



Illuminations

SPECTRUM 3847



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1. Introduction

Illuminations is designed to help make the learning curve in the FIRST Robotics Competition (FRC) more gradual. The information contained in this document should put you on the path to designing and building a successful FRC robot, but that is not the only thing involved in this competition. Successful teams often share certain characteristics, and we hope to shine a light on a few of those qualities.

2. Developing your Brand

FRC teams are very similar to small corporations. When working with people that do not know who you are or what you do, one of the most critical aspects is building your brand. Your team number is given to you so you have to work with that, but everything else about your team is your choice.

Deciding a team name and brand is one of the first things your team gets to decide together and can be a very fun experience. Have everyone brainstorm names/themes and then come together to decide on a final choice.

Your name, colors, logo, uniform, cheers, and anything else can be unique to your team. You can choose to relate to your school or sponsor, but it is not required; there are many tiger, hawk, etc. based teams, so picking something different, unique, and memorable is often a good idea. Also, cyber, robot, bot, tech, and many others have been used by many teams and will not make yours stand out at competitions. This does not mean that you cannot use them; just that it should not be the defining thing that makes your brand special. Think about why your team is unique and emphasize those aspects.

List of Current Team Names

Here is a list of all registered teams from last year.

<http://tinyurl.com/frc-teamlist>

Do a quick search through this list to ensure you are not choosing a name that already exists. Your team will want to avoid having the same name as another team. It will reduce confusion.

Naming ideas

School Mascot Based: FRC#2936 Gatorzillas (The Gators)

Number based Names: FRC#1024: Kill-a-bytes, FRC#2468 Team Appreciate

Combined Schools: FRC#111 Wildstang (Wildcats and Mustangs)

Sponsor Based: FRC#118 Robonauts (NASA), FRC#191 X-cats (Xerox)

Seemingly Random: FRC#254 The Cheesy Poofs, FRC#1902 Exploding Bacon, FRC#3847 Spectrum

"Brands, at their best, are, among other things, bundles of meanings, some of them robust, some of them delicate, all of them poised to speak to one or more segments and to deliver an understanding of not just what the product does but what it means – its cultural meaning." - Grant McCracken

3. Communication

The most important part of any successful team is communication. FRC is a huge project that involves a large group of people. If everyone is not on the same page, it will be difficult to achieve success.

Google Group Email List

We have found the use of a Google Group to be one of the best ways to keep everyone up to date and to keep the build season progressing. Get all team members, parents and any other stakeholder on to the list, and then it is easy to send information to everyone that needs it.

Nightly Build Log

We also started producing a nightly blog entry (3847.blogspot.com) about our team for the general public as well. You do not need to do this in a public manner, but we find it helps to do something internally for your team such as a nightly email that includes the next day's to do list.

Facebook Group

We have a Facebook group where the team members are able to speak to each other more readily. It is also where we upload all of our photos and videos during the build season.

Team Calendar

A team calendar can be extremely useful for keeping the team aware of when meetings and other events are taking place. Google Calendar works well for this.

Document Sharing

Another important system is to be able to transfer files back and forth amongst team members. We use Google Docs for all our documents, spreadsheets, and presentations. This allows multiple team members to edit the documents at one time and ensures everyone has the most current versions. We also have a team Dropbox account that allows us to share other files and publish things to the web easily.

Code Repository

Our programming team is using GitHub.com to collaborate on software development. Not only is it easy to use, but also allows you to version your code which guarantees backups.

"Communication leads to community, that is, to understanding, intimacy, and mutual valuing." - Rollo May

4. Build Season Tips

Inventory the Kit of Parts

You should take inventory of the kit of parts as soon as possible, labeling each part with **your team number and the year in permanent marker**. Though you only have one of everything this year, as you continue on in the competition in the future, you will begin to collect duplicates of things, and it is nice to know which year they came from. Go over what each part is called and its function with the entire team.

Store Important Documents and “Bag and Tag” items

Take all the information packets, vouchers and documentation out of the kit of parts and store it in a safe place. **This also includes the robot bag and tags**. All of this information is very important and should not be damaged or misplaced during the build season. We normally take it out of our workshop entirely, but if you have a secure cabinet or another location away from the rest of the kit of parts, storing it there is okay as well.

Take care of your electronics

Your driver station laptop, RoboRIO, and speed controllers are some of the most expensive parts of your robot and you do not get new ones each year (you may get some speed controllers but never enough). Make sure you keep them clean and working. Cover them when they are not being used (Avoid getting metal shavings in them, this can cause them to fail). Clean them with compressed air regularly and make sure to store them somewhere where they cannot be lost or stolen.

Team Updates:

Make sure to watch the FIRST website for team updates. They are posted every Tuesday and Friday during build season. Note that updates to the manual could affect the legality of your robot design; it is better to know early than to find out during inspection at the competition.

Design Fundamentals

Simple

Design for your robot to be as simple as possible. This does not mean to choose to just put a moving box onto the field. It means that you should try to remove anything from your design that is not necessary. A simpler system, with less moving parts or less code, that is able to accomplish the same thing will often be more reliable and save you time. Your design should also be quick to build, with as few specialty parts as possible which will allow you to assemble your robot quickly and repair it in a hurry if something breaks at competition.

Prototype

Prototype as much of your design as possible. It is near impossible to decide if something is truly going to work without testing it. The prototypes do not need to be perfect, a plywood mechanism powered by a hand drill will let you test the concepts.

Reliable and Robust

It is better to have a mechanism that works 100% of the time but does less than a mechanism that does more but only works 75% of the time. At some point that other 25% is going to be an elimination match.

Repairable

Design your robot so that when it breaks you can quickly fix it. It will be much easier if you can swap out motors, or parts with the turn of a few screws instead of cutting welds and welding a part back on. For

the parts of your robot that are complicated, make spares during build season and bag them with your robot, that way you can just replace them if they break.

Standardized Parts

If you can use the same part in multiple places, it will make having spare parts easier. Furthermore, you will be able to improve on one part of the robot that will make the rest of the robot better as well. During construction, make sure that all bolts used are of the same size. Reducing choices is actually a good thing.

