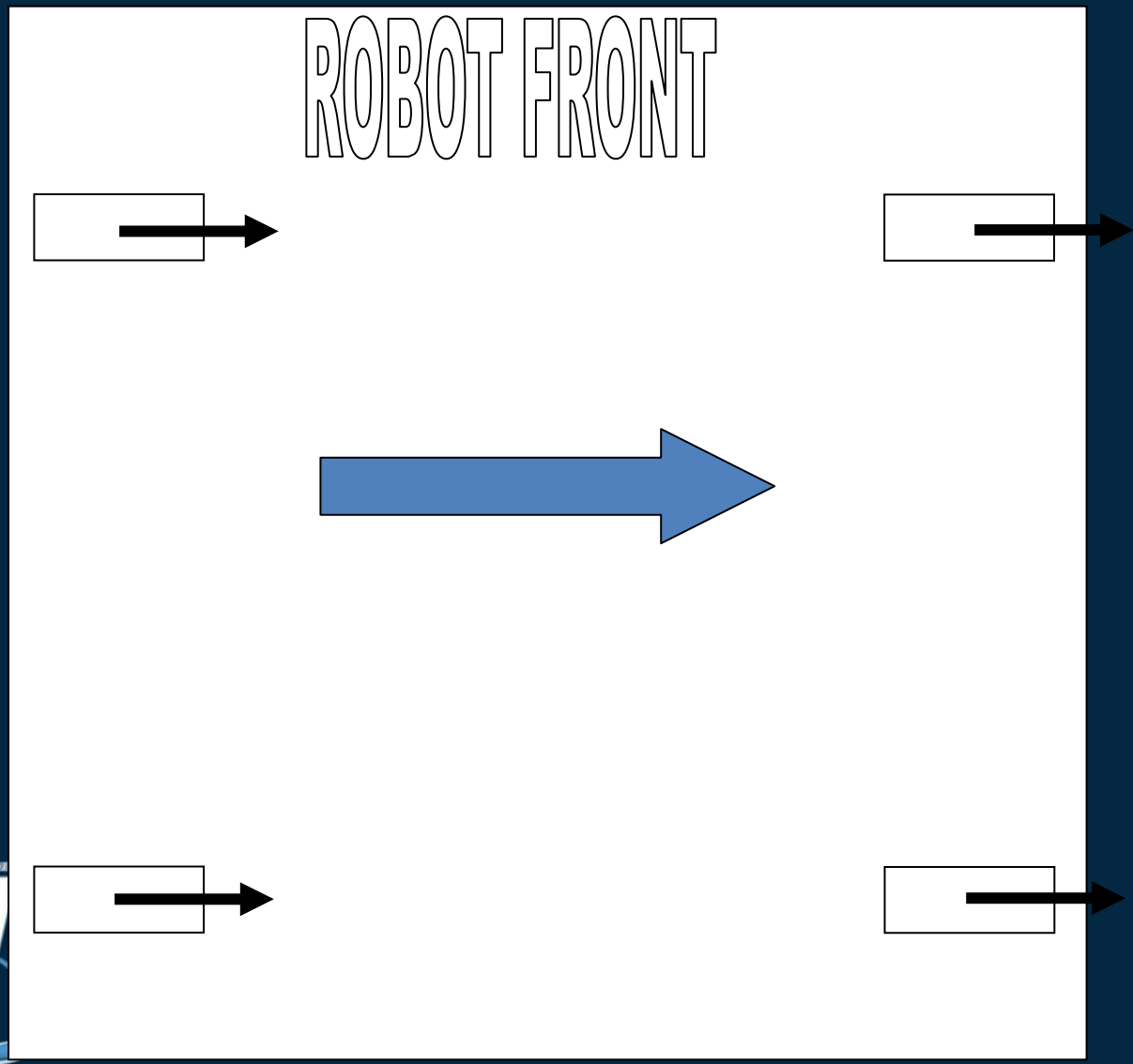
34

118

Crab Drive



Crab Drive



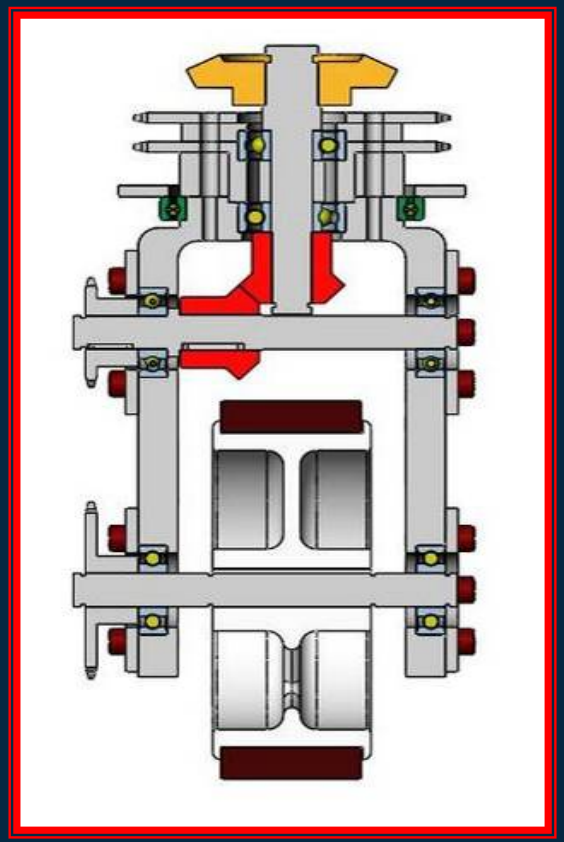
Holonomic vs. Crab

Holonomic	Crab
Easier to build	Harder to build
Weighs less	Weighs more
Relies on wheel slip to move	Turns wheels to move
Low traction wheels required	Any traction wheels desired
Speed limited by wheels	Speed limited by gearing
Slow change of direction	Immediate change of direction

