

**FIRST Lego League Survival Guide:
Central Texas Edition**

A Guide to the Guide

This Guide was written to help FIRST Lego League (FLL) Teams located in the Central Texas area through their first year. However, it cannot even begin to express the experiences one will have participating in the FIRST Lego League program. Every new team that enters is unique and will go about completing the FLL Challenge in an entirely different way than another team. That being said, this Guide is meant to only be that, a guide. As a reader, it is meant to lead you down the path giving you the tools to create a successful first year being part of the FIRST Lego League program. But ultimately, it is what the team puts into this program that decides its outcome. Please allow this Guide to fit your needs and the team's needs as much as possible but allow for some flexibility, as it will be needed. I sincerely hope that this Guide will provide you with what you will need to continue to inspire, educate, and learn from the young minds of today so that the entire team is impacted to continue with STEM and FIRST throughout their lives.

--Claire Blakely, author

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1. What is FIRST Lego League?

FIRST Lego League (FLL) is a robotics competition for elementary and middle school students and is part of an organization called **FIRST (For Inspiration and Recognition of Science and Technology)**. The goal of the FLL Competition is to inspire students to continue with science, technology, engineering, and math (**STEM**) throughout their lifetime and to encourage parents and educators to be involved in the FIRST and STEM communities.

In September of each year, a specific game challenge is released. This challenge relates to a topical theme or issue in the world and it is up to the teams to not only build a robot that can accomplish missions but also create a patentable solution. FLL teams can consist of between two to ten students and a maximum of two **coaches**, with as many student or adult **mentors** as needed. In addition, coaches and mentors are able to coach and mentor multiple teams. It is suggested that the student to robot ratio is 5:1 in order to keep students engaged.

There are three main components to the **FLL Challenge**, the robot, the project, and the Core Values. The robot is the main component used in competitions and is made out of Lego MindStorm pieces. At the center of each robot is the **brick** (shown on next page), essentially the brain of the robot that stores all of the pre-programmed missions that are used for the competitions. In addition to each season's competition, there is the project. This is everything directly related to the challenge itself. **The project** is comprised of a five minute presentation (usually given at a Qualifying Tournament) that explains the team's main problem, solution, and how they showed off their solution to the community. Finally, the Core Values are the most important part to the FIRST Lego League Challenge and incorporates values that each successful team should possess. The Core Values are as listed:

- 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!

(Source: <http://www.firstlegoleague.org/mission/corevalues>)

As the Core Values suggest, the most important part of a First Lego League team is making sure that both students and adults have fun while enjoying the process so that everyone can continue on their journey of STEM education.



The Brick or Brain of an NXT robot.

1.1 The FLL Game Challenge

This section will be referenced throughout the document and helps specify the specific components of the game challenge that are typically consistent each year. More of the game challenge is specifically talked about later on in this document.

Every year, the game challenge is usually comprised of ten **missions**, which are mini challenges that robots complete to earn the most points. At a **Qualifying Tournament**, which is the first step in the team's journey of competitions and usually held in December, the teams are ranked based on their highest score. The way a Qualifying Tournament is set up, is that teams have an opportunity to showcase their missions during three matches, their highest score determining the rank. This gives teams a chance to continuously improve upon their score throughout the day. However, score is not the only thing that matters as in order to move onto the Invitational or other Regional events, teams must be well rounded, meaning they can exemplify the Core Values and their project.

In addition to each team playing three matches, they also do three presentations. The first one is where the team has a chance to showcase the robot to the judges, explaining how they came up with their design and demonstrating it in practice. The next one is their project, which is a five minute presentation on the team's innovative solution and methods to share this information with the community. At the end of these two presentations, judges have the opportunity to ask questions of things not covered in the original presentation. The final judging period is the Core Values. In this period, the team is given a task revolving around these set values that they complete with their other team mates.

Specific to game matches, teams can send up two representatives who can touch the robot in designated areas. On the game mat, there is a black box with tick marks on it,

named **Home Base**. This is the only place team members are allowed to touch the robots as everything else the robots do must be completely autonomous. However, teams do not have to worry about one robot that can do everything as, team members can add or remove manipulators or pieces to solve different missions. **Manipulators** are considered pieces other than the drive base that help the robot complete its missions. For example, a manipulator can be an arm attached to the motor. Home Base is a good place for the robot to come back after each mission in order to lessen the complications. However, there is only a specified time amount, usually around two minutes and thirty seconds, so whatever the team does in Home Base, must be done quickly and efficiently.



A generic FIRST Lego League Home Base.

A generic FIRST Lego League game mat.

2. How to Get Involved

FIRST Lego League is a relatively easy program to get involved with as all it truly encompasses is joining a team! However, this may prove difficult if there are not teams within your area. One of the ways to overcome this challenge is by creating a team, in which this Guide can help. Although if there is a team in your area, start by contacting the coach or mentor to see if there is any room to join. In addition, anyone living in the Central Texas area is invited to join the Central Texas FLL Yahoo! Forum or if outside of the Central Texas area, FIRST TeamUp. These two groups can help match prospective students and adults with existing teams. The links to this information can be found in the resources section.

However, if, as a parent/guardian or student who is unable of being on a team because they have aged out of the program, they may volunteer at local Qualifying Tournaments or regional events. To find out how to volunteer at events (which usually start in early December and continue through April), contact Central Texas FIRST, if living within Central Texas. In addition to volunteering at events, one can always mentor a team using the FIRST TeamUp website to find any teams in the area that are in need of mentors.

2.1 Creating a Team

Things Covered In This Section:

- ✓ Identifying a Community
- ✓ Recruiting Events
- ✓ Registering with FIRST
- ✓ Creating a Team Name

The first step in creating a team is gaining members. Most FLL teams are associated with either an elementary or middle school, giving it the ability to be run by parents, guardians, or a technology teacher at the school. However, successful teams have been found in communities such as Girl Scouts, Boy Scouts, and the Boys and Girls Club.