Iterate

If your design is not working as well as you want do not fret, just make it better. If your robot is working exactly like you planned do not get complacent, just make it better. Basically, you must remember there is always room for improvement.

Your Drivetrain is Fundamental

Your drive train (part that makes the robot drive around i.e. motors & wheels) is the single most important part of your robot. The kit of parts normally comes with a very reliable drive train that teams can have constructed in a matter of hours. Unless you have a very good reason, we highly recommend that you use the kit of parts drivetrain. Teams will have spare parts if something breaks at events, problems will be detected quickly, and solutions can be given without a tremendous amount of troubleshooting. If you want to upgrade from the kit chassis, COTS options from VEXpro or Andymark allow for robust options that your team can experiment with. Elements of the drive train should not be sacrificed for other portions of the robot unless a great deal of thought has gone into it.

Track Purchases for your Bill of Materials (BoM)

Keep track of all your purchases that you make for the robot. Part of the inspection process is turning in a Bill of Materials (BOM). It is much easier to create this at the end of the season if you have a list of everything that you purchased.

Inspection Checklist

Later during the season, FIRST will release the inspection checklist for the year. However, right now you should review 2016 inspection checklist, so you know what inspectors are looking for (Note: this will change with the updated rules for 2017).

<http://tinyurl.com/frc-inspectionchecklist>

Common reasons teams fail inspection

Fix these issues before you bag your robot for a less stressful competition experience.

Size and Weight

This is the first thing inspector's check. Design your robot to be at least an inch smaller than the maximum dimensions. Also buy a scale or borrow one from somewhere. Weight your parts as you add them on to the robot so you can estimate how much weight you have left. Shaving off a pound at competition is doable but not fun; five pounds is near impossible without removing systems.

Sharp Edges or Protrusions that pose a hazard for participants, robots or field

Please make sure you can run your hand along every part of your robot without being cut. Every part that goes on the robot should be filed or sanded to ensure everyone's safety. This is for the protection of your team and the field crew at events that may have to interact with your robot.

Bumpers

The bumper rules are very specific and often confusing. If you have a question about how the bumpers must be constructed, please ask a veteran team for help.

Team Name

Prominently and proudly, display the team's school name and primary sponsor(s) name/logo. The contributions of your supporters are not something to forget, so a team should try to recognize them frequently. An easy way to recognize your school and sponsors is by making them stickers that you put on the robot. It is simple thing to do with a printer and sticker paper. However, it is much harder to do at competition where access to a printer is not always easy, so also bring a printer to competition.

Electrical and Pneumatic Systems

This is a very common area for mistakes. Make sure the team wiring your robot has read the manual. The rules for wire gauges, wire color and circuit breakers are very specific and it is time consuming to fix mistakes at competition. The pneumatics section is also very specific in what is allowed and what is not allowed. Ask a veteran team during build season for help if you have any doubts about the electrical or pneumatic systems; these rules are in place to keep everyone safe.

Practice, Practice, Practice

The sooner you can get a moving chassis in the hands of your drivers and programmers so they can begin practicing the better you are. You do better in FRC, like all sports, the more you practice. Make sure you are deliberately trying to improve. Time yourself, develop metrics for how well you are doing. Work to get better. If at all possible have a nearly working robot with a week or two left during build season so you can practice with it, find flaws and correct them before the competition. There is always a way to improve your robot.

Consider what you want to keep out of the bag

In most years you are allowed to bring some amount of fabricated parts with you to competition along with any Commercial Off The Shelf (COTS) parts (Read the Robot Rules for specifics). This means you can keep building small portions of your robot or hold back parts for testing that do not have to go into the bag. Figure out what's your priority and what will fit under the weight limit and keep that out of the bag to keep working on. This often includes your RoboRIO so you can keep testing the program. Everything else should go in the bag(s), including your bumpers.

*"Hard work is the price we must pay for success. I think you can accomplish anything if you're willing to pay the price."
- Vince Lombardi*

5. Post-Bag Pre-Regional

Your robot's in its bag. Is it time to rest? Maybe for a day but there is still a lot to do. If your regional is week one or two, you should be doing much of this during build season.

Plan your Pit

Your pit is your home away from home while at competition. Everything you bring has to fit into a 10 foot cube (smaller at some competitions). Look at Appendix A for Spectrum's Pit Construction Guide.

Image and Spirit

T-shirts, buttons, banners, handouts, and flags are all things to consider for your team's spirit and image.

Have team members be working on these things during this time, be really creative.

Pack Up

Figure out everything you will be taking with you. During your pit design you should cover most of this, but spare material and parts are critical to a successful regional. You can bring all the spare COTS items you want like raw material, motors, and electronics. Do not worry if you do not have everything, there will be plenty of teams able to loan you some items if needed but it is faster and easier if you have the stuff you know you might need.

Things to remember

Some type of cart for your robot, power strips, tools, batteries and chargers, Driver Station laptop, and controllers.

Watch the other competitions

Would you expect someone to play football well without ever seeing a game? The same applies to robotics competitions. If you are not in a week 1 regional, watch the webcasts of the weeks before your event. This give you a good idea of how the game is going to be played, and you maybe be able to see strategies or ideas that your team can use to succeed at your event. Webcast links will be posted on Chiefdelphi.com before the events.

"Expect the best. Prepare for the worst. Capitalize on what comes." - Zig Ziglar

6. How to Get Picked for Eliminations

“Be the team you would want to pick” – Dr. Joe Johnson

This is a very simple idea but one that is often overlooked. Teams pick alliance partners on more than just robot performance. Be friendly to all teams and work well with your alliances during qualifications: be a model of Gracious Professionalism. Be on time to every match and ready to perform the strategy that has been decided upon by your alliance. Help out other teams, loan tools or parts and be nice.

Drive in Every Match

Veteran teams know that any driving robot is better than the best robot sitting still. If you have a drivetrain that works consistently through every single match of qualifications, your chance of being picked is far greater than teams that have a less reliable robot. Even if your scoring mechanism or something else is broken, put your robot on the field and play defense – showing you can do that is also a way to get picked. This means you should focus on your drive train during build season. It is the most important part of any robot. Keep it simple and reliable.