Crab Drive Types

Distributed

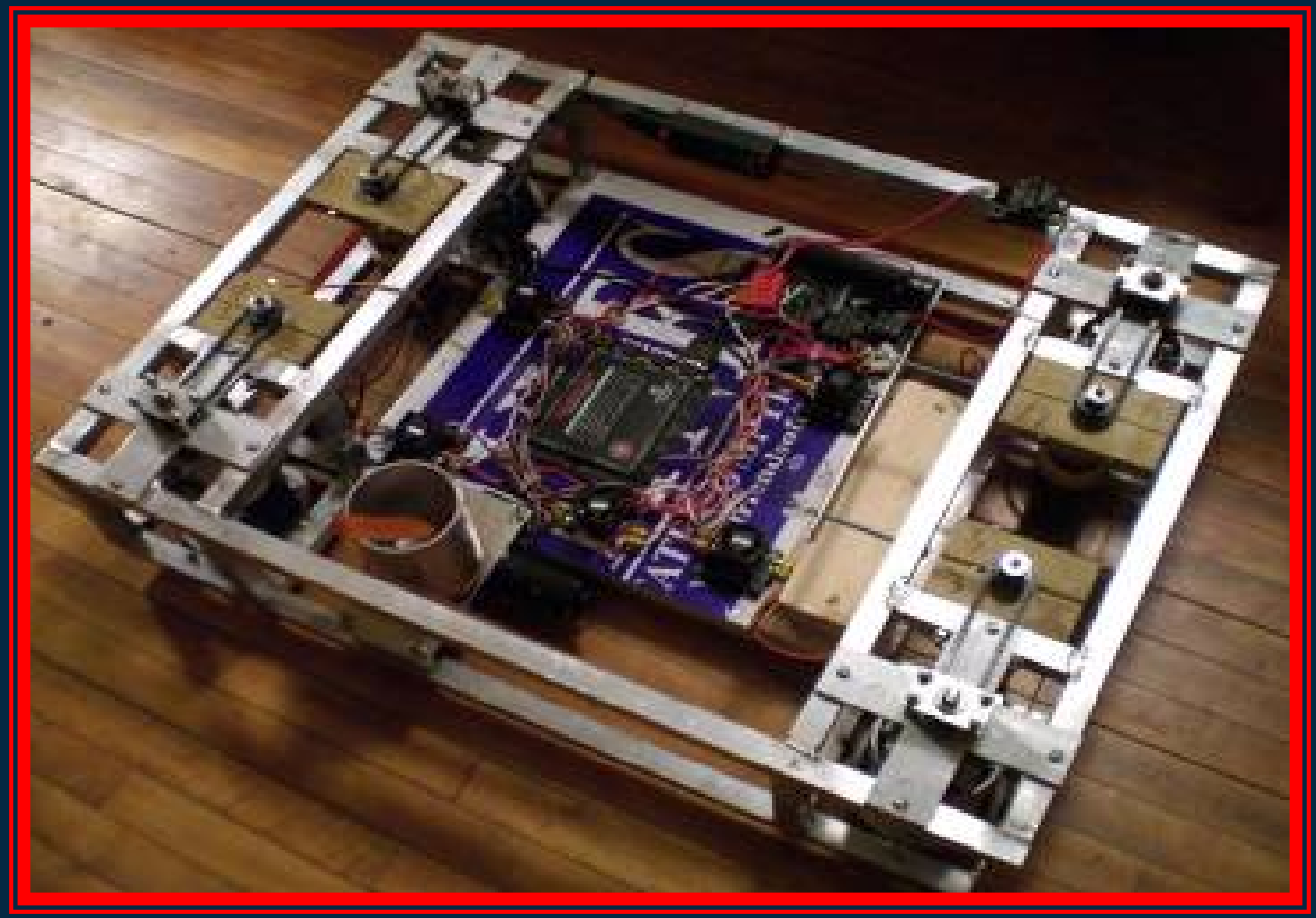
Coaxial



Coaxial Power Distribution

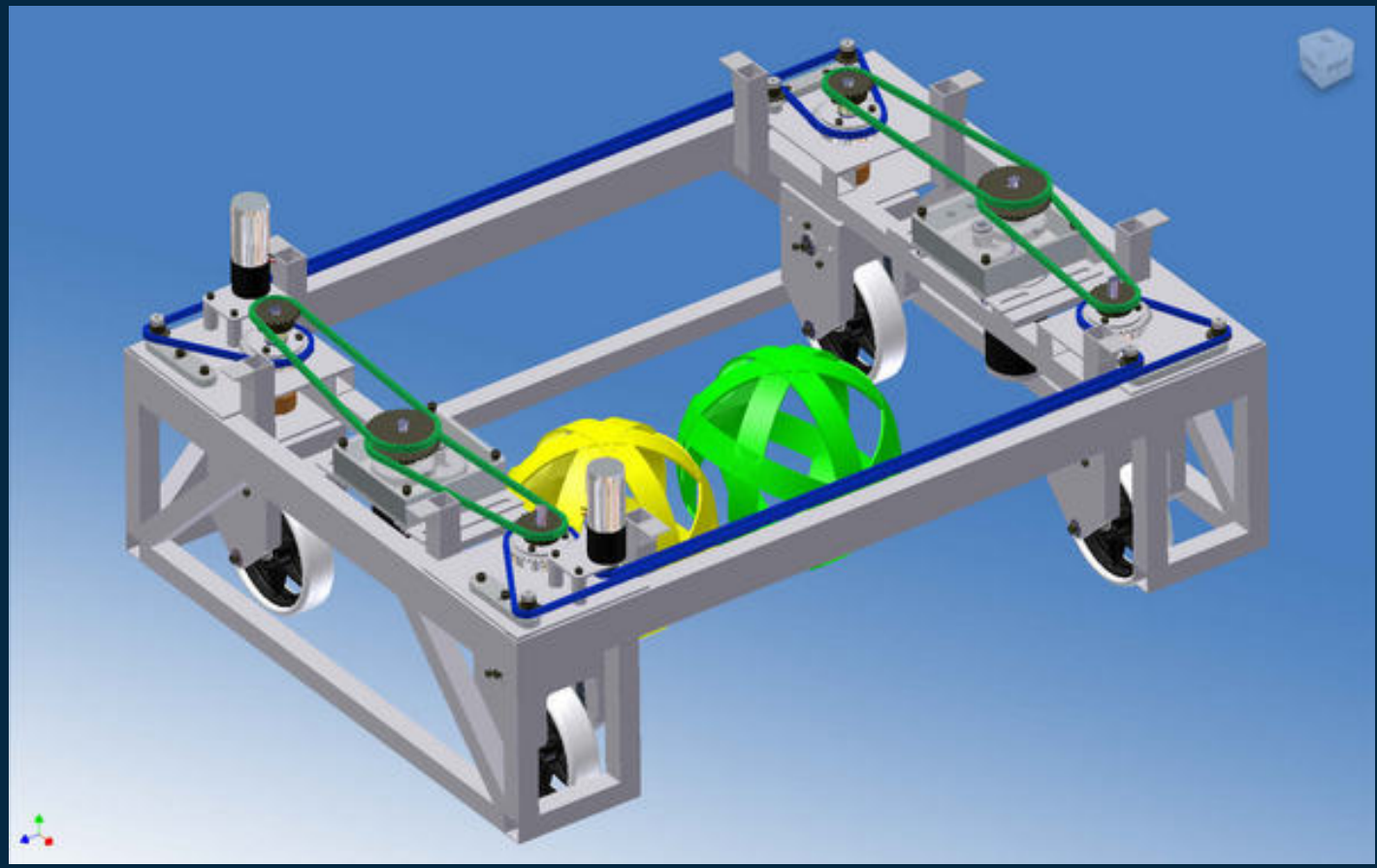
Coupled

Coaxial Power Distribution



Distributed (4 gearboxes)

Coaxial Power Distribution



Distributed (2 gearboxes)

Distributed vs Coaxial

Distributed	Coaxial
Self contained motor in pod	Motor located outside pod, driven thru chain/belt
Limited number of pod rotations	Unlimited number of pod rotations
Single-speed gearing	Ability to shift, if desired
Drivetrain power limited to single motor/wheel	Ability to add motors to drivetrain easily

CYBER BLUE
Decision Process and Actions

Decision Steps

- Evaluated manufacturability, design complexity, estimated cost of each type
- Borrowed modules from Team 118 and Team 111 to “get our hands on” the modules
- Tore down and rebuilt each module
- **Decision 1**
  - Made decision to use distributed modules

Inquiry

- Found that a *FIRST* supplier was planning to sell “Wild Swerve” Modules
- The modules were similar to 111, Wildstang’s, design which is what we were interested in
- Talked to supplier about purchasing prototypes
- Created a need for a “Make or Buy” discussion

The Pros of Making Your Own

- Making allows you to fully understand how the drive assemblies will work, since you take them from paper to fabrication
- Credibility, because it is your team's design
- Ease of assembly, adaptation in your hands

The Cons of Making Your Own

- Takes lots of time to design and manufacture
- Precision Machining Required
  - Does our team have the capability of machining parts to necessary precision?
- Decreases time that drivers have to practice
- Decreases time allotted for programming
- Only a few can be involved with the process
- Cost/Scrap?