Decide on a community of students, whether that be a neighborhood association, school, or just a group of friends. Once a community has been established, a team might need some sort of recruiting event to gain more members. At this recruiting event, it is important to get the word out so many people show up. One possible consideration is if the target community is a school, is to collaborate the recruiting opportunity with another pre-existing event, such as Back to School Night or a school festival/dance. However, there have also been instances in which an informational meeting was held serving food, providing a general idea of what the team would be doing, and how much commitment both the students and parents would be putting in. This type of event best works in a school or Girl/Boy Scout community and is recommended for those who have previously been involved in FLL or another FIRST program.

A recruiting event is usually held before the September of the upcoming year, since that is when the game challenge is released. It will be much easier to run a team if the members are established before summer, however it is not required. Before the recruiting event, one might educate themselves on FLL in order to handle questions such as commitment level and finances. Numerous amounts of resources on this topic can be found at <http://www.usfirst.org/roboticsprograms/fll> as well as within this Guide.

During the recruiting event, a sign-up sheet with parent name, e-mail address, or some other form of communication should be used. This will help in gaining contact with interested parties about joining the team. Finally, it might be beneficial to have some fliers on general information, such as meeting times and places, at the recruiting event. However, this is not necessary as it might be easier to establish this general information after a team is formed.

After the team is formed, with up to ten students and two coaches, it is very important that the coach or mentor registers with FIRST, if the team plans on competing. If the team does not plan on competing but would like to use materials and complete the challenge by itself, the coach can order materials via this website: <http://www.firstlegoleague.org/challenge/startateam#%20STEP%202:%20Form%20your%20team%20&%20register>. This website includes both ordering materials and registering with FIRST.

Finally, the last thing to make a team official is coming up with a name! This is usually the first step in letting the students be creative with their team and also serves as a

swell ice breaker if the students do not know each other. If going to a Qualifying Tournament (or even if not), it might also be a good idea to create a t-shirt design or some other imagery that can identify the team. Some teams get really creative with this by having matching hats, catchphrases, or even songs to describe their team, although this not required by a FIRST event.

3. Running a First Year Team

So now, the students are ready to build, the parents and guardians are ready to find out what FLL is, and overall the team is ready to embark on their first season. Before everything can get into motion, however, there are a few housekeeping things that need be taken care of--starting with finances. Unfortunately, FIRST Lego League is not a free program as there is money involved in registering, gaining kits, and creating a table. Below is a table of expenses needed to run an FLL team, as of the 2014-2015 season.

3.1 Finances

Item	Cost
FLL Team Registration	\$225
Lego MindStorms EV3/NXT Kit	\$420
Field Set-Up Kit (Game Mat)	\$75
FLL Table (Built by team)	Approximately \$75
Qualifying Tournament Entry Fees	Approximately \$75
Other (Food/Shirts/etc.)	Approximately \$75-\$100
Total	\$945-\$970

As a first time coach, parent/guardian, or mentor, this can seem like a lot of money. However, there are a couple of ways to lower the cost. The first one is grants. If the team is within the Central Texas Area, they are eligible for different grants. To find grants within the team's area, go to Central Texas FIRST's website, found in the Resources section of this Guide, to look for qualifying grants. Many times these grants are awarded based on first come, first serve starting in the early months of summer so it is important to check the website frequently. Grants can cover the cost of the Lego MindStorms/EV3 Kit and the Field Set-Up Kit. Most of the time, grants give special priority to teams with a large number of girls or in an underserved community. However, there are still options available if this does not sound like your team. Another service offered is GrantWrangler (<http://www.grantwrangler.com/>) which provides up to date grants of businesses in your area.

Fundraising is also a viable option. Things such as a team bake sale or a garage sale are successful ways to earn money with very little money needed to start.

3.2 Parent & Guardian Involvement

Parent and guardian involvement is an important aspect to the FLL competition. Although this might not be as important if the team is at the higher age spectrum (ages 13-14), it can drastically make a difference in the stress levels of the coach and add to the team's sustainability plan. As a first year team, parent/guardian involvement is highly recommended. To start, hold a parent/guardian meeting at the beginning of the year. (This is noted on the Guideline of Proposed Meetings.) At this meeting, talk to the adults about FLL and what the coach's goals are for the team. This will help to get the adults more involved in what their child is doing. In addition, if the team has younger members (ages 9-10), it is a good idea to have parents and guardians be more involved in the weekly meetings. Encourage the adults to help their student build and program, much like a mentor would. This gets everyone excited for STEM and FLL!

3.3 Kickoff Meeting

One of the first opportunities that a coach has to gain insight into FIRST Lego League is through the Coaches Kickoff Meeting, usually held in mid September. This kickoff event is meant to be just coaches and parents/guardians and is a way for other adults in the area to meet up and learn about the **FLL Challenge**. At the event, the game challenge is released and is usually followed by specifics into the missions. It is highly encouraged that first year coaches go to this event to gain a network of other coaches and mentors in the FIRST Lego League community. In addition, this is a good time to gain more insight into the game challenge so that this information can be shared with the entire team at the next meeting.

3.4 Meetings

Depending on how many members there are on a team, there are different ways to run meetings. Overall, during the competition season there are three main concepts that the team should focus on in order to be ready for a competition--the robot, the project, and the Core Values. In order to keep things organized, it is a good idea to focus on a different aspect of the robot or the project each meeting. It is suggested that a team should have at least one, 2-hour, meeting each week with the prospect of having two, 2-hour meetings as it gets closer to a competition. In addition, at the start of each meeting, it is recommended that a coach or mentor reminds students of the Core Values. There is not a specific project that needs to be completed before the tournament regarding the Core Values, but there is a portion of the competition in which the students must show how they work together and embody them with everything they do. Thus, if the team is able to embody and apply the Core Values during the meetings, they will have a much better time performing them during the competition.

The next sections regarding meetings are a suggested overview of how these gatherings can be run. They are broken into three categories: the robot, the programming, and the project. In addition, there is a proposed meeting schedule to help organize

meetings. It should be stressed that each team is different and with that, comes different meeting styles. This is meant as a guideline and should be made flexible as needed.