Under Promise, Over Deliver

Actions speak louder than words. If you say you can score during hybrid mode or perform the endgame, make sure you mean it. Teams that oversell themselves leave bad impressions when they do not meet expectations. Know your limitations and state them plainly; it is better to have a real strategy that can be executed than an idealized strategy that has no chance of working.

Have a responsible and knowledgeable drive team

Your drive team is the face of your entire team. They are the ones that interact with the other teams and often set the perception for the rest of the team. Make sure these team members are able to be responsible, so that they are on time for every match and are able to communicate clearly with the team members and mentors from other teams. They should also be extremely knowledgeable about the robot and game. Often it is the drive team that has to make last minute repairs to the robot, if they do not know how it works and how to fix it you could lose valuable time and matches. They also have to be aware of strategy and the game rules to avoid penalties and play smart.

Develop your Brand

Rookie team numbers get jumbled in the heads of everyone at competition. “Was it 4876 that did well or was it 4768?” You want to make yourself stand out from all the other teams, this means doing the little things like making T-shirts, flags, banners, and making your pit reflect your brand. Make sure that teams not only know your name but your number because that is how the rankings are listed at competition.

“Competition has been shown to be useful up to a certain point and no further, but cooperation, which is the thing we must strive for today, begins where competition leaves off.” - Franklin D. Roosevelt

7. Texas Specific FRC Information

Community

- **Texas FIRST** - <http://groups.google.com/group/texas-first>
The Texas FIRST Google group is an email list that allows for easy communication between Texas FRC teams. Please join the group and post any questions that you have. It's a great way to get help and receive guidance from other teams within the state.
- **Texas Mentor Talk** (www.spectrum3847.org/TexasMentorTalk)
We are starting on a conference call program among mentor across the state of Texas, with goal of having a convenient place for local teams to ask and answer questions and discuss issues from around our state.

Pre-Bag Scrimmages

Find out if your area has a Pre-Bag Scrimmage. These events normally take place the last weekend of build season, and they allow teams from around the area to test their robots against each other. Even if (especially if) your robot is not complete, come to a pre-bag scrimmage. Houston has had one for many years and so has the Dallas area. This year we will be hosting a week 0 scrimmage before the build season ends. It is a great time to ask a veteran team to inspect your robot for flaws or get help improving it.

Off-Season Events

Off-season events are FRC competitions that are hosted after the Championship event before the new season begins. The events are much more relaxed with few judged awards and fewer teams. They are often hosted in school gyms and may only be a single day. They provide an inexpensive opportunity to continue to compete with your team's robot and also a great chance to introduce more students to competition. These are the events that many Texas Teams attended last year but they change from year to year so look for updates on Chiefdelphi.com and in your inbox.

- **Texas Robot Round Up**
Every July, Texas Robot Round Up has become the de facto state championship as teams from every regional in the state make the trip to our capital city, Austin, TX.
- **The Remix**
A new event for 2012, the Lone Star Regional committee along with FRC#1477 held an off-season event in the Woodlands, TX in late October. It was an invitation only event but may expand in the future.
- **Texas Robot Invitational (TRI)**
An event hosted at Strake Jesuit by Spectrum 3847. Allen Gregory IV along with the Lone State Regional committee runs this event during the summer at Houston, TX in late June.
- **Ozark Mountain Brawl**
Not actually a Texas off-season event, OMB was held in Springdale, Arkansas in June of 2012. Many Texas teams made the journey up to visit our northern neighbors.

Texas Regional Directors

If you have questions and do not who to ask, your regional director(s) are great sources for information.

FRC in Texas - Southern

<i>Regional Director</i> <i>Lucia Sevcik</i> <i>lsevcik810@aol.com</i>
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FRC in Texas - Central

<i>Regional Director</i> <i>Patrick Felty</i> <i>pfelty@usfirst.org</i>	<i>Assistant Regional Director</i> <i>Jessica Jankowitsch</i> <i>jessjank@gmail.com</i>
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FRC in Texas - Northern

<i>Regional Director</i> <i>John Shellene</i> <i>jshellene@sherpamanagement.com</i>	<i>Senior Mentor</i> <i>Joe Varnell</i> <i>jvarnell@usfirst.org</i>
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FRC in Texas – Northwest

<i>Regional Director</i> <i>Christopher Caddel</i> <i>ccaddel@usfirst.org</i>

8. Other Advice

- **ASK FOR HELP!**

FRC is a large community of kind people who are willing to help. Part of the challenge is learning from your mistakes and tackling this huge project, but a more important part is sustaining your team for years to come. Please ask for help early and often. From using tools to talking about designs teams are willing to help teach you. Even if it is not robot related, teams will step up when asked. The stories you will hear after being in the program a few years will amaze you from picking up stranded team members at airports, hosting entire out of city teams for events, or building entire robots on practice day; the FRC community always finds a way to step up.

- **Build your team and your robot**

Your team will see more of each other than possibly their own families, so it is critical that the team is able to get along with each other. Furthermore, they should eventually love each other. Take time during the off-season to have fun as a team. Your team could go paintballing, bowling, play board games, or do any activity that you all can enjoy together.

- **Make people feel wanted**

People like to go where they feel wanted, respected, and celebrated. Say hello and goodbye to people by name. Update them on what is going on, and ask for their opinions, advice, and suggestions.

- **Have Snacks**

People will stay at build meetings longer if there are snacks.

- **Get the word out and show off your robot**

Invite your administrators, parents, school board, teachers, students and anyone else you can think of to come see your robot. Be proud of what you build no matter how it turns out. Remember that just trying to build a robot is more than 99% of people have ever done. We promise they will be impressed.

- **Create a Chairman's Award Entry**

Rookie teams cannot win the Chairman's Award but the entry is not about the award it is about documenting your team's accomplishments for the year. The essay, executive summary, and photos are just a vehicle. Also having one your rookie season makes your next year's entry much easier.