The Pros of Purchasing

- Quickest option
  - Gives time for modifications
  - Time to program
  - Time for drivers to practice
- Identical to Others
  - No competitive disadvantage
- Learn through assembly and inspection

The Cons of Purchasing

- Legality in 2010 season?
- How to repair?
- Cost?
- Possibly less learning opportunities
- Availability of Modules and Spare Parts
- Team Image (How would other teams perceive us)
- Just like everyone else
  - No competitive dis-advantage

Our Decision

Purchase

- WHY
  - Quickest way to have a drive system
  - Highest probability of a system for the 2010 season, if this drive type was beneficial
  - Look at swerve drive as a full system
  - Optimum time for driving practice
  - More time for programming / learning

Making Purchasing A Learning Process

- Talked with supplier to obtain prototype modules
- Made an agreement with supplier to create assembly instructions for the kit of modules
- Committed to share our process via Chief Delphi

Assembly of Swerve Modules

- Learning
  - Module 1:
    - 4 students + 1 mentor
    - Assembled
    - Documented Procedure
    - Photographed
  - Module 2:
    - 4 other students + 1 other mentor
    - Used instructions from group 1
    - Made modifications and updates

Assembly of Swerve Modules

- Module 3:
  - 4 other students + 1 other mentor
  - Continued making modifications and updates
- Module 4:
  - 4 other students + 1 other mentor
  - Also continued making modifications and updates on instructions.

Assembly of Swerve Modules

- End Result
  - 16 Students directly involved with the build and creation of instructions
    - Students from multiple sub-teams
      - Design, Manufacturing, Communications, Electronics
  - Well “tested” Assembly Instructions
  - Feedback for Manufacturer

Chassis Design

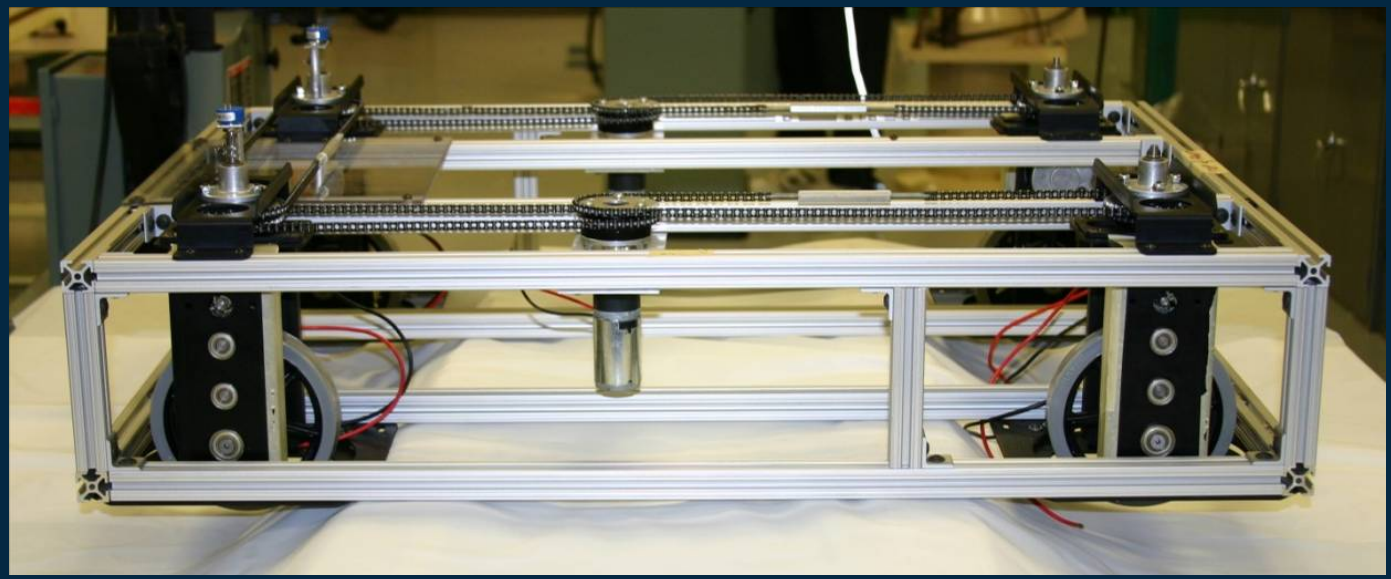
- Decided a basic rectangle or square would be best for our prototyping needs
- Couple 2 pods together for rotation
  - Later decided to tie all 4 pods together via chain

Chassis Design

- Chose 80/20 as chassis material
  - Easy to build
  - Easy to modify
  - Flexible for prototyping (Huge Plus)
  - Partnered with 80/20 for materials