3.4.1 Guideline of Proposed Meetings

Date	To Do
First Meeting (Early to Mid September)	Parent & Guardian Meeting: Coach/Head Mentor explain what FLL is about to parents. Students design shirts, come up with team name and imagery.
Mid September	Kick Off Meeting for coaches, mentors, and other adults only.
Second Meeting (Late September)	Go over game challenge, rules, and familiarize with kit of parts. After talking through the game challenge, have the team come up with a list of goals they would like to complete by the end of the season. If time permits, try talking through drivetrains and begin to build a basic robot.
*Weekend Meeting Suggested Meeting Time: 2-3 hours	This will be a day to build all of the components for the mat. Suggestion: Make this a fun activity to allow for the students to get to know each other better.
Third Meeting (Entering into October)	Finish building basic robot. Begin to brainstorm ideas and missions that the team wants to solve.
Fourth Meeting	Continue brainstorming ideas. Talk through engineering design process. Decide on which missions will be solved and who will solve them.
Fifth Meeting	Begin prototyping ideas for each mission. Draw out ideas and have students explain what the idea will consist of. Begin building ideas.
Sixth Meeting	Continue prototyping. As students finish prototyping, introduce them to programming basics. Play Peanut Butter and Jelly game (explained in programming section).
Seventh Meeting (Nearing end of October)	Finish up prototyping. Start on programming. Have students map out what the robot needs to do for their programs and begin to program.
Eighth Meeting (Beginning of November)	Split meeting in half: programming and project. Have students continue to tweak programs. Half way through, start talking about the project. Talk about the problems associated with the theme. *Possible Homework: Have each student

	research a topical problem they are interested in.
Ninth Meeting	Split meeting in half: programming and project. Continue tweaking programs and redesigning, if needed. Have students share out research done about problems. Finalize one central problem. *Possible Homework: Have students research more in depth of central problem.
Tenth Meeting	Split meeting in half: programming and project. Programming should hopefully be coming to a close as students finish up with the robot portion. Have students share out further research and begin brainstorming a solution.
Eleventh Meeting (End of November: This is usually the time when there might be a need for two meetings a week.)	Research Project: Finalize solution. Begin putting all research and solution into presentation material. Come up with a way to present information to community and at Qualifying Tournament.
Twelfth Meeting (This might be the same week as the eleventh meeting.)	Practice Day: Practice the research project, finalize the robot. Practice questions judges might ask at competition. *This can also be a good day for a parent showcase, depending on how much time is left.
Thirteenth Meeting	Parent Showcase (if applicable): Do a mock presentation of the project and robot for parents and family. This might not be applicable if there is not enough time.
Early December	Competition Day!

3.4.2 The Robot Meetings

Things Covered In This Section:

- ✓ Engineering Design Process
- ✓ How to Choose Missions
- ✓ Drivetrains
- ✓ Manipulators
- ✓ KISS
- ✓ Prototyping

Solving an everyday engineering problem can be tough, especially if this is the team's first time. However, if one were to ask engineers where to begin, they would most likely say, to go through the engineering design process. There are many different variations of the **engineering design process** but they all involve identifying the

problem, brainstorming a solution, prototyping a solution, and finally, making that solution be a final product. This is not purely a linear thing, however, sometimes it takes many cycles of brainstorming and prototyping before one has a final solution. The important thing is to not give up as the point of the FIRST Lego League Challenge is for it to be challenging but for there to always be a creative solution.

At the first build meeting, it is recommended that the coach or mentor finds a simple version of the engineering design process and talks through it with the students. Explain what the team will be doing with the students and come up with goals that each person or the entire team wants to accomplish. As a coach, maybe set some dates for when the team should ideally accomplish their goal, for example, finishing the project a week before the Qualifying Tournament.

As part of the robot portion of the FLL competition, there are many different missions that the team can complete to earn points. The goal of the robot portion is to score the largest amount of points by the time of the Qualifying Tournament. However, if the team makes it a goal to move past the Qualifying Tournament, the team will not be able to rely on points alone. In order to move on, the judges look for the most well rounded team that can successfully complete all portions of the game challenge. Do not worry too much about getting the robot to score all the points, but instead, focus on the challenges that the team can do accurately and consistently.

Identifying the Problem

As mentioned before, the robot portion of the game challenge is broken up into about ten different missions, varying in difficulty. As a first year team, it is recommended that the team focuses on three missions that they can do accurately and consistently before moving on to more. However, if the coach feels as though their team is completing missions faster or slower than originally expected, this number can be varied. These missions can be chosen as a team or, if the coach decides to split up the team into smaller groups, the missions can be chosen in these groups. (The latter usually works for teams of four students or above.) The way in which one goes about choosing missions is entirely up to the team and may take some trial and error before the team can come up with the best missions to complete. As a tip, have the students map out the mission, explaining the exact steps the robot will need to complete. This can help to decide the difficulty of a mission and also help with programming, which will be talked about in the next section.

Designing a Solution

Once the team has chosen its missions, it is time to build the robot. Much of the FIRST Lego League competition involves creativity, with each robot differing significantly depending on the team's skills and goals. Although this Guide will try to explain how the engineering design process can aid in building the robot, ultimately the final product will depend on a team's creativity, skills, and goals. Most of the robots seen at the Qualifying Tournament will have the same basic drivetrain with different manipulators. Usually the **drivetrain** consists of two back wheels and one wheel in the front to steer. For a basic drivetrain, use the five minute bot. This can easily be found by Google searching Five Minute Bot and can be used for either the NXT robot or the EV3. Here are some possible links for building instructions:

NXT Robot: http://www.nxtprograms.com/five_minute_bot/steps.html

EV3 Robot: <https://shslab.wikispaces.com/5+Minute+Bot+for+EV3>

The Five Minute Bot is a good basic drivetrain that manipulators can be easily added to. This is also a good way for a first year team to get to know the parts and pieces that are in their respective kits, making the engineering design process simpler when creating manipulators. However, the Five Minute Bot is fairly basic and lacks in creativity. If the Five Minute Bot is too basic for the team, there are many different robot designs that can be found through Google searching FLL EV3/NXT robots that might be more fun to build. Again, what the team decides on for their drivetrain is completely up to them and should adhere to their goals and wishes.