- **Take Lots of Pictures and Video**

They come in very handy for all sorts of reasons, but the biggest thing is it allows your team to remember their history and accomplishments. Photos going through build season will allow your team to remember just how far they have come. Also remember to take a team picture at every competition (We forget this far too often.)

- **Label everything**

Most teams all have similar items so when you are at events it is easy to misplace things or loan them out. If your stuff is not labeled, it is probably not getting back to you. Team number is more important than name or school. (A solid color choice helps as well, we use a lot of purple tape).

"I think a lot of our team commitment is a silent understanding that each one of us has poured our life into what we're doing." - Claire Carver-Dias

9. Resources Guide

Spectrum Recommended Reading: www.Spectrum3847.org/RecommendedReading

A constantly updated database of useful technical and nontechnical books, guides, and presentations.

Official FRC Links

- **FRC Manual** <http://tinyurl.com/frc-resource>
Have the official FRC manual. Please read the administrative sections. They will answer many of your questions. What awards are given and how can I win them? Who do I contact at FIRST?
- **FRC Resources:** <http://www.firstinspires.org/resource-library>
This is like drinking from the fire hose, it is the main resources page provided by FRC. It has everything you need to know, but it can be difficult to navigate. Spend some time looking through it, and you will learn about the robots and how to run a successful team.
- **RC Blog:** <http://www.firstinspires.org/robotics/frc/blog/>
News direct from the Director of FRC at FIRST. It is updated at least once a week.
- **FRC Season Calendar:** <http://www.firstinspires.org/robotics/frc/calendar>
Allows you to keep track of important dates.
- **FRC Kit of Parts:** <http://www.firstinspires.org/robotics/frc/kit-of-parts>
The Kit of Parts website has the setup guides for all of your controls system items. It also has manuals and data sheets for many of the items in the kit of parts. If you do not know what an item is in the kit of parts or how to use it please let us know. We will be happy to point you in the right direction. (Note: there will be a new link for the 2013 Kit of Parts.)

Rookie Programs developed by other FRC Teams

- **RINOS by Team 20:** <http://www.raiderrobotix.org/rookie-resources/>
A nice set of manuals for developing a team.
- **“Team in a Box” by Team 341:** <http://www.team341.com/community/team-in-a-box/>
A DVD that provides a lot of information for rookie teams.
- **MOEmentum by Team 365:** <http://moe365.org/moementum/moementum.php>
This is a very useful guide for first year teams created by team 365. It walks you through a typical FRC season build schedule.
- **Textbook For Success by Team 1114:** <http://www.simbotics.org/resources/workshops>
A compilation of tutorials, videos, and guides to help get rookie teams on their feet.
- **Rookie Organization by Team 1511:** <http://penfieldrobotics.com/resources/rookies.php>
Sample forms and planning advice for rookie FRC teams.
- **Ignition by Team 1912:** <http://team1912.com/ignition.html>
How-to guides for how to run a team and technical skills.

Useful Links

- **Chiefdelphi:** www.chiefdelphi.com
This should be your most visited website during build season. This is the water cooler of FRC, where all problems are solved, and ideas are hatched. The mentors who spend their time answering questions on CD have been around FRC for many years, many of them have literally written the book on the subject.
- **The Blue Alliance:** www.thebluealliance.com
This is the archive for FRC; it hosts team records from previous years as well as an extensive collection of archived match videos. It is a great place to get design ideas from previous years and also scouting information for other teams.
- **NEMO:** <http://www.firstnemo.org/>
This is a great resource for everything that goes into a FRC Team that is not technical robot knowledge. They work to improve the organizations, not just robots. If you are lucky enough to have non-engineering mentors on your team, send this link to them. It will get them started with ways they can make the most contributions to the team.
- **Team 358's Website:** <http://www.team358.org/files/>
Literally everything you ever wanted to know about FRC. The amount of links and information on their website is staggering. If you cannot find it anywhere else, it is a good bet that 358 has it. From statistics about the program to very detailed technical pages, they have it all.
- **FRC Links:** www.frclinks.com
A simple website that helps you navigate the usfirst.org webpage for useful information about teams and events.
- **Screen Steps Live:** <https://wpilib.screenstepslive.com/s>
This is the official WPI programming tutorials for Java and C++. This will be updated with information about the 2015 control system on Jan 3rd.
- **Team 2168's RoboRio Beta Test Site :** <http://controls.team2168.org/>
A very useful resource for information on the new 2015 Control System. Includes solution to many potential problems.

"Enthusiasm is one of the most powerful engines of success. When you do a thing, do it with all your might. Put your whole soul into it. Stamp it with your own personality. Be active, be energetic, be enthusiastic and faithful and you will accomplish your object. Nothing great was ever achieved without enthusiasm" - R.W. Emerson

10. FAQ

What is FIRST?

The answer you should give and every one gives: **For Inspiration and Recognition of Science and Technology a nonprofit organization that strives to increase STEM education around the world.**

Trivia answer: USFIRST is the United States Foundation for Inspiration and Recognition of Science and Technology. They stopped using the US once it became a global program and is now www.firstinspires.org

What is FRC?

FRC stands for the FIRST Robotics Competition. It's the highest level robotics competition organized by the USFIRST organization. It's one of the most competitive robotics competitions available to high school students and one of the few that encourages engineers and mentors to work alongside the students.

When did FIRST start, why did it start?

FIRST was founded in 1989, and FRC was first held in 1992 in a New Hampshire High School. Maize Craze was the first game played; in this game, the robots were tethered onto a bed of corn kernels. Dean Kamen founded FIRST to inspire students to pursue STEM career opportunities. Woodie Flowers, a professor at MIT, was instrumental in bringing the competitive aspect to the competition as he had been using a similar model in one of his courses at MIT for several years.

Who are some important people in the FRC world?

Dean Kamen – FIRST Founder, famous inventor, and designer. His inventions include the segway, portable dialysis machines, and innovations in water purification.

Woodie Flowers – FIRST National Advisor and father of competition robotics. His course, MIT 2.70, was one of the first design competitions that involved competing robots.