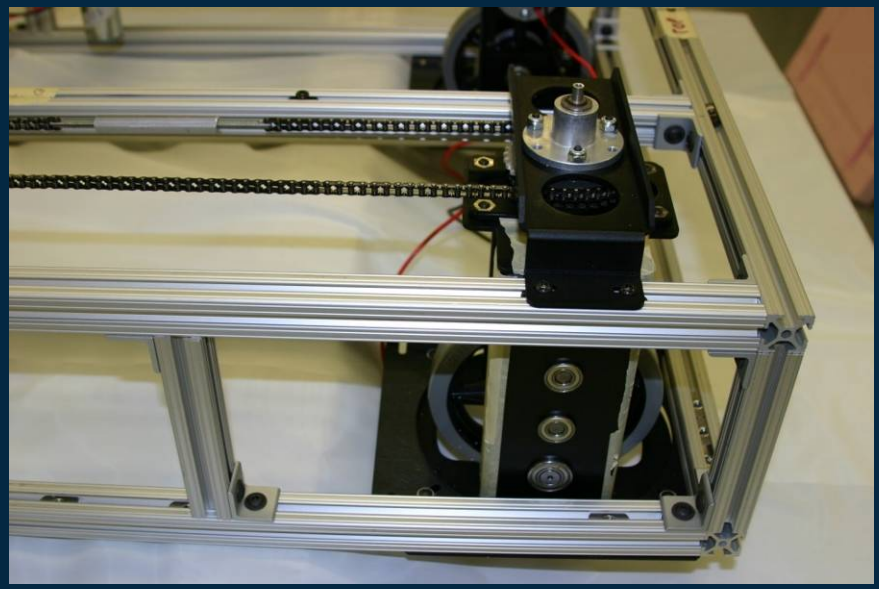
Chassis Build and Drive Assembly

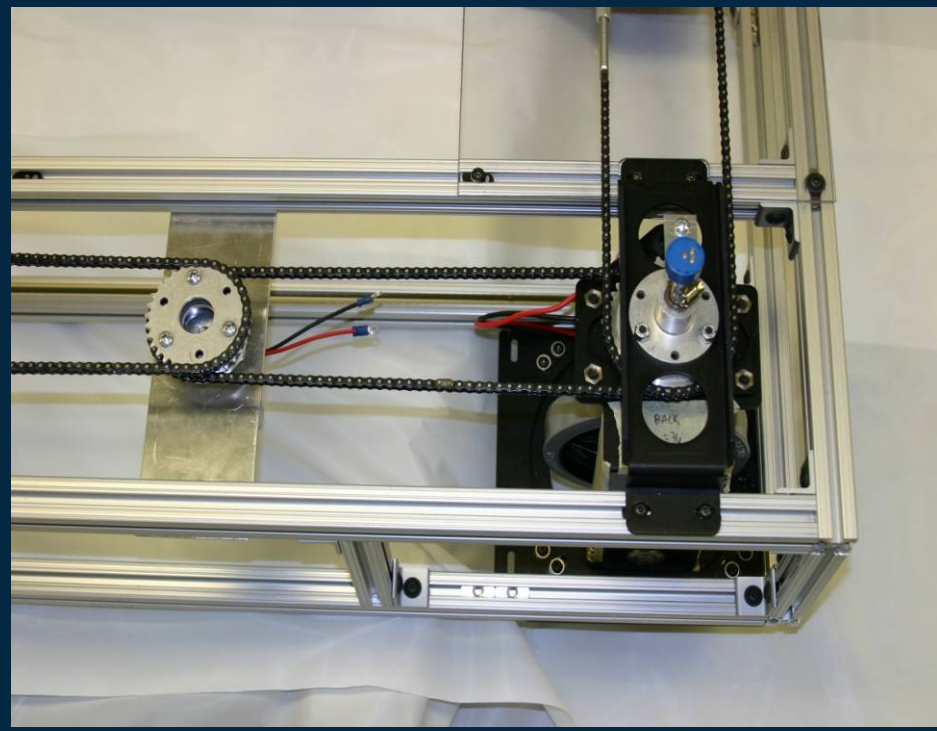
1. Built the Chassis System
   - 80/20 Material



Chassis Build and Drive Assembly

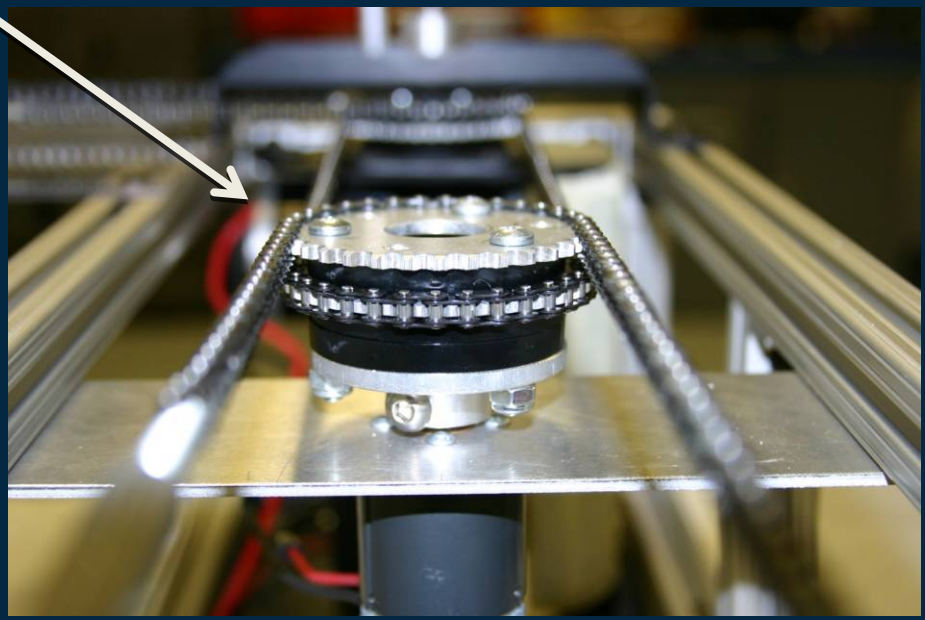
2. Installed Drive Modules.

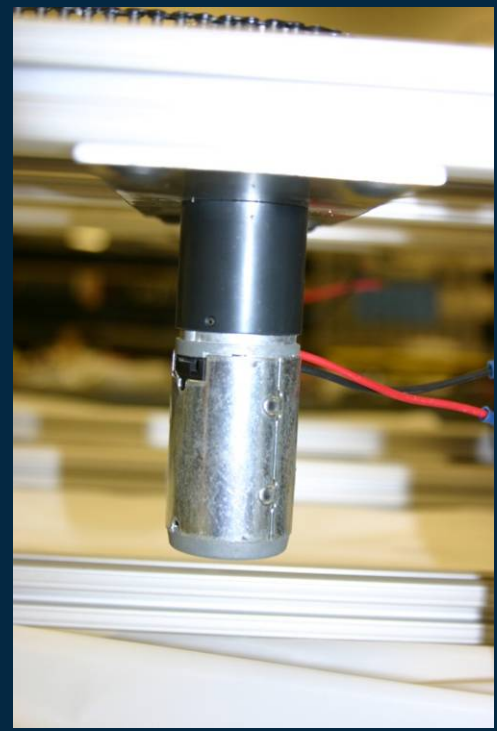




Chassis Build and Drive Assembly

- 3. Installed rotation motors.