Once a drivetrain is established, the next best thing is to focus on the manipulators. The **manipulators** will vary mostly on what missions the team decides to do. For example, if the mission is to grab a chair and bring it back to base, a robot might need something to pick up the chair by using an extra motor. In order for a manipulator to be decided on, one must map out exactly what the mission requires. This is the first step in the engineering design process: figuring out the problem. How a team can do this is first by imagining what the robot will need to do to complete the mission. This might be easier if the students imagine how a human would accomplish this task. Some things to think about are:

- ❖ How will the robot/human move to accomplish this task?
- ❖ Do they need to vary height in any way?
- ❖ What simple processes will the robot/human need to use?

After establishing a basic idea of how the mission will need to be completed, it is time to design how the robot will complete the chosen missions. This can usually start by having students draw out some sort of manipulator to accomplish the task. When students finish the drawing, have them talk through how the manipulator will work. This will help establish a better understanding of exactly what the student wants the robot to do. This is also where a great deal of the creativity aspect comes. In the robotics world, there is a saying called KISS, or Keep It Simple, Silly. Depending on the team's goals and identity, teams will usually pick a combination of being creative and keeping the design simple. However, if a student really wants to complete a complicated or creative design, it is important to let them. This may cause more frustration on part of both the mentor and the student, but if the student is able to see their design come to life and learn the restrictions in doing so, the experience is much more meaningful.

Prototyping and Making that Solution be a Final Product

Finally, once the design is drawn and thought through, one must prototype. As a mentor, help the student find the pieces and work through how they feel it should be designed. This step will probably take multiple cycles of building and testing until a final product can be achieved. Once a final product is achieved, it is time to start on the programming.

3.4.3 The Programming Meetings

Things Covered In This Section:

- ✓ Obtaining Programming Mentors
- ✓ Peanut Butter and Jelly Game
- ✓ Mapping out the Programming
- ✓ Testing the Programming

Obtaining Programming Mentors

Living in Central Texas is a very helpful thing when it comes to the FIRST Lego League Challenge because there are a wide variety of technology companies that are eager to help with FIRST Lego League teams. One of the biggest companies is National Instruments. National Instruments designed and created both the programming and the robotics kit used for the FLL challenge and as part of giving back to the community, they love to help mentor in programming. Thus, if the team is a first year team, it is highly recommended that the team takes advantage of programming mentors as they are professionals who are more than willing to help teach students basic EV3 and NXT programming. In order to request mentors, either specific to programming or to building, go to this website: <http://firstintexas.org/mentors/requestamentor/>. There is a FIRST® Robotics Competition Mentors request form at the bottom of the page.

Whether the team is using an EV3 kit or an NXT Kit, the programming language is visual based, meaning the students code using pictures and symbols. This is a great feature as it makes the programming simpler for the students and parents/guardians/mentors to learn quickly. Because there is a difference from the NXT Kit to the EV3 Kit, this Guide will not go into specific details related to programming. However, there are many helpful tutorials on usfirst.org that are related to FLL programming and can be found in the Resources section of this Guide. Regardless of the program that the team is using, the first step in basic programming is figuring out exactly what the robot needs to do. If this is the team's first exposure to programming basics, they might not fully understand the specificity that goes into a programming language. If this is the case, it is recommended that the coach or mentor plays the Peanut Butter and Jelly game with the students.

The Peanut Butter & Jelly Game

The **Peanut Butter & Jelly game** is one of the many examples in teaching young students basic programming. The way it works is someone is given a task to create a peanut butter and jelly sandwich (acting as the robot), with the students telling the "robot" what to do. The trick of it is that the students, who are acting as the programmer, must be very specific in its actions. For example, if the students say 'get some jelly' without telling the robot to pick up the knife or opening up the jelly jar, then the robot does not have means to do that. The "robot" would literally interpret "get some jelly" as picking up the entire jar or scooping out a bunch of jelly with their hand. This game can be modified based on the skill level of the participants, ranging from somewhat specific such (open up the jelly jar) to very specific (place hand on lid of jelly jar and turn in clockwise direction). In terms of the EV3 and NXT programming, the level of specificity

lies in the middle of these two examples, consisting of direction to turn, rotations, and other such sensors. Once the students understand the need for specificity, they can continue with programming using the EV3 or NXT programs.

Mapping out the Programming

One of the first recommended steps is to have the students map out the program on a piece of paper. Have them include the route the robot must take, including the distance between each turn. In addition, if there is a manipulator involved, have them include what the manipulator needs to do and where it should start. It might also be helpful to mark where the robot starts within Home Base, using the tick marks provided. Once a complete map is thought out with as much detail as possible, the student can start programming and testing their mission.

Testing the Programming

Usually it is very hard to get the mission exactly correct the first time trying the programming. That is completely normal and opens up possibilities to improve upon student problem solving skills. Much of the programming involves trial and error and making tweaks in the program along the way. When the student encounters a problem, have them first look back at their code to make sure that everything they want it to do is correct and that they did not forget any steps or add any extra steps. If the student finds something wrong with the code, only make one change at a time. This is a tedious process but helps for better understanding of what caused what problem by changing one variable. This can also be extremely helpful if a similar problem were to occur in order to fully establish a causal relationship.

3.4.4 The Project Meetings

Things Covered In This Section:

- ✓ Breaking Down the Theme
- ✓ Identifying a Problem
- ✓ Coming up with a Solution
- ✓ Sharing that Solution

Something that makes FIRST unique is the emphasis on not only engaging students in STEM principles, but teaching students business and writing skills. This is what the project is all about--incorporating a system for teams to solve everyday problems with patentable solutions, marketing their solution to their community, and finally, presenting it to a panel of judges at the Qualifying Tournament. This might sound overwhelming, especially if the students are young and have never been exposed to marketing and business skills before. However, the project is much more creative than just business ideals, with the presentation ranging from skits or songs, to just an informal conversation.