Frank Merrick – Director of the FIRST Robotics Competition, author of most FRC blog posts, and all around loved guy by the FRC community

Game Design Committee (GDC) – The FRC GDC is responsible for designing the game for each season. It is made up of some FIRST staff members and outside advisors. This group also answers the questions posed to them in the FIRST Q&A.

Al Skierkiewicz – Chief Robot Inspector and mentor of team 111 Wildstang. Known as “Big Al”, he is very active on Chiefdelphi, and answers robot inspection and technical questions.

Andy Baker & Mark Koors – Founders of AndyMark Inc. a company that supplies many FRC components and parts for teams. You will see them FTAing (Field Technical Advising), inspecting and all around being awesome at many FRC events. Both of them were previously FRC mentors.

John V-Neun & Karthik Kanagasabapathy – Employee's of VEX Robotics and instrumental mentors

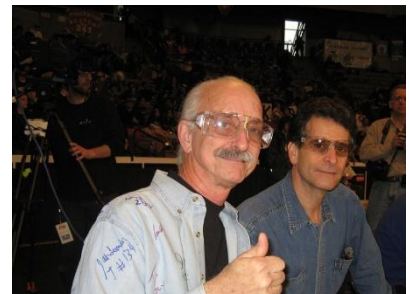


Figure SEQ Figure * ARABIC 1 Woodie Flowers & Dean Kamen Source: wikimedia.org

in the FRC community. From presentations, to resources they have both provided invaluable help to the community.

What is the FIRST Q&A site?

The Q&A (Questions and Answers) site is the only official source for answers to questions about the FIRST robotics manual. The GDC answers the questions and answers can be taken as part of the manual. You should have a team member who is responsible for reading the Q&A site and reporting to the team about important Q&As.

What are Team Updates?

Team Updates are released on a bi-weekly basis during the build season. These are official amendments to the manual. It is critical that you team members reading team updates and understanding what has changed. Often key rules will be changed for various reasons in the middle of the season.

What is Chiefdelphi?

Chiefdelphi.com (CD for short) is a public online forum that is a common discussion host for FRC topics. It is sort of like the water cooler of the FRC community. CD is an extremely valuable resource to all teams. Technical advice is given often and freely and most of your questions have probably already been asked and answered on the form so please use the search function. Reading CD is one of the best habits you can have if you want to be successful in FRC.

How long is build season?

Build season is exactly 45 days long. Starting on a Saturday at the beginning of January and ending on a Tuesday in mid-February. Build season ends on a Tuesday because you used to have to ship your robot in a crate via Fedex and it was easier for them to do pickup in the middle of the week. In recent years the robot must only be bagged by midnight on the last day. However, you don't have to completely stop building during the time the robot is in the bag. Read the rule book for how much weight of spare and replacement parts you can bring in with you unbagged to each event. Many teams will pull off certain parts of their robot to continue to work on them, an example would be to remove a ball shooter to tune it more

What motors can we use? What motors should we use?

You can use a very specific list of motors that is established in the rules. You cannot use any other type of motors, which includes motors on linear actuators or motors attached to other devices. In recent years teams have been given more motor choices than would be wise to use on any one robot. This means you need to decide which motor is best for each section. Motor specifications are given by FIRST each year and you can determine how much power each motor has in general it is better to have too much power dedicated to a system than too little. CIMs, MiniCIMS, BB550s, DD750s, and BAG motors are all high power motors and are often used by competitive teams. There are reasons to use some of the lower power motors that are allowed but in many cases it's better to use a higher powered motor.

How do we make a motor attach to _____? How do we make a motor spin slower?

Interfacing to motors is a common problem for many new FRC teams. In recent years this have become much easier. VEXpro.com and AndyMark.com both sell gearboxes, sprockets, gears, hubs and other useful items for interfacing motors to mechanisms on your robot. VEXpro's VersaPlanetary gearbox is one of the most versatile gearboxes ever developed for FRC, it is inexpensive, allows you to use a large variety of motors and has a common mounting pattern, and multiple shafts.

What are the differences in the types of speed controllers?

For most teams the biggest difference is just how much they cost and how much space they take up. Most teams just use PWM to control their motors directly and all the speed controllers are able to do that. The new Talon SRX and old Jaguar motor controllers can use CAN to control the motor and do more advanced options. The Victor, Talon, Talon SR, and Jaguar are pre-2015 controllers and are no longer in production but are still legal. The Victor SP and Talon SRX and 2015 motor controllers.

Do we build 3 robots or do we team up?

You are only responsible for building one robot. Some teams choose to build a duplicate practice robot that they never bring to competition but are able to use for driver practice. You will be put on an alliance of two robots for each match, unless the rules change.

Who can be on the team?

Anyone can be on your team. The only real rule is that only pre-college students can be the drivers or the human player and you must have an adult be responsible for checking your team in and being your main contact in TIMS. Other than that how your team operates is up to you. You can have younger students help, you can have as many mentors as you want from a field. It's all up to you and how you want your program to be run.

How much does the robot cost?

This really varies from team to team. Some teams build using only the kit of parts and few bits of hardware from a hardware store, other teams have advanced machining resources and produce many precise custom parts from raw materials. There is a budget restriction each year on what the total cost of the robot can be not counting the kit of parts but this is rarely an issue for most teams. Most teams are somewhere in the middle between the lowest and highest spenders. \$1000 to \$2500 in addition to the kit of parts is probably about average for FRC teams.

How much help can we get from other teams?

The simple answer is as much as you want and as much as they are willing to provide. There is some merit in learning on your own but there are no rules against building the same robot as another team. If the situation arises where you have a team you would like to partner with you can collaborate on the entire robot.