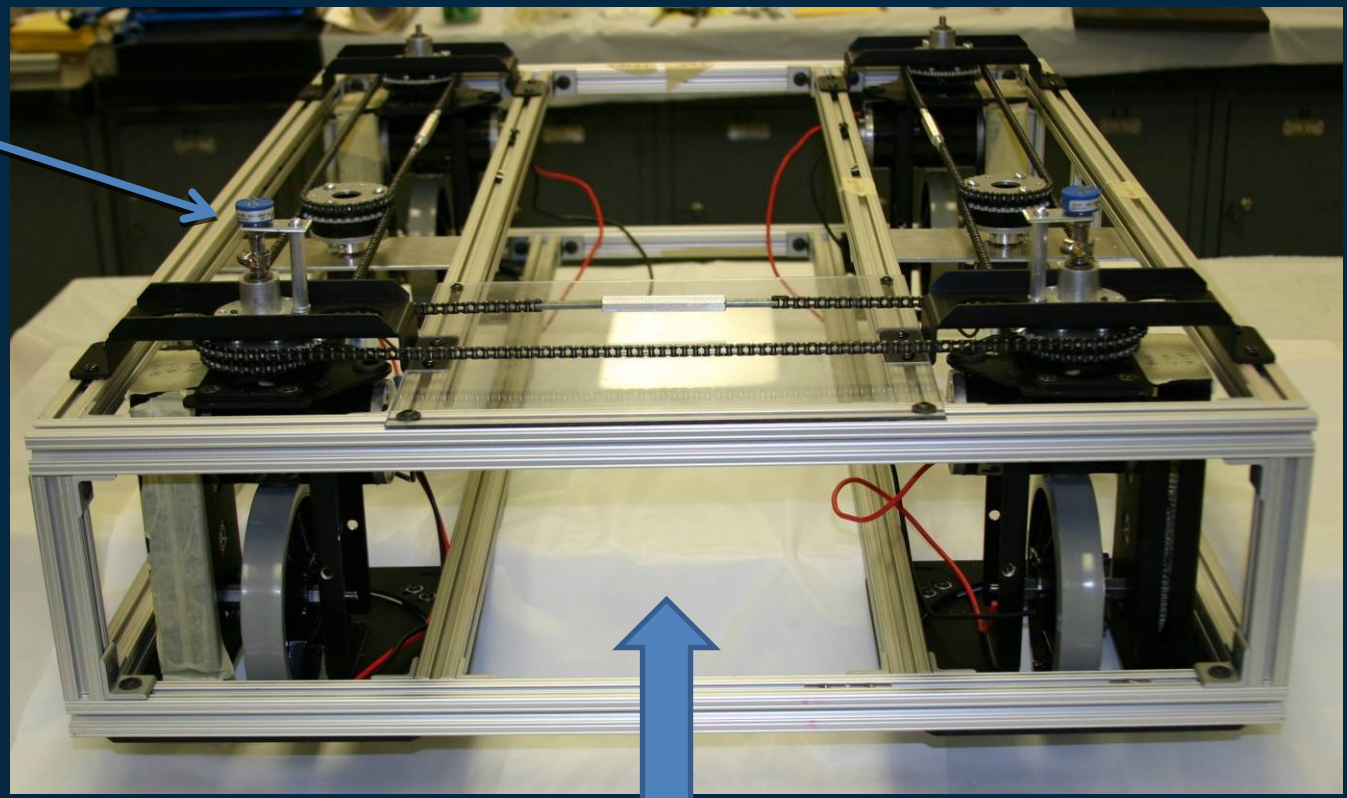




Chassis Build and Drive Assembly

4. Wired and Installed Electronics.

potentiometers

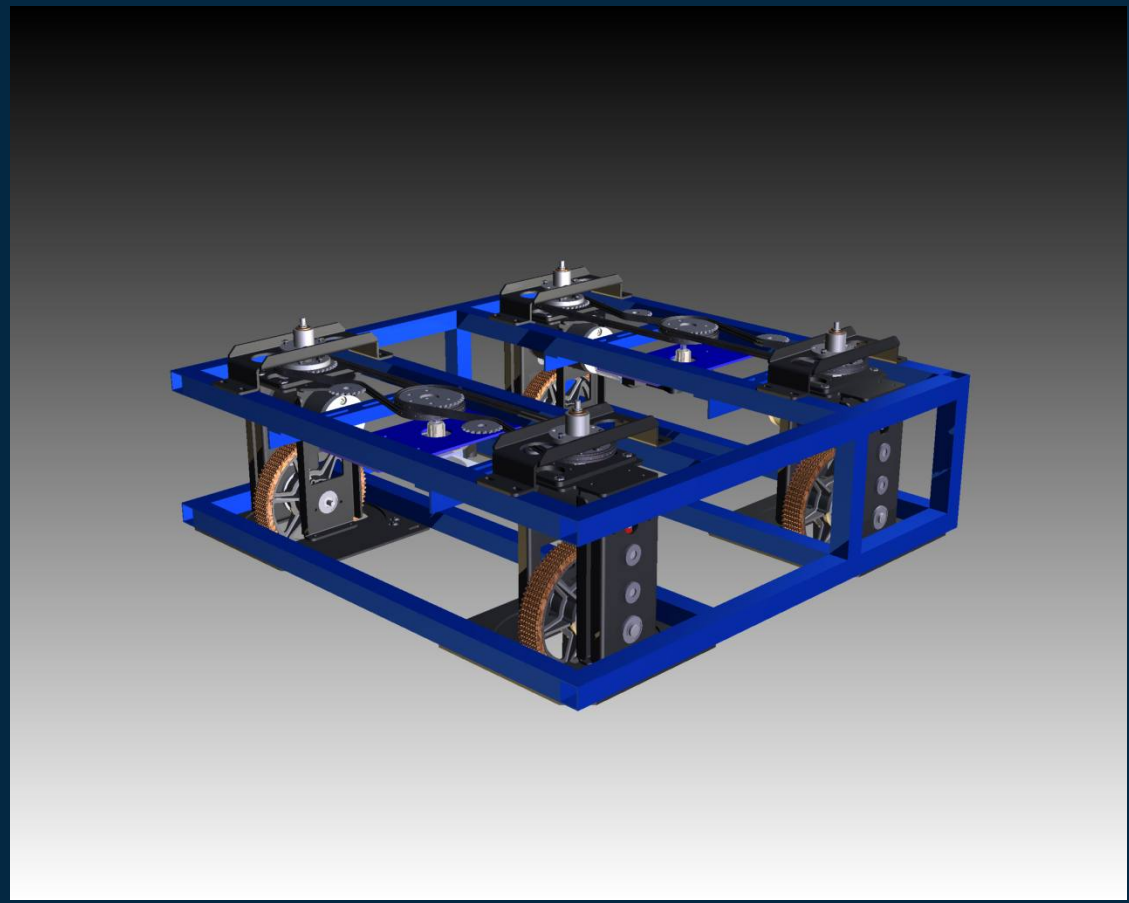


Electronics Board

Controlling the Crab drive

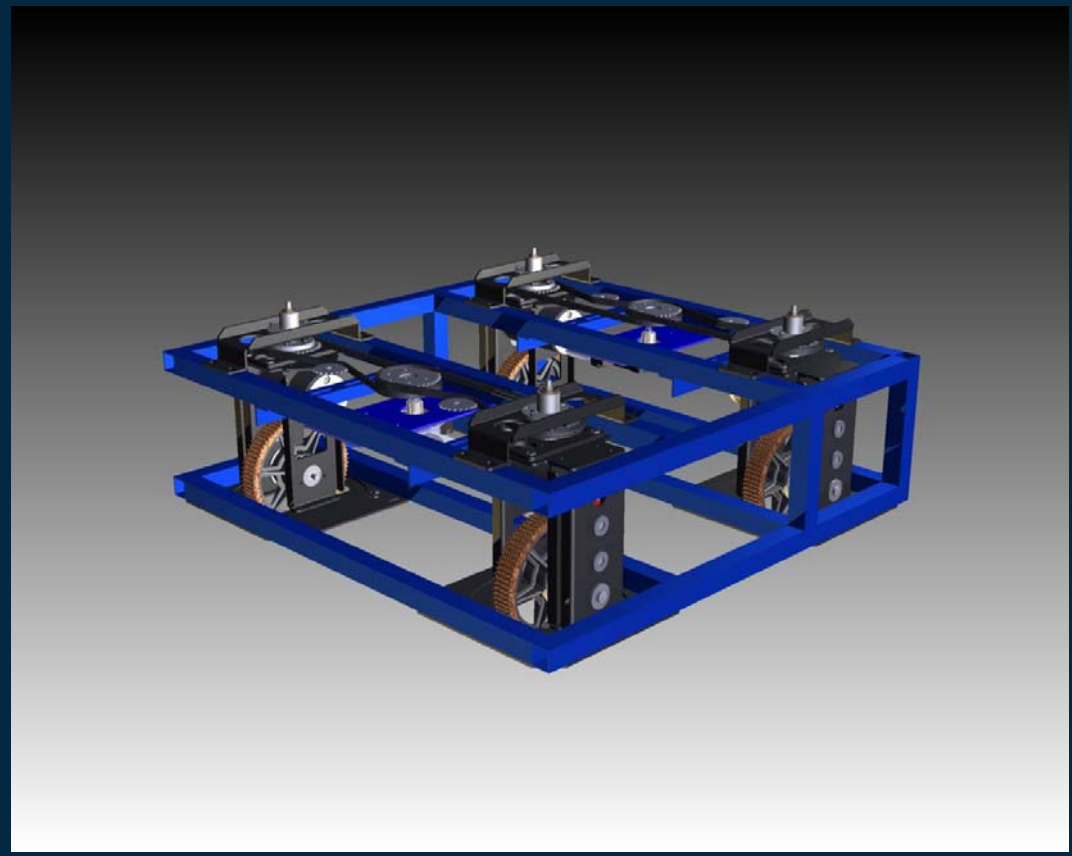
We need to…

- Turn the wheels, and robot
- Program the controls for the driver



Turning the Wheels

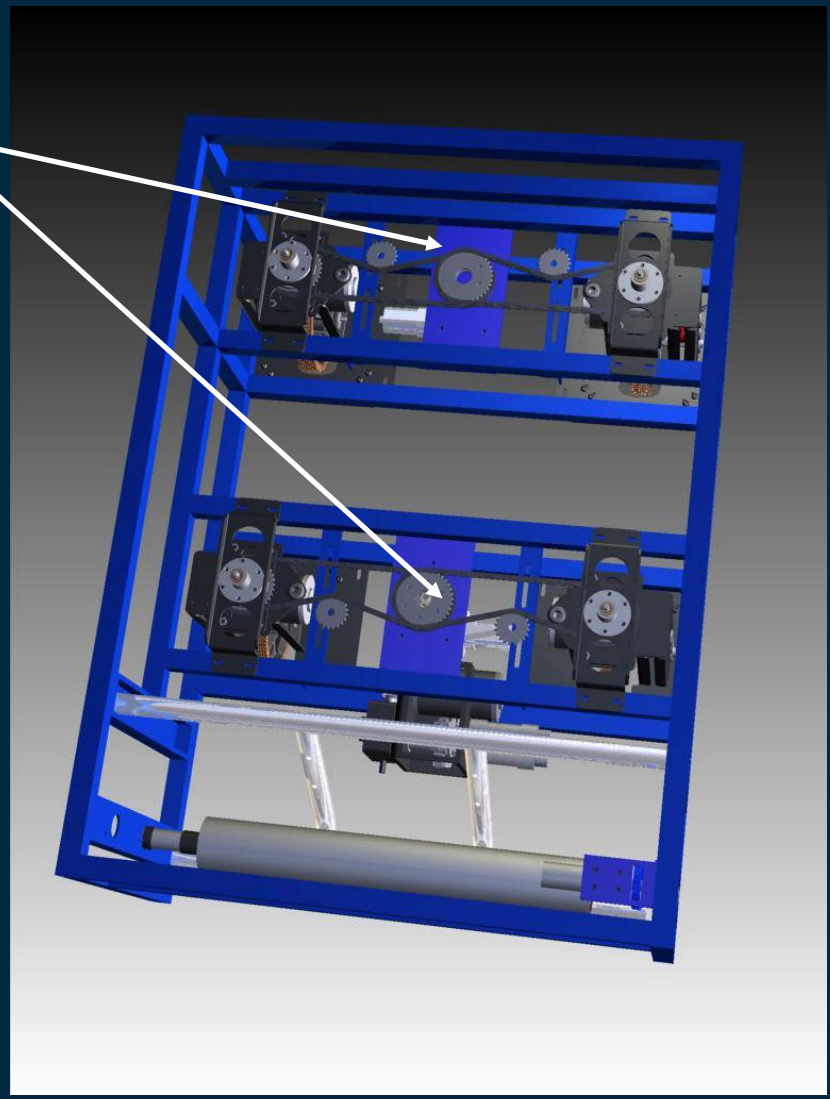
- Need to know angle of wheel rotation and how the wheels rotate.