Breaking Down the Theme

The first step in starting the project is to identify the problem, or theme, of the game challenge that year. The theme is not necessarily an outright and direct question or problem--(for example, the theme for 2013 was just natural disasters). Thus, it is up to the team to start by finding problems within that theme. Start with a list of problems that plague the world and that have to do with that theme. For example, with natural disasters, a team could talk about a specific natural disaster, such as tornadoes, or focus on the problems such as helping relieve victims of natural disasters.

Identifying a Problem

Coming up with a problem is a very broad area so coaches and mentors must allow each team member to do research and really think about a problem that interests them. Once everyone has had a chance to fully think about problems they might want to explore further, have everyone share their problems along with a few facts or interesting points to note that they may have found. This is a good way for everyone to get their idea in and able to express it so that others might be interested in it. Once a complete list is compiled, start narrowing down potential problems to focus on. It is recommended that there is one main problem that the team focuses on, however the team might find that many specific problems relate under one thematic problem. This could be a good way to allow for everyone's opinion to be heard and expressed as part of the project. Be sure to keep in mind that for every problem that is focused on, a solution should also be made, as this can also help narrow down potential projects. After a final problem has been chosen, it is time to come up with a solution.

Coming up with a Solution

Coming up with a solution involves much more than just coming up with a problem. At the **FIRST Championships**, which is the international competition involving all four robotics programs (Jr. FLL, FLL, FIRST Tech Challenge, FIRST Robotics Competition) to crown the international winner of each event, many teams come up with patentable solutions. If the FIRST Championship is the team's end goal, it is recommended that the team take this into account when finding a solution. However, one might find that it hinders creativity to create something within this guideline.

To start, it is recommended that each student does some research on the decided problem, focusing on why it is a problem and other ways people have come up with solutions for it. This can be part of a regular team meeting or could even be done outside of regular team meetings. In addition, it could be as structured as giving each student a specific topic area to research. Once research has been gathered, it is best to share out all of the research so that everyone has some background knowledge on the problem. This process will help to adequately find solutions.

When coming up with a solution, it is suggested that the team can identify previous resolutions but are also able to come up with one solution that they can call their own. This solution can be an improvement on previous information or can be something unique that the team came up with. Either way, it is suggested that the team be able to draw or create a model of their solution so that they can explain it to their community and the judges at the Qualifying Tournament.

Sharing the Solution with the Community

With every solution, comes a way to share it with the community. To start, try contacting the leader of the community that the team is a part of. For example, if the team's community comes from Girl Scouts or a school, ask to see if the team can do a showcase of the robotics program. This is a great way to not only show the community what the students have been learning but also for the students to teach their fellow mates about their solution and experiences in FLL. If the team is not part of a specific community, try to showcase the project at some sort of community event, for example a neighborhood association meeting, or even the schools the students attend. If none of these options fit the team, try contacting a local news stations and see about showcasing the solution there.

The sharing of the project can be practice for the Qualifying Tournament as the students will have to give a presentation to the judges. Before the actual sharing, come up with a way for the students to share their project. This can be in the form of a skit, song, or PowerPoint presentation. The presentation should include the team's decided problem, solution description, and at the Qualifying Tournament, how they are educating others about their solution.

The final parts to the project come down to one thing: practice. Make sure the students are comfortable with what they are saying and doing during their presentation and emphasize that it is okay to make mistakes. A coach/parent/guardian can even accompany the team into the presentation room on competition day to help settle nerves while giving the presentation.

3.5 Competition Day

Things Covered In This Section:

- ✓ Team Logistics
- ✓ Checking In
- ✓ Qualifying Tournament Set-Up
- ✓ Ceremonies and Match Play
- ✓ Presentations
- ✓ Closing Awards Ceremony

At this point, the team has worked for three months perfecting their robot, project, and incorporating the FIRST Core Values into their meeting times. The team already has much to be proud of, and **the Qualifying Tournament** is a fun way to share with judges and other teams what the team has accomplished. The Qualifying Tournament is an all day event usually held on a Saturday in early December, and usually held at a local high school. Because the event is all day, there are a few logistics to figure out before going.

Team Logistics

The first logistic is food. At some Qualifying Tournaments, there are systems set up where a team can order food through the tournament. However, these cost money and if the team has financial considerations, a better solution would be encouraging everyone

to bring their own lunch. There will be a break from the competition, usually around noon, for volunteers and teams to eat.

The next logistic is parent chaperones. If parents/guardians are not heavily involved in the meetings, encourage them to support their child at the Qualifying Tournament. This is a great way for students to show off what they have accomplished with their parent/guardian and a good way for these adults to become more involved in the FIRST Lego League program. Having parents and guardians experiencing the competition first hand, makes them more likely to be excited about what their child is doing and become more involved in the team. The final logistic is what to bring. Usually, it is a good idea to bring the

- ❖ Robotics kits
- ❖ A couple of computers that are running the programming software along with their chargers
- ❖ Any materials needed for the presentation
- ❖ Any materials needed for team imagery

The team will not need to bring the table, field, or other kit pieces, unless otherwise noted through Central Texas FIRST e-mails.

Checking In

When first arriving at the FIRST Lego League Qualifying Tournament, as a coach, check in your team. This is a way for the hosts to know when teams have arrived and when volunteers will provide the match and presentation schedule. Once checked in, make sure the team members know where they are going. It is suggested that the coach and team sets up a meeting time so everyone can set up together.

Qualifying Tournament Set-Up

When all of the team members have arrived, find the team's pit area. For most Qualifying Tournaments, there will be a pit area, an arena area, and a presentation area. The **pit area** is a table allotted specifically for a team to work on their robot and programming. This is also the holding area for all teams before presenting or competing. The pit area will most likely also include a practice table with a game mat so teams can test their programs before their next matches. In addition, the pit area can be a great place to practice **Gracious Professionalism**, by competing in a positive environment, bringing others up instead of putting them down. Within this environment, it is easy to ask other teams for spare parts and other help. In the spirit of Gracious Professionalism, sometimes Qualifying Tournaments are lacking in practice fields or tables. If the team has a practice field or table, consider letting the tournament borrow it for the day in order to allow other teams to be able to practice.