APPENDIX A: SPECTRUM PIT DESIGN GUIDE



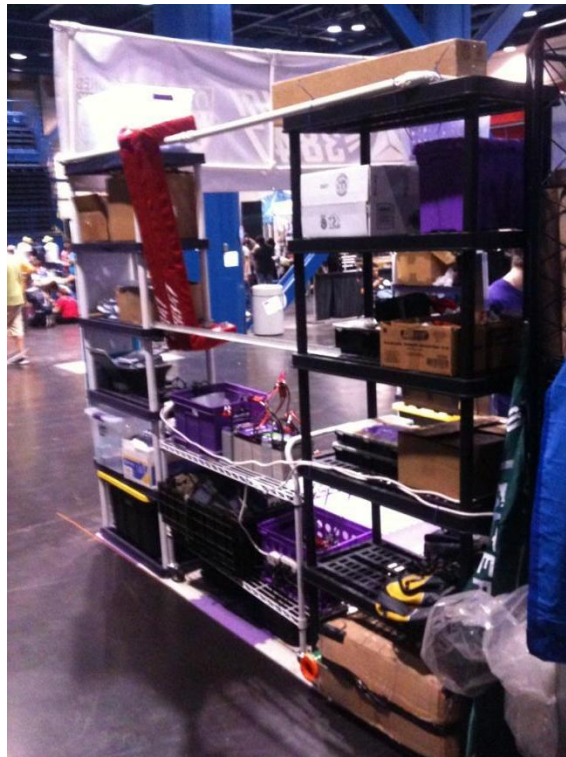
2012 Spectrum 3847 Pit (Lone Star Regional)

BENEFITS TO USING THE SPECTRUM 3847 PIT

- ▲ ***Foam Tile Floor-*** As the 'pitmaster' for this past FRC year, I can tell you that standing on the foam floor for hours at a time is much better than standing on the usual concrete floor for that period of time. The foam floor looks much better than the gray concrete and draws peoples' attention. It is easy to sweep and vacuum and provides an excellent surface to get on your hands and knees to work on the robot.
- ▲ ***Tall Shelves*** - The shelves provide a lot of space to fill with the various things that you bring to competition. Things are organized and easy to get too. The shelves also provide structure for your pit. The front two shelves are excellent for hanging signs and posters and whenever you need to put something down for a second the shelves provide plenty of surfaces to keep your floors clear. We stored our printer and laptop on one of the shelves so it provided a table surface to work on. The shelves can be purchased from many hardware stores, like Home Depot or Lowes. They should be 18" wide and 72" tall. We purchased five shelving units; one for each of the four corners and then distributed the fifth among the four shelves to make them one level higher. This made them about 7.5 feet tall with one spare shelf piece. The shelves are plastic which makes them light weight. They also have holes in them so you can easily attach things to them with zip ties.
- ▲ ***PVC Support Structure*** - It helps stabilize the shelves that are standing tall. The banner covers the PVC to keep your pit looking nice. We used the crossbars to hang our bumpers when not in use. This can also be used to hang blue banners, posters, etc.
- ▲ ***Front Pit Posters*** - We printed posters for the front shelving units. When judges come by, you have the posters on the front to remind you of speaking points. The posters also give people walking by something to browse if no one is in the pit. These posters are mounted on foam board and attached with Velcro. This means that we can easily change our sponsor poster each year without having to ever print a new banner.
- ▲ ***Banner*** - The banner is 10' x 3' and covers the upper section of the pit. This puts our pit right at the 10 foot height restriction and allows our banner to be easily seen from many parts of the arena. In the future we may expand with more banners so that they can be seen from all directions.
- ▲ ***Heavy Duty Bins*** - These bins worked really well for us. We used them mostly to hold raw materials such as metal and wood. They are very strong and can be used as stepping stools when needed. For the pitmaster, the box under the table worked as a nice chair when business was slow.
- ▲ ***Wire Cart*** - We use a wire cart between the two right shelves. It stores our batteries. A bin for personal items is also placed on the lower shelf. This cart is nice because it fits exactly between the two of the shelves in the 10 x 10 area if you construct with the handles facing towards each other. This cart is also used during the eliminations rounds as our battery/tool cart. It is very light weight and also helps with load in and load out of the pit.
- ▲ ***Tool Boxes*** - the area between the two left shelves is storage for our tools. We have one large rolling tool box and two small portable tool boxes next to it. These allow us to easily know where our tools are and also the boxes help the load in and load out process.
- ▲ ***Overall*** - This pit leaves a lot of space to work on the robot. The lane is wide and accepts the robot and cart easily. You never want your pit to be too crowded, so when the robot is in you can't have too many people hanging around. The lack of seating space is great for discouraging people from lollygagging and crowding the pit. The bench-top power tools on the back table allow you to do small modifications yourself instead of having to wait in line for the NASA machine shop. We bring a table cloth with us to cover the provided table; it makes it look a little more professional. We also bring a printer, which is great for printing handouts, stickers, forms, and other things you may need during competition. All the surfaces and bins for organization make a huge difference. You can bring more items to support other teams and yourself, and easily access these items.

BILL OF MATERIALS

- ▲ **Foam Tiles** - 100 square feet in whichever colors you like. We ended up only purchasing 96 square feet and just hide an empty tile in the back of the pit under the table. <http://goo.gl/qxyAo>
- ▲ **5 x Plastic Shelving Units** - These are similar to the ones we purchased but in white. <http://goo.gl/s3f1N>
- ▲ **Wire Cart** - <http://goo.gl/kwUTg>
- ▲ **PVC Pipe Support Structure** - 1" PVC pipe: Ten pieces of 1" PVC cut into 54" pipes along with two 27" pipes and two pieces of 2" PVC. You will need six right angle PVC fittings and seven T PVC fittings.
- ▲ **3 x Heavy Duty Bins** - We use bins similar to those from 2015 for withholding, extra parts, etc.
- ▲ **Various Other Bins or Boxes** - These are used to store and organize the many tools and materials needed during competition.
- ▲ **Large Tool Box** - We brought along the large tool cabinet that we used in our lab. It was heavy but it fit easily into our pit and kept our pit very organized.
- ▲ **Portable Tool Boxes** - We brought along some portable tool boxes. These allowed us to easily transport and store tools. We could also take these tool boxes to other team's pits to help them with their robot.
- ▲ **Power Strips** - We used four power strips to give us many more outlets. You will need quite a few for your battery chargers and power tools. These have an extra long cord which eliminates the need for extension cords. <http://goo.gl/0igDf>
- ▲ **Bench Top Tools** - Bring any smaller scale table power tools to have on your back table for use by you or other teams. We brought a band saw, drill press, and bench-top belt sander.
- ▲ **Cleaning Supplies** - A shop-vac is very useful. When cleaning, you can sweep dust and shavings into a pile and then vacuum it up instead of using a dustpan on the foam surface. On that note, don't forget your broom and dustpan; no one likes a dirty pit area.



