FTC Robot Build

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Who am I

- Mechanical Engineer
- Coached FLL for 8 seasons
- Coached FTC for 3 seasons
- Build Mentor for FRC for ~4 seasons

What are we going to cover?

- Getting ready for the season
- Developing design concepts
- Organizing the build
- Schedule
- Developing the robot

FLL Core Values are a great foundation

- We are a team.
- **We do the work** to find solutions with guidance from our coaches and mentors.
- **We know our coaches and mentors don't have all the answers**; we learn together.
- We honor the spirit of friendly competition.
- What we discover is more important than what we win.
- We share our experiences with others.
- We display Gracious Professionalism® and Coopertition® in everything we do.
- We have FUN!

From https://www.firstinspires.org/robotics/fll/core-values

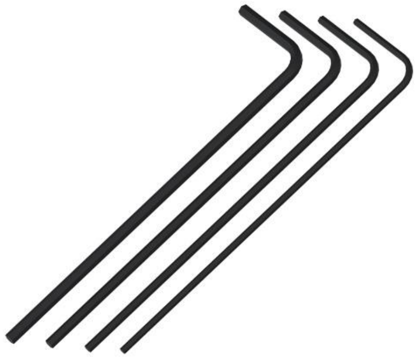
Budget

- Know your budget, and push for it to be as large as possible
- Funds are needed for:
  - Getting organized (bins, trays, etc)
  - Basic build materials (standard robot parts)
  - Extra build materials (polycarbonate, latex tubing, etc)
  - Spare parts (things break and you want backups)
  - Tools
- Look for grants and don’t be shy to ask companies to sponsor your team

Tools – Hex Drivers

- A must are hex drivers (7/64”, 3/32”, 5/64”, 1/16”)
- Also useful are ball head drivers
- And a 7/64” T-Drive

T-Drive



Standard Allen Wrenches

Hex Driver

Hex Driver with Ball Head

Hobby stores, Amazon, and tools stores all sell these

Other Tools

- Battery powered drill
- Jigsaw with metal blades
- Vice or clamps to hold down material
- Needle Nose pliers
- Anderson Power Pole Crimper (or visit an FRC team to borrow theirs for a few minutes)
- Anderson Power Pole Insertion Tool

Anderson Powerpole crimper

Anderson Powerpole connector tool

From powerwerx.com

Storage

- Various storage containers are useful in keeping things organized
  - Toolbox for tools
  - Trays with lids for fasteners
  - Bins for other parts

Approaching the Robot Build

- The next section covers how to approach the challenge
- Don’t start building until the team has a plan
- Avoid dictating design, rather help the kids realize different concepts
- Do not let the mentors start building the robot => **“Mentor Bot” is NEVER successful since data wasn’t used to drive the design**

Define Functions and Ideate Solutions

- Look at the game elements and identify function
- Use a system to capture and rate functions using something like Morph and Pew matrices
  - The basic concept is to identify several ideas for each function
  - Then use a system to rate the ideas
- Depending on time and resources, prototype the top ideas
  - Let the data make the decision

Prototyping

- Prototyping is a really good way to identify issues and develop a design
- Assign kids to each idea that have a stake in making it work
  - Encourage some friendly competition
- The prototypes should be really simple
  - Utilize cardboard, tape, zip ties, and some basic parts
  - The implementation doesn’t have to be pretty
- Use an objective method to evaluate design
  - Not just how far or how fast, but more importantly is **how consistent**
- The data is a great teaching exercise and good Engineering Notebook material
- The decision from data is not subjective and less likely to have hurt feelings

Set Goals

- The kids probably want to do every aspect of the game with no concessions
- The steps covered on the previous slides should give a pretty good idea for the key parts of the robot
- Prioritize the functions
- Limit the work to the highest priority functions
- Set a deadline for the build, and push hard to meet this deadline
  - Recommend build stops 4 weeks before competition
  - Leaves time for development and practice

Timeline of Build Season

- From kick-off to first competition is typically 9 to 12 weeks
- Week 1 is game analysis
- Week 2 is prototyping
- Weeks 3 to 6-8 are build
- Following 2 weeks for development – test and tune
- Final 2 weeks is practice
  - Drivers need time to practice
  - Programmers need time to check software and finish autonomous

It is far better to have a robot that does a few things well than a robot that does everything poorly

Organizing the Team for the Build

- The key is parallel work streams (team effort)
- Typical areas
  - Chassis
  - Game Spec 1
  - Game Spec 2
  - Programming
  - CAD
- I’ve found 2 or three kids on a work stream with a mentor is ideal
- Each work stream should understand the goal set from the game analysis

The Build – Types of Parts and Sources

- Tetrix Parts
- Raw materials
  - McMaster-Carr for raw stock, fasteners, and all kinds of hardware
  - AndyMark
  - ServoCity for servos
  - Powerwerx for electrical items (connectors and wire)
  - Amazon for standard types of things
  - 8020.net for sliders
  - Grainger another hardware source
  - VexRobotics or Banebots for transmissions (connect to AndyMark motors)