The next area of the Qualifying Tournament is the **arena**. This features competition game fields where the team will compete with their robot. Although there might be multiple competition tables set up, this does not mean that teams will be competing against each other in a specific match. This is only to help run the competition quickly and smoothly. The arena is also a place for family members and other members of the team to watch the event.

The final area is the **presentation area**. This is usually in a series of classrooms, if the event is set up inside a school, where teams will give their three presentations-- Project Presentation, Core Value challenge, and Robot Presentation. Most of the time there will be volunteers who will guide the teams back to the presentation area so that teams will not have to find them on their own.

Ceremonies and Match Play

After settling into the pit area, there will usually be a Coach's Meeting that entails going over the logistics of the competition. It is important that each team sends at least one adult representative to attend this so that the team can be informed on how the day will proceed.

After the Coach's Meeting commences, it is time for the Opening Ceremonies. This is a time where all of the teams go to mark the starting of the competition. Usually, the Opening Ceremonies runs about 30 minutes and all teams are expected to attend. There, volunteers will explain some of the more important logistics involving the event and get the teams excited about the competition. Sometimes there are also guest speakers to introduce students to what they can do when continuing to pursue STEM careers. After the opening ceremonies, it is time for the games to begin!

As mentioned before, each team gets three matches per Qualifying Tournament to showcase their robot and what it can do. Overall, this should not be a stressful thing as teams have the opportunity to improve their scores throughout the day, with the team's highest score at the end of the day going towards its ranking. It is important that each team makes every attempt to attend all three of their matches so that they can continue to improve.

Presentations

As part of the match schedule, each team will have time to present their project, their robot, and demonstrate how they utilize the Core Values to the judges. The judging period usually has all three of these presentations back to back and will not interfere with the team's robotics matches. At the beginning of the morning, note when the team's judging periods are to make sure that the robot will be ready for both the judging period and their next match. In addition, when leaving for the judging period, take everything the team will need for each presentation, including the robot with all of the missions the team would like to showcase. A good idea is to print out the programming of each mission to show the judges during the robot presentation. The team will not need to bring in anything to the Core Values-judging area. For each judging area, with the exception of the Core Values judging area, mentors and coaches are allowed to attend. They are not allowed to provide advice or commentary but they can video record to provide feedback to their team after the presentation. More detailed information on each presentation is provided below.

Closing Awards Ceremony

At the end of the day, once everyone has presented and competed, it is time for the Awards Ceremony. At the Qualifying Tournament, it is very important that a positive environment is emphasized throughout the competition and thus all of the volunteers go to great lengths to do just that. Following FIRST's Core Values, it is much more

important that the students had fun rather than what award they received. Depending on the number of teams competing throughout Central Texas, a certain percentage at each Qualifying Tournament will be invited to the Invitational Tournament. In order to be invited, judges look for the most well rounded teams, exemplifying all aspects of the FIRST program. Even though the team might not make it to the Invitational Round, they can still qualify for various awards at the Qualifying Tournament. Some of these awards include the Core Values and the Project Award. Regardless of what the team wins, the team should be proud of what they have accomplished in the past three months.

3.5.1 The Robotics Presentation

The robotics presentation is the part to showcase what the team's robot can do. Preparing for this presentation is simple as it is what the team should be doing with the robot. During the presentation, the judges will ask to see the robot in action, meaning that the team can demonstrate each mission as if they would during a match. Along the way, the judges might ask questions, inquiring about how the robot was completed, how the programming was prepared, and even, what kind of mentors the team uses. If the team would like to be fully prepared for the presentation, try asking them sample (and optional) questions prior to the event. Some sample questions include:

- ❖ How did you come up with this design?
- ❖ Who came up with which designs?
- ❖ Who did the programming and how did you come up with it?
- ❖ Who helps you on your team to complete the robot and programming?
- ❖ How did you utilize the engineering design process?

Make sure that each team member can explain their part in helping build or program the robot.

3.5.2 The Project Presentation

The project presentation consists of a five minute presentation addressing the team's main problem, creation of their solution, and how they plan to spread their solution to the community. At some Qualifying Tournaments, the timing for the presentation starts as soon as the students walk in the room so make sure to take timing into account. In addition to the presentation, judges will be able to ask questions to the participants, possibly exploring more in depth into topics covered in the presentation. Some of these possible questions include:

- ❖ How did you come up with this solution?
- ❖ What kind of research did you do?
- ❖ Is this an original solution?
- ❖ How did you share this solution with your community?

With many of these questions, it is recommended that the students have a solid background in the problem and the solution to back up their answers.

4. Off Season

Things Covered In This Section:

- ✓ Starting Off
- ✓ Polishing Skills
- ✓ Engaging the Community
- ✓ Learning from the Community

The competition has come to an end but that doesn't mean education in robotics has to as well. Off season is a time when teams can continue working on their skills without feeling the pressure of a competition. Technically the FIRST Lego League season runs from September to April, as April is when the World Championship takes place. However, if the team did not make it that far, meetings do not have to stop.

The off season is not a requirement by FIRST but can be very helpful in maintaining and improving skills. This can be a good time for everyone to reflect on how they did during the competition season so that everyone knows where they can individually improve, and overall, where the team can improve.

Starting Off

If the team decides to go into off season, start the first meeting by having a debriefing session. Talk to the students about what they enjoyed about the competition season and what they did not. It might be a good idea to bring up their goals that they made at the beginning of the competition season to see how far they have come and where they can still improve. During this discussion, have the students come up with another list of goals--either what they would like to accomplish by the end of the off season or goals for the next competition season. This is a good way to set a timeline of things to be accomplished during the off season.

Polishing Skills

Off season meetings can be run much like competition season meetings. In order to better student skills with the robot, have students continue using the same mat and complete missions that they might not have gotten to. Try challenging the students with the more challenging missions involving more complicated sensors or manipulators. This is a good way to improve their problem-solving abilities and get to know the programming better. One idea is to have each student take responsibility for one mission. Although this might be a challenge with a limited number of robots, each student will have a mission that they take credit for at the end of the off season and students can continue to work together through challenging missions, improving their utilization of the Core Values. If students are running out of missions to do, see if the team can borrow an older mat and kit or have them figure out the same challenges in different ways.