Prototype Robot Rendering

For Example...

- We move two sets of wheels and use potentiometers to find the angle



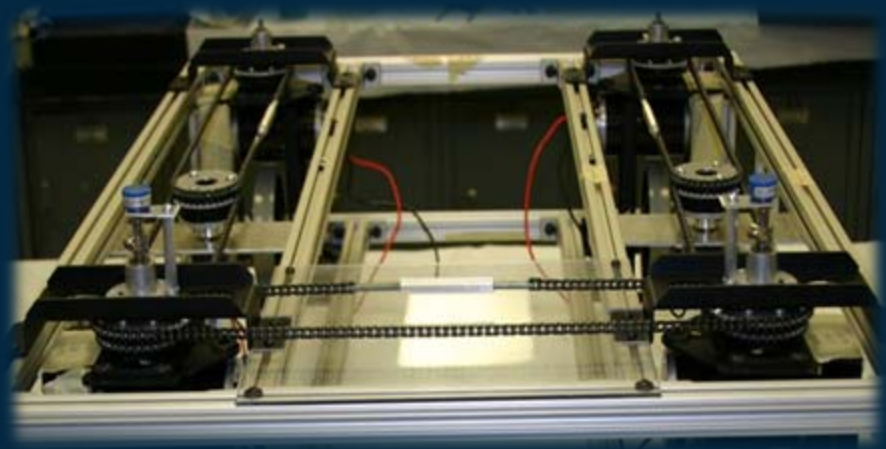
2010 Competition Robot Rendering

Swerve Use in 2010

- Even with 5+ months of off-season work, we had to make a decision
- One “Key” to Breakaway for us was mobility
  - swerve helped accomplish this
- Limited us from going over the bumps
  - Required “build small” and go through tunnel