ASSEMBLY

Notes: Assembly can be tricky. When you first arrive at your pit with your materials, you have tons of stuff, but nowhere to put it. You want to do your best to stay out of the aisle, but having your 10'x10' area crowded will slow down your pit construction. Our team did our best to arrive early to the pit area and get the floor and shelves assembled quickly while most of our stuff was in the aisle and then place things where they go. Build your pit beforehand and have a 'pitmaster' get the feel of where everything goes. He/she will direct as everyone helps to assemble the pit at competition.

1. The floor is the first thing that you want to do. Place your tiles on the floor and put the small border pieces on the edges. Place a piece of tape over the whole front side of the tiles. This reduces the chance of tripping as you enter the pit and helps when sweeping to keep your pit area tidy.
2. The next step is shelves. The assembly is pretty self-explanatory. Put four poles into each level and attach them all to each other. Each corner shelf should stand 5 levels (7.5') tall. Put the poles with the fitted side down. The heavy duty bins listed above are a very tight fit with the shelves. We discovered that over time the shelves settle or the poles sink into the foam tiles and it makes the heavy duty boxes barely fit. One possible solution may be placing wood under the shelves to prevent the poles from sinking in. We had two boxes under the front two shelves and one under the table. Our boxes were heavy and needed room to pull them in and out repeatedly so we kept them on the lowest level. The heavy bins help to stabilize the shelves as well.
3. Next, we will construct our banner holder/ structure stabilizer. First, make a square PVC structure that has two 54" pieces per side. In between the two pieces on the sides place a 't' PVC fitting or a PVC coupling. On the back two corners put right angle PVC fittings. On the front two corners place t's connected to right angle fittings facing upward using the two inch pvc pieces. Place the shorter PVC pipes out of these right angle fittings and then connect those two at the top using the same configuration as a side of the original square. Connect the banner using zip-ties. Place this PVC structure on top of all four shelves. Zip tie the PVC to the shelves. This should keep the PVC on the shelves and keep the shelves stabilized.
4. Organize. Find places for everything. Put the heavier stuff on the lower shelves and the lighter stuff up higher. Things that you will only need once or twice such as Chairman's supplies can go on the highest levels. Put the battery cart in between two of the shelves on the side. Put your toolboxes on the opposite side. Put handouts near the front of your pit at chest height so that you can get to them easily. We had a printer in our pit which was very handy and saved a few other teams and us several times. The tables that are usually supplied are rough and unappealing to the eye. To resolve this, we covered our table with a tablecloth to look better and allow for easy cleaning. Place all your table-top tools on the covered table. Place a 'trashcan' and your shop-vac under the table. Get your power strips plugged in and distributed throughout your pit. Place bags and other personal items on the first level of the back two shelves. This keeps them out of the way but not impossible to reach if something is needed.
5. Your pit should be mostly done. Do a sweep to clean up any mess made and get everything plugged in and good to go. Keep the pit clean of debris and people to keep things safe and organized. Have your 'pitmaster' stay in the pit most of the time to ensure that things are staying organized and to talk to judges/safety inspectors when they stop by.

Please send any comments or suggestions for improvements to team@spectrum3847.org

APPENDIX B: TEAM TOOL LIST REQUIRED

Tool	Price	Uses
Corded Drill 3/8" chuck	\$30.00	Drilling holes and driving screws. A corded drill is cheaper and allows you to avoid batteries.
Drill Bit Set	\$50.00	Get at least one bit set that has a lot of bits so that you don't run out when they break or get lost
Driver Bit Set	\$10.00	Used to all you to drive screws with the drill. Be very careful if your drill doesn't have a clutch setting.
Screw Driver Set	\$10.00	Get a large set with many different sizes, you will use them for other things as well like flexing the connectors on the power distribution panel.
Allen Wrench Set	\$5.00	Socket Head Cap screws use allen heads, and they don't strip as easy as normal machine screws, get a standard set
Pliers	\$10.00	Needle nose for grabbing small objects and into small spaces. Linesmen's pliers for grabbing large things and cutting wire. Channel Lock pliers for the larger tasks. You will use these all the time.
Vicegrips	\$10.00	Will fix a lot of problems when you don't have the right tool for the job, like removing screws that have had the head stripped off
Diagonal Cutters	\$5.00	Cutting wire and zip ties.
Scissors	\$3.00	Cutting fabric, zip ties or even paper
Hacksaw	\$10.00	Will be your go to tool for cutting stock metal when you don't have more expensive power tools
Wood Saw	\$10.00	If you don't have a table saw, you will need this to make the bumpers and possibly other parts of the robot if you are constructing with wood. You could get a local hardware store to cut it for you, though they may charge.
Sand Paper	\$10.00	Used to smooth rough edges
Files	\$10.00	Much better than sand paper for smoothing edges of cut material and will last longer.
Wire stripper and crimper	\$5.00	Used for the electrical team to cut wires, strip off portions of the insulation and crimp connectors to the ends. If you don't have them, another cutting tool like a razor blade and pliers or vice will work but they won't be as strong of a crimp.
Clamps	\$20.00	Any clamps will do as long as you can hold down material while you drill and cut it.
Permanent Markers	\$3.00	Very useful for marking on material before you cut it or drill it
Ruler	\$1.00	Used for measuring smaller more precise distances
Tape Measures	\$5.00	Measuring long distances
Multimeter	\$5.00	Allows you to check if wires are connected and if components are getting power from the battery. Also lets you determine the voltage of the battery
Electrical Tape	\$1.00	Insulate wires and connections on the robot.
Zip Ties	\$5.00	I'm not sure to include this as a tool or a fastener but you will find many uses for them. Buy a lot
Duct Tape	\$5.00	Not the best thing to use for robot construction, but it's nice to have when making jigs or quick fixes to prototype something
Hammer	\$10.00	Used to transfer momentum to objects. Put a piece of wood on the object you are trying to move and it can replace a rubber mallet. At some point you will need a hammer.
Chain tensioner	\$12.00	Used to stretch chain when you are combining them. Make sure you get the right Chain tools for the size chain you are using. The kit of parts uses #35 roller chain.
Chain break	\$15.00	Used to break the chain links apart so you can make it the correct length.
Solder	\$15.00	Allows you to make custom electrical connections. Most useful when using sensors.
Towels	\$0.00	Old T-shirts, or towels from your house can work for this. Needed to clean up grease and other spills
Grease	\$5.00	Can be bought at most Auto-parts stores, should be used on all of your gearboxes
Brush and Dustpan	\$10.00	Clean up after yourself, it makes life much nicer.
	\$280.00	