The project is another good thing to focus on during the off season. Although the students have already completed the project for that year, try having them focus on another aspect. There are usually many different problems associated with the game theme that the students can focus on to create a solution. If the students are not all that

interested in the game theme for that year, simply choose another theme. On the Central Texas FIRST FLL page, there is a list of previous challenges that students can access. The project meetings can be handled much the same way they are handled during competition season and is detailed in the project section of this Guide.

Engaging the Community

Another great thing the off season offers is a way to get more students into robotics. Because FLL teams can only have a maximum of ten students on the team during competition season, this restricts the number of members from the team's respective community that can be involved in one competition year. For off season, try opening up meetings to the entire community. This can help refresh members who might be leaving the team next year or inspire others to start FLL and robotics teams of their own.

However, opening up meetings to an entire community can also prove problematic, especially if there is a restricted amount of materials the team possesses. In that case, try organizing a community showcase. This can happen at the end of off season (whenever the team decides that to be) and is a good chance to show others what the team has accomplished. At this showcase, the students can have a chance to show the missions they have been working on during off season and also have a chance to share their project with the community and parents/guardians.

Learning From the Community

One of the final great things about engaging a team into the off season is the opportunity to go outside of regular robotics meeting. Living in Central Texas, there are many different technology companies that would be willing to show FIRST Lego League members future careers involving STEM. This is a great way to get the larger technology community involved and show students everyday situations involving robotics and STEM. To start, try asking adults involved in the team if they know of anyone who would be willing to give a tour of their workplace. Another option is to try an internet search for companies in the area and contacting them to see if a tour could be arranged. This is also a great way to utilize National Instruments or other mentors, to see if they would be willing to arrange a tour.

The off season can ultimately be run into the next competition season, but that is up to the community, coach, and team. However, if at a school, most after school clubs will have to be ceased at the start of standardized testing and into the summer break. That is completely okay because as much fun as it is to do robotics, it might be a good idea to take a break before going into the competition season. Either way, going into the off season, the team will have an advantage over others when it comes to the following competition season, while sustaining those skills and providing opportunities for students to continue into STEM careers some day.

5. Glossary

Brick or Brain: the part that controls the movement of the robot and is where the pre-programmed missions are downloaded.



Core Values: the fundamentals of FLL and what every team should strive to compete by. The complete list of Core Values can be found here: <http://www.firstlegoleague.org/mission/corevalues>

Challenge: the game that is released in September of each year consisting of a specific theme or problem facing the world. There are three parts to the challenge: the robot, the project, and the Core Values.

Coach: one whom is usually in charge of the team. Some responsibilities include, making a schedule, organizing when the team will meet, and overall, day to day running of the team.

Coopertition: competing in a cooperative environment.

Drivetrain: The base of the robot that involves how the robot will move. A basic FLL drivetrain consists of two back wheels for power and third wheel in the front for steering. (Pictured on next page.)

Back wheels.



Front wheel for pivoting.

Engineering Design Process: a series of steps used by professional engineers to map out how an engineering problem can be solved. A simple engineering design process involves: figuring out the problem, brainstorming and researching solution, prototyping the best solution, and continuously improving upon that prototype to get a finished product.

FIRST: For Inspiration and Recognition of Science and Technology; comprised of four different robotics levels from elementary school to high school, all designed to get students interested in STEM.

FLL: FIRST Lego League; the second level of FIRST that aims to teach 9-14 year olds not only about robotics but also how to develop presentation, business, and marketing skills.

Gracious Professionalism: a way of competing that involves bringing other teams up instead of putting them down.

Home Base: on the competition game mat, where the robot starts out. It is designated as a black box with tick marks and the entire robot must be contained within that box at the start of each match. This is the only place a team member can touch the robot during match play.

Mentor: one whom is usually specialized in a specific area of FLL and will help the team as needed in this area. However, this is not always true as a mentor can be a student who is generally interested in helping the students.

Missions: a series of mini challenges that the robot must complete as part of the Challenge in order to earn the team points.

Peanut Butter & Jelly Game: a way for team members to learn about the specificity programming requires by having the students give instructions to a coach (acting as the robot) on how to make a peanut butter and jelly sandwich.

The Project: consists of creating a patentable solution to the topical theme along with creating a presentation outlining the problem, the team's solution, and who they shared that solution with the community.

The Qualifying Tournament: the competition where the team can show off what they have accomplished. Usually held at one of the local high schools or by a partner of FIRST.

The Robot: an autonomously moving robot built out of Lego MindStorm parts with the brick as its core.



Source: Wikimedia Commons. Photo By: Eirik Refsdal.

STEM: Science, Technology, Engineering, and Math.

The Game Mat: the area where the robot challenge is played. The mat usually has up to ten missions that the robot can complete to earn points.

The Table: 96" by 48" of wood where the game mat lies. Each team will need to build their own table but will not have to bring it to their competitions. The instructions can be found here:

<http://www.firstlegoleague.org/sites/default/files/Challenge/TeamResources/NaturesFury/2013-14TableOnly.pdf>



A FIRST Lego League table holding a generic game mat.

The Team: a group of two to ten kids and one or two coaches all excited and eager to learn about robotics. A good recommendation is a robotics kit to student ratio of 1:5.

The World Championships: the biggest competition held by FIRST and is comprised of teams who have qualified at their regional/state events.

6. Helpful Resources

<http://www.usfirst.org/roboticsprograms/fll>

The official FIRST website on FIRST Lego League. Contains information on what FLL is about, how to start a team, and specifics about the game challenge.

<http://centraltxfirst.org/fll-program>

The Central Texas FIRST website on FLL. Provides other resources for how to get through the season and is a good starting point for other specific questions about FLL in Central Texas. This is also the same website where you can find previous game challenges to help you in your off season endeavors.

<http://centraltxfirst.org/fll-program/faq#how-do-i-find-an-fll-team-in-my-area%c2%a0>

Part of Central Texas FIRST's website, a way to find FLL teams in your area. Here, you can join the Central Texas FLL Yahoo! Forum or create an account for FIRST TeamUp.