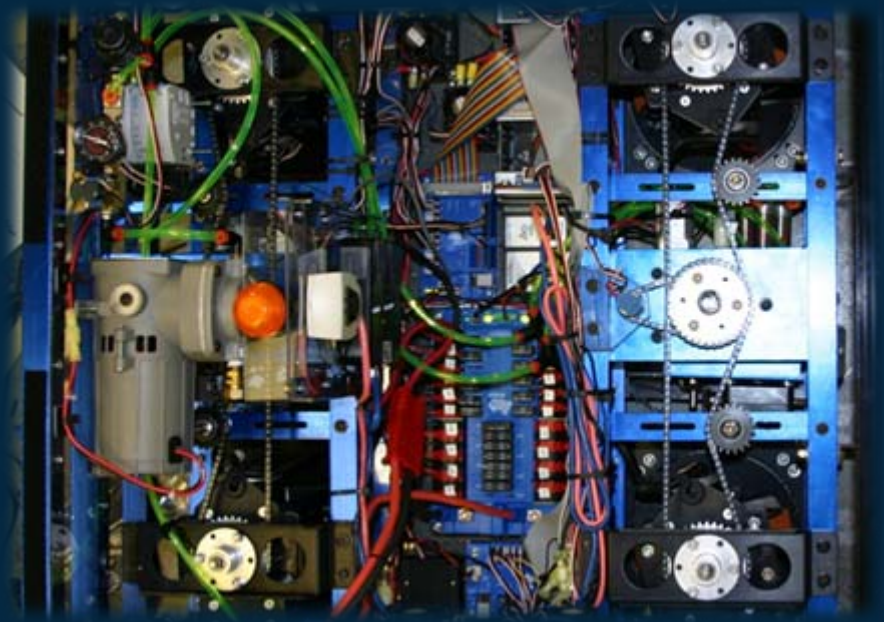
Changes from Fall to 2010 Season

- Went from 4 chained wheels to Front and Back



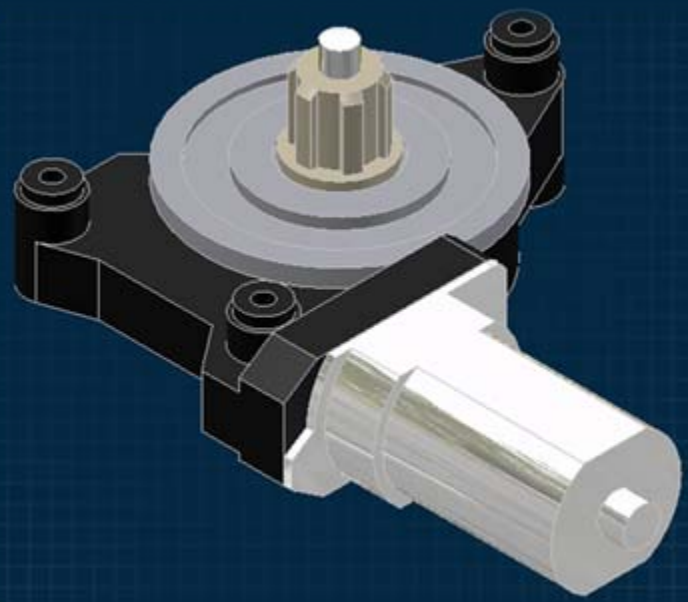
Four Pods Rotate Together

Front Pods Together
Rear Pods Together



Changes from Fall to 2010 Season

- Used Globe motors on Prototype
- Switched to Window motors for Competition



Changes from Fall to 2010 Season

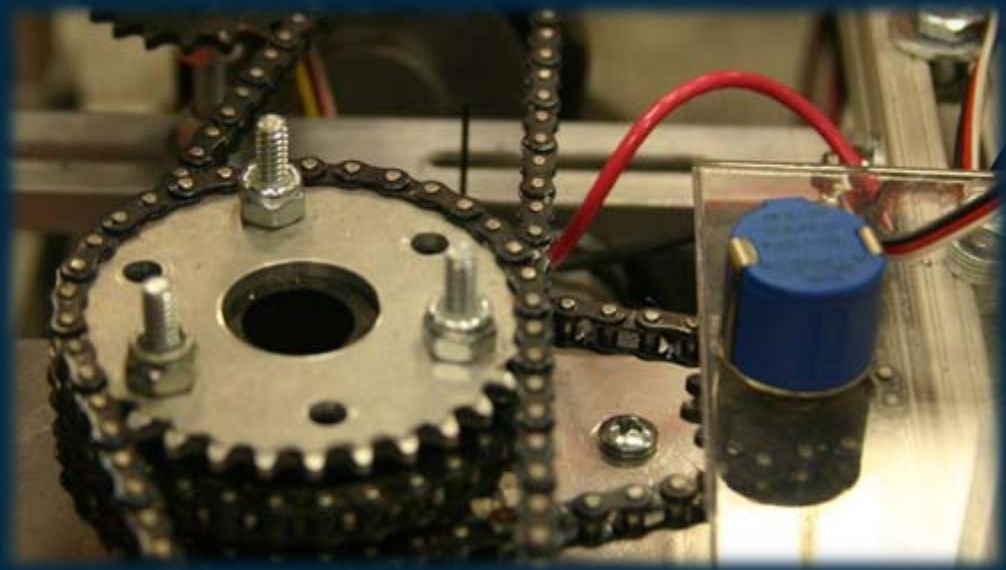
- Wide orientation chassis for the Fall
- Long orientation chassis for 2010 season