Transmission of Power

- The most common ways of connecting motors are:
  - Tetrix gears (40, 80, and 120 tooth)
  - Chain (1/4” which is known as T25)
  - Direct drive
- Keep in mind the FTC motors generally have a transmission on the front, and there are different gear ratios
- Sometimes servos are a better answer
  - There are various sizes and types of servos

Electrical

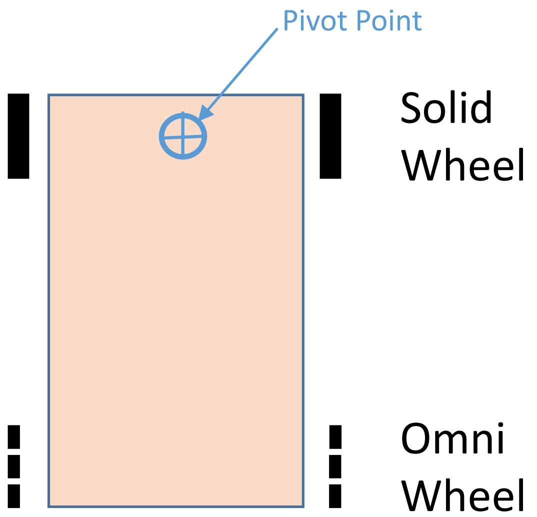
- For the most part, just use Anderson connectors for all 12 volt connections
  - For new teams, means cutting off the molex connectors off the batteries and chargers to replace with Anderson connectors
- Servos just plug into the modules
  - May need extension wires, which are available from lots of sources (like Amazon)
- Use lots of zip ties to keep things tidy

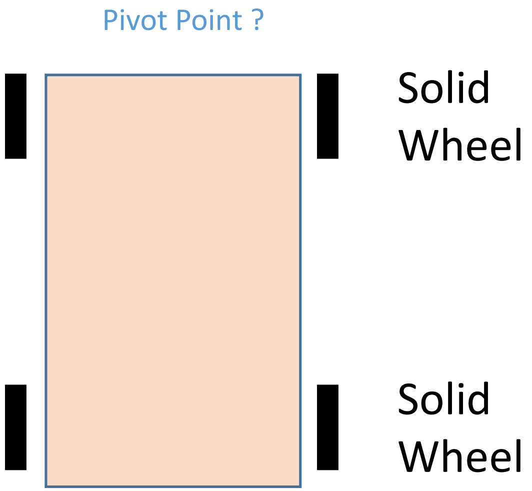
The Build - Chassis

- Consider the constraints of the game when looking at the chassis design
  - Is there a size constraint on the field that would limit the robot size
  - Does the robot need to drive up a ramp or other object where traction is different than the standard polyurethane floor tiles
    - Omni wheels aren’t usually very good for traction on hard surfaces
  - Is weight an issue?
    - Some years the robot needs to lift itself, in which case, look to minimize weight
    - Other years, the game encourages pushing, in which case, look to maximize weight
  - Consistency of autonomous driving
    - Great prototyping experiment of different designs

The Build – Chassis – Instant Center

- Consider how the design affects the center of rotation during a turn





- A good design has a defined turn center

Game Spec

- It may be best to build the game spec elements separate from the chassis
  - Allows more work streams
  - Doesn’t tie up chassis for testing
  - Can often just power motors by plugging directly into battery (no control, other than on and off)
- May need a base to mimic chassis to hold things at right height
- Understand how various game spec elements will fit together and on the chassis, along with the associated motors

Layout

- Carefully consider where to place the battery and phone
- They need to be accessible, yet not fall out
- Use the location of the battery to balance the weight
- Locate the phone where the FTA’s can easily see the screen

Support Programming

- Build some thing like a basic chassis for the programmers to use while the main robot is being built
- This could even be done ahead of the season for training

Development

- Also can be thought of test and tune
- Do some runs, collect data, and compare back to the performance goals. Think of a way to test it which is measurable, and repeatable. Track this as you make changes.
- Focus on consistency – if the robot works 10 out of 10 times at your build field, it might only work 5 out of 10 times at the competition
- When something isn't consistent, analyze why, and look for small changes to improve consistency. But don't redesign the robot.
- This will involve hardware (robot design) and software. Remember both can contribute to consistency.

Practice

- Driver practice is as important to the robot performance as the design
- Include not just the driving, but setting up and running autonomous
- Consider how many drivers you want
  - 1 pair is like most FRC teams
  - 2 pairs offers some backup and chance for different approaches
  - More is difficult for each pair to get in enough practice

Summary

- As you go, reflect on success, challenges, and things learned
- If you get to a point where you can’t find things, pause and get organized
- Remember the Core Values
- Enjoy the journey