<http://www.firstlegoleague.org/sites/default/files/Challenge/TeamResources/NaturesFury/2013-14TableOnly.pdf>

The instructions to create the table for the robot challenge found on the FIRST official FLL website.

<http://www.firstlegoleague.org/mission/corevalues>

The FLL Core Values from the FIRST official FLL website.

<http://www.firstlegoleague.org/challenge/teamresources#Robot-Game>

A helpful website when dealing with the game challenge. Has many resources on programming, building, and other game specific (and non specific) information.

<http://firstintexas.org/mentors/requestamentor/>

FIRST in Texas's website request a mentor form. It is located at the bottom of the page.

http://www.nxtprograms.com/five_minute_bot/steps.html

If using an NXT robot, step by step instructions to create a Five Minute Bot drivetrain.

<https://shslab.wikispaces.com/5+Minute+Bot+for+EV3>

If using an EV3 robot, step by step instructions to create a Five Minute Bot drivetrain.

<http://www.grantwrangler.com/>

An easy way to find out more about grants being awarded in your area.

<http://www.firstlegoleague.org/challenge/startateam#%20STEP%202:%20Form%20your%20team%20&%20register>

Under the Start a Team tab of the official FIRST FLL website, provides information on how to register your team with FIRST and order materials for the season.

7. Other Questions

What is the age range of FLL?

FLL is a program engaging students 9-14 years of age. This is not to say that participants over 14 cannot participate, but they **cannot** be registered as a student on a team. Some of the ways participants over 14 can participate are: volunteering at competitions or mentoring other teams. If a student is younger than nine, that student **can** still be registered as a student on an FLL team. However, this is up to the discretion of the coach, mentors, and that student's parents/guardians and is only recommended if the student does not feel as though the Jr. FLL program, which has students from 6-9, will challenge them enough.

Will I need to buy new materials every year?

Unfortunately, yes. Because the game challenge is different each year, the game specific mat and game specific kit will need to be purchased each year. However, the NXT/EV3 Kits and the table for the game challenge **does not** need to be purchased each year.

What happens when I register my team?

When you register your team, you will be given a team number. This is a way for FIRST to keep track of how many FLL teams are competing each year. Every year, you will need to re-register with FIRST.

Do I still need to register if I don't plan on competing?

No, you do not. The only time you need to register with FIRST is if you are planning to compete at a Qualifying Tournament.

Should the team continue into off season?

This is up to the team. If you find that the team is enjoying the program and the parent and guardian volunteers, coaches, and mentors are willing to keep helping, then by all means, continue into the off season. The off season is a great time for the team to continue improving upon their skills without competition. It will leave the team at a larger advantage over other teams that did not continue into the off season.

If the team decides to go into off season, when should the off season end?

Much like the decision to go into off season, this is up to the team. However, if you are working with a school, the school may ask you to cease activities getting into standardized testing time and through the Summer (May to August). If the team is not through a school, it may still be a good idea to stop activities over the Summer to allow the students a break.

Is it better to buy the NXT Kit or the EV3 Kit?

In terms of technical abilities, the EV3 is a better choice. The EV3's brick is faster and has a stronger processor than the NXT's brick. In addition, the EV3 allows for up to four motors to be connected at once instead of the NXT's three. However, if the team is trying to cut down on expenses, it might be a better option to go with the NXT model, as that will be the least expensive.

Is it better to compete rather than to solve the missions without competing in a Qualifying Tournament?

This really depends on the team's financial considerations and where the team wants to go. Competing is a great way to not only excite your team about robotics, but also an excellent opportunity to meet with other teams and get to see their designs. However, if the team has financial considerations, competing and registering with FIRST may not be a viable option. If your team decides not to compete, one solution is to hold a showcase to the community to show off all that your team has accomplished.

In addition, this decision might not be up to the team. If the team has acquired a grant in which one of the qualifications is that the team must compete in the Qualifying Tournament, then the team must compete. Check all grant regulations before applying.

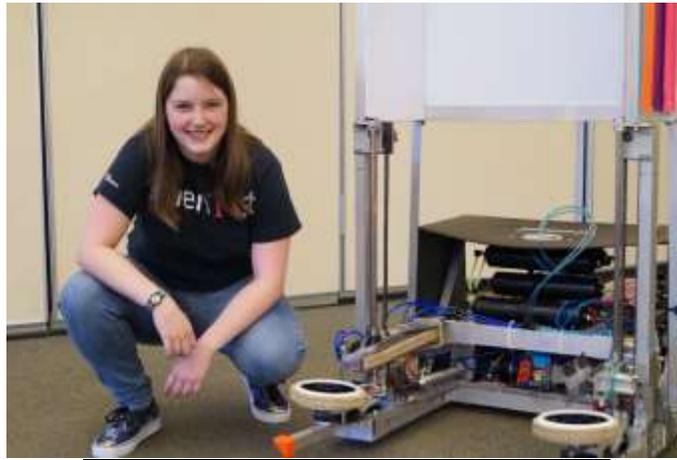
What is the time commitment for FIRST Lego League?

On a monthly basis, the competition season runs from September to April, April being the FIRST World Championships. However, if the goal of the team is to just get through the Qualifying Tournament, the competition season will be much shorter, running from September to December.

On a weekly basis, this really depends on the team and its goals. Some teams want to make it to the FIRST World Championship, meaning they might meet every day. However, other teams are content with only competing at a Qualifying Tournament, and may only meet once or twice per week. For a first year team, it is recommended to meet at least once for 2 hours each week, with possibly more meetings as it gets closer to a competition.

About the Author

Claire Blakely has been involved with robotics for the past five years. She was inspired upon this path beginning in the eighth grade when she joined the FIRST Robotics Competition Team 2881: The Lady Cans, a girl led Girl Scout robotics team in the Central Texas area. Since then, she has started three FIRST Lego League teams at elementary schools feeding into her high school, marking the first time in 2013, that every single school that fed into her high school had some sort of robotics program. She created this guide as part of her Gold Award Project for Girl Scouts to inspire others to pursue STEM through FIRST programs.



Claire Blakely with FRC Team 2881's 2015 competition robot.