Changes from Fall to 2010 Season

- Moved Potentiometers from the top of the pod to a small sprocket on the chain

Fall

2010 Season

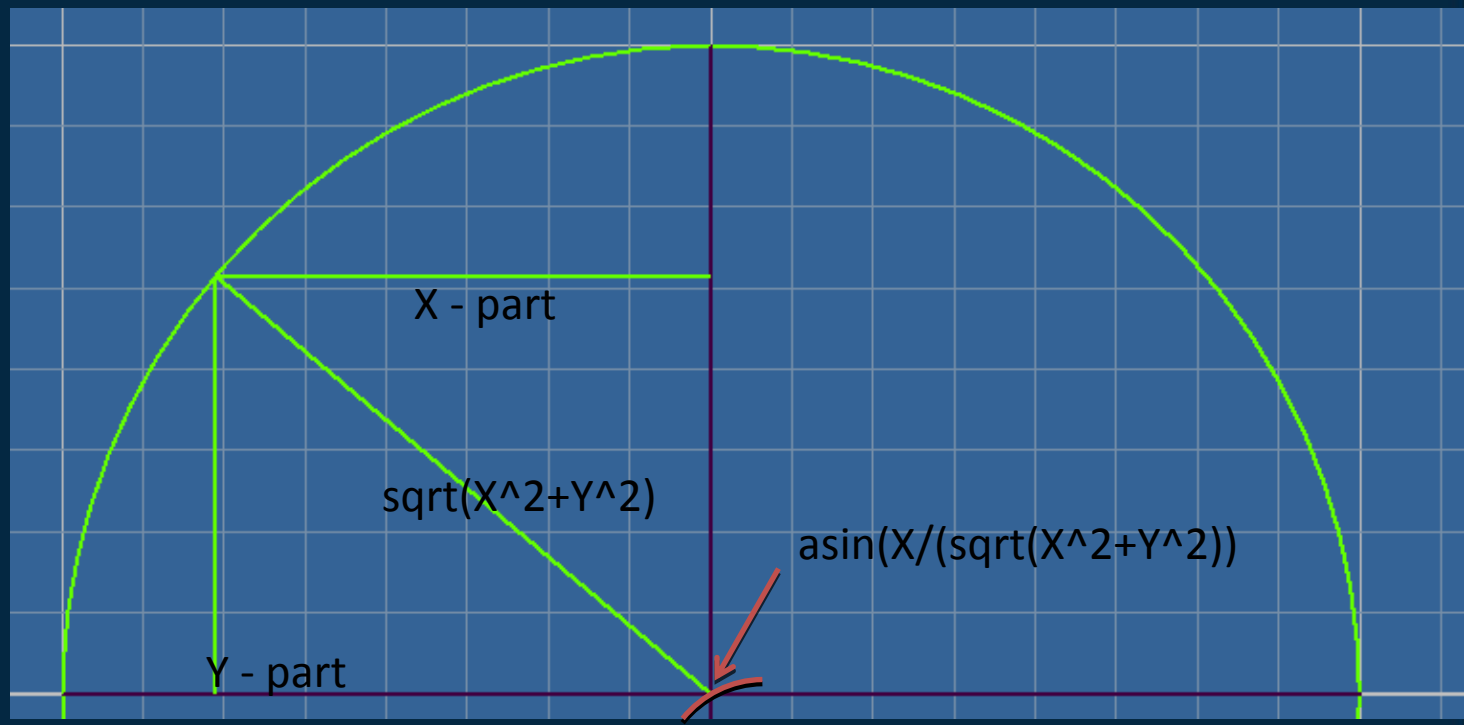


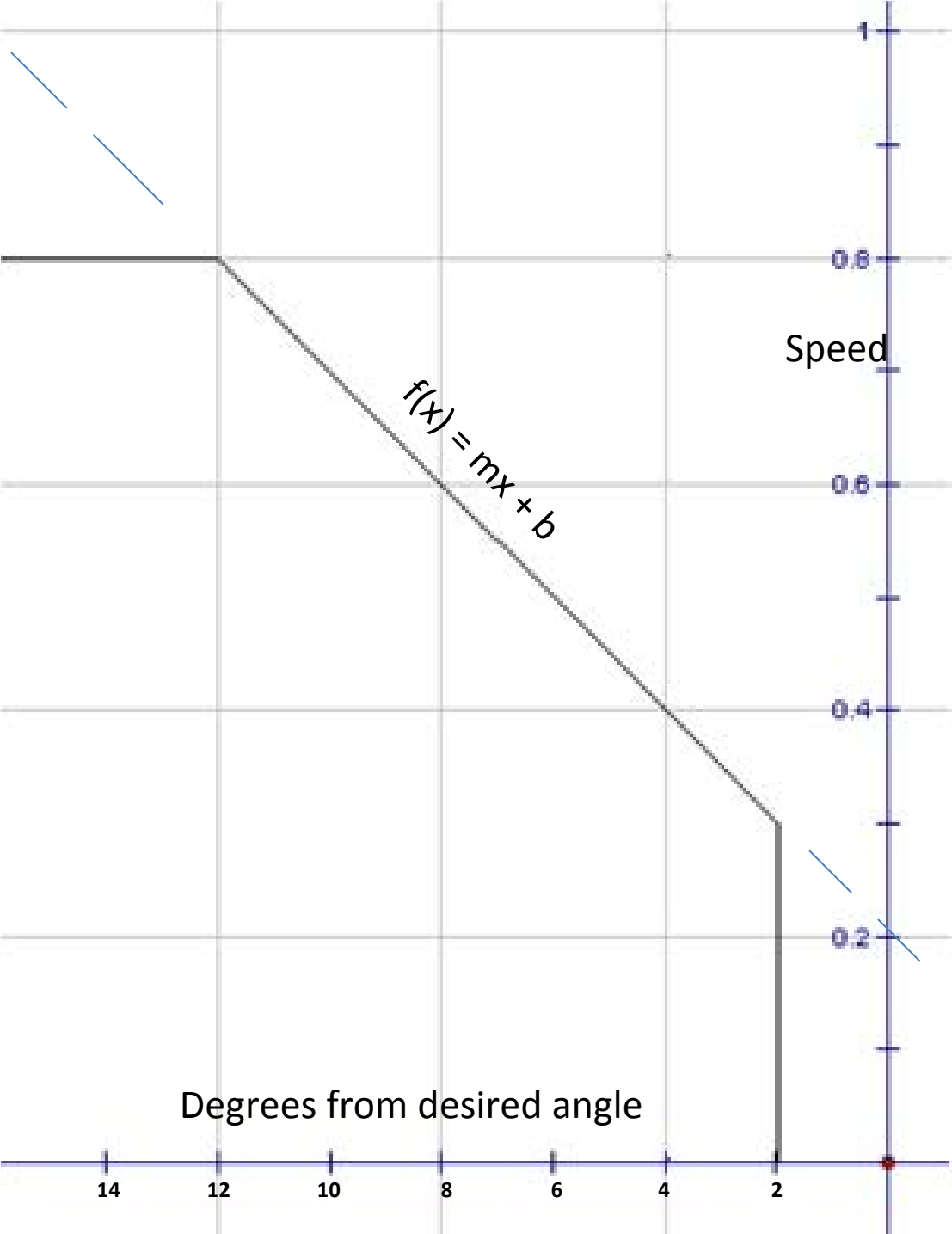
Controlling the Crab drive

- Gamepad
- Right Stick - One-Stick Tank-Drive
  - Forward and Reverse
  - Push left – turn left
  - Push right – turn
- Left-Stick - Crab-Drive
  - Push Left – pods rotate left
  - Push Right – pods rotate right
- Buttons - Car-Drive
  - Tops: front wheels
  - Bottoms: back wheels

Controlling the Crab drive

- The gamepad sticks
  - Using trig to calculate angles

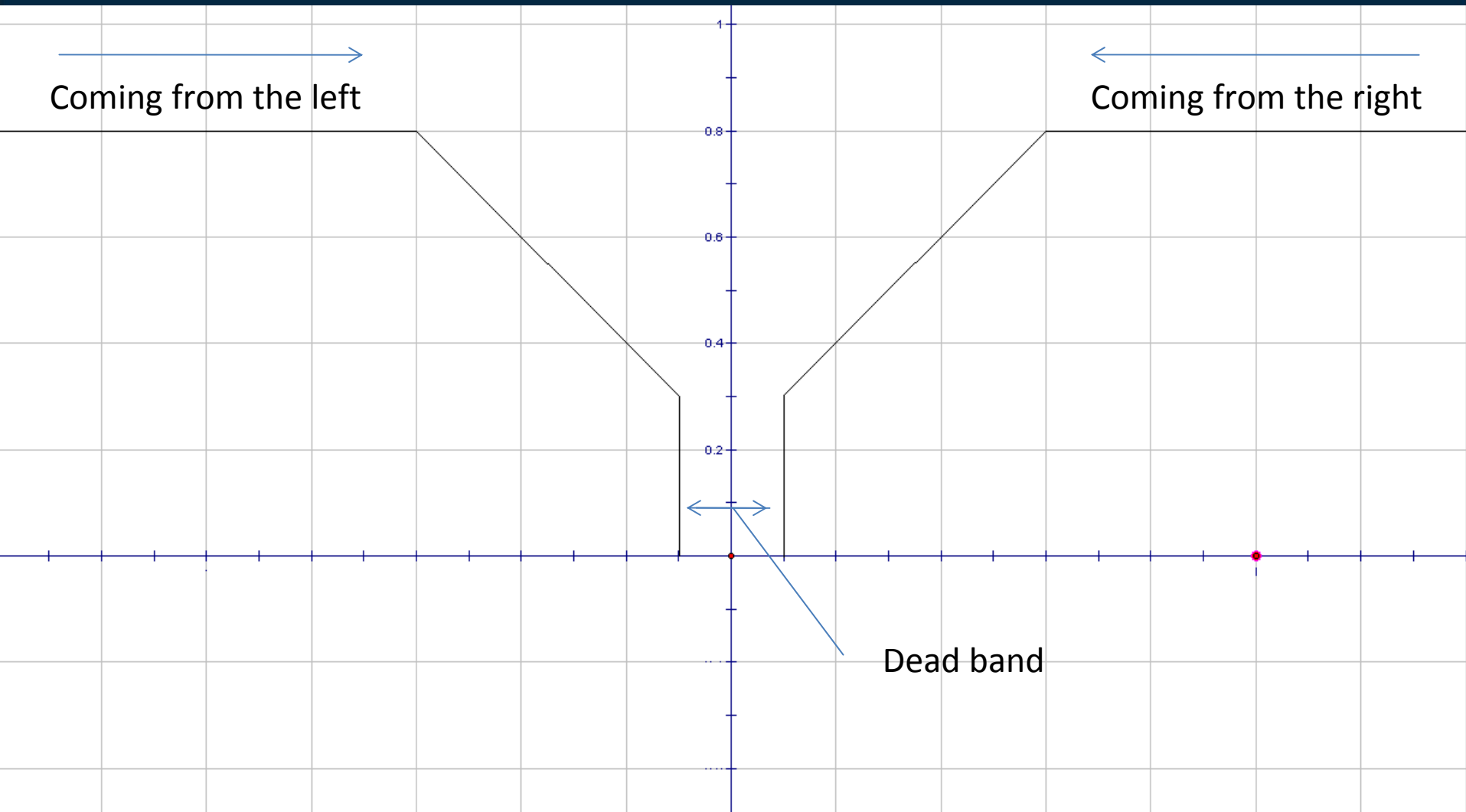




Swerve Wheels

- Adjustable speed to prevent over shooting
- mx + b form and limits achieves this or some other mathematical equations.

Controlling the Crab drive



Lessons
Important Considerations

Important Things to Keep in Mind

- Need a way to align the Modules
  - Very important when there are any changes in the system
    - We used a hard foam board with wheel cut-outs
- Watch for friction in the system
- Motors can overheat
  - A wide variety a problems can arise when dealing with a crab drive
- Build In “Safety Features” as you develop your system
  - “Mechanical Stop” to prevent over-rotation

Next Steps – Fall 2010

- Evaluate These Options
  - Weight Reduction
  - Access Points to wheel assembly nuts and bolts
  - Direct mount for pods
  - Individual Motor on each module rotation (eliminate chains with gearing)

Swerve Implementation Tips - Fall

- It’s never too early to start
- Talk to other teams as much as possible
- Purchasing IS an option, but it doesn’t have to be THE ONLY option
- Get the student driving something ASAP
- Never settle for “good enough”

Swerve Implementation Tips - Season

- Does the swerve meet your requirements?
- Did you learn enough in the Fall to make it work?
- Plan your time wisely
- CAD is a HUGE help
- Precision is key

Questions/Comments?

Contact information:

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