HELPFUL

Tool	Price	Uses
Drill Press	\$120.00	Able to get holes that are much straighter than a hand drill and is more powerful so you can drill larger holes.
Drill Press Vice	\$15.00	Allows you to vice things to a drill press
Hole Saws	\$50.00	Easily cut large holes in things, very useful if you are going to be over the weight allowance. Get a nice kit and it will last a long time, you can get cheaper sub \$20 sets but they won't last as long
Counter sink	\$5.00	Allows you to "counter sink" screw and bolt heads. This means that the head of the fastener doesn't stick out above the material.
Band Saw	\$120.00	Metal and Wood Blades, used to easily cut parts
Belt Sander	\$60.00	Make parts smooth, take off small amounts of material, much easier than hand filing and sanding every part
Centerpunch	\$10.00	Used to mark holes before you drill them, very important if you want to get accurate hole placement.
Bench Vise	\$80.00	Holding parts, bending metal, and many other useful functions
Combination Square	\$8.00	Measures from a strait edge, also a level and a scribe
Caliper	\$20.00	Used to preciously measure objects, very useful if you are doing any CAD modeling. A 6" caliper should be enough for most FRC applications.
Arbor Press	\$45.00	Press bearing and gears
Rubber Mallet or Dead blow	\$5.00	Used when a hammer would mess up the surface of what ever you are hitting. Can be substituted for by a hammer and a piece of wood in most cases.
Wrench set standard	\$20.00	Used on nuts and hex head bolts, you can use pliers but you are less likely to strip them if you use the proper sized wrench
Allen Wrench Set Metric	\$5.00	Sometimes you get a metric allen head, hopefully you won't buy any. But other parts you buy may have one on them.
Metric Wrench Set	\$10.00	Same as above, but with normal wrenches
Ratchet and Sockets	\$40.00	When you need one it will be much nicer than using a normal wrench
Jigsaw	\$40.00	Used for cutting large sheets of material like plywood and polycarbonate. Make sure you are using the correct blade for your material.
Dremal and bits	\$100.00	Can be used for nearly any project, but can take a long time
Detail File Set	\$6.00	When your bigger files are too big. Lets you get into small parts are file them down.
Deburing tool	\$12.00	Makes cleaning cut metal much easier
Cordless Drill	\$100.00	Same as a corded drill but allows you to use it away from a plug, also they normally have a clutch setting that makes them better for driving screws
Miter Saw	\$110.00	Cutting lumber and also aluminum and steel with the proper blades
Rivet Gun and Rivets	\$15.00	Light weight fastening system. Easy to use but can be expensive if you keep having to drill them out
Corded Drill with 1/2 chuck	\$120.00	A 1/2" chuck is useful for larger holes and also you can spin a 1/2" shaft for prototyping
Heat Gun	\$30.00	Allows you bend pvc, and heat heat shrink tubing for electrical connections
Cooping Saw	\$7.00	Useful for hand cutting detail work, if you don't have a scroll saw
Tap and Die Set	\$40.00	Allows you to put threads into holes and on to shafts
Tap Magic	\$9.00	Tap Oil used when tapping holes
Loctite Blue	\$4.00	Secures bolts and screws so they don't vibrate loose. Very useful if you're not using nylon lock nuts.
Punch Set	\$12.00	Non-automatic center punches, and also pin punches for using roll pins. Chisels will be less useful
Vacuum	\$50.00	A small shop-vac will be very useful for cleaning up your work area.
	\$ 1,218.00	

OPTIONAL

Tool	Price	Uses
Air Compressor	\$200.00	Allows you to use air tools
Abrasive Saw	\$50.00	Able to cut steal shafts
Sheetmetal Break	\$250.00	Bend metal and lexan
Clamp on amp meter	\$100.00	Able to read motor currents on the robot
Angle Grinder	\$40.00	Can cut steel shafts
Scroll Saw	\$110.00	Used for making cuts that are more complicated
Cross Slide Vice	\$100.00	Used to line up holes, but can also do simple milling type work
Table Saw	\$140.00	Easily cut large sheets of plywood or other sheet metal.
Router	\$120.00	Used to do cuts into wood, easily cut complex shapes and special edges
Bench Grinder	\$50.00	Used for grinding steel shafts, need special wheels for aluminum
Powerpole Crimper	\$40.00	Required if you are using Anderson powerpole quick disconnects
PWM Crimper	\$20.00	Allows you to crimp PWM Cables, if you buy the headers and pins you can make your own
Large Gauge Hammer Crimper	\$20.00	Allows you to crimp large gauge wire like the 6 AWG wire for battery terminals
Gear Puller	\$20.00	Allows you to pull gears off of shafts
Self-Centering Drill Press Jig	\$10.00	Drill holes in round stock easily
Tubing Cutter	\$7.00	Used to make strait and easy cuts in pneumatic tubing
Label Gun	\$20.00	Makes labeling parts and wires much easier. Keeping an organized shop is critical to a successful team.
Scale	\$45.00	150lb postal scale will help with keeping track of the weight of your parts
	\$1,342.00	