2

HOW FLL WORKS

FLL is a unique competition. Unlike science fairs or robotics competitions, it consists of a wide range of team challenges that require individuals to combine many different skills to excel.

A new team may find the many aspects of FLL a little confusing at first. If this describes you, we'd like to help! In this chapter, we'll explain each category of the competition and how it works.

Although FLL is sometimes thought of as a robotics competition—like its counterparts FIRST Tech Challenge (FTC) and FIRST Robotics Competition (FRC)—robotics actually make up only half of the challenge. FLL has four different categories:

- Robot Game
- Project
- Robot Design
- Teamwork

These categories are combined into exciting competitions called *tournaments*. The following sections give an overview of tournaments and then describe the specifics of each category.

Tournaments

Tournaments are the climax of an FLL season. At a tournament, teams deliver their Project presentations, attend Robot Design and Teamwork interviews, and compete in the Robot Game.

Regions throughout the world host championship tournaments. The winners of these tournaments move on to the next level; qualifying tournament winners move on to the state tournament and so on. For example, in the United States, winners of state championships compete in national or international invitational tournaments.

The World Festival is a huge international invitational tournament composed of some of the best teams from around the world. Although it isn't the culmination of all championships, it is one of the most celebrated and prestigious tournaments. Learn more about upcoming FLL tournaments in your area on FLL's website, *http://www.firstlegoleague.org/*.

Robot Game

The Robot Game is one of the robotic categories of FLL, and it is one of the most well-known and exciting parts of the competition. For this challenge, teams have three to five months (the actual time depends on the region) to build and program a LEGO MINDSTORMS robot to autonomously accomplish several missions on a 4-by-8-foot playing field in two-and-a-half minutes. *Autonomous* means that the teams may not remotely control the robots. The robots compete for points by accomplishing as many missions as possible during a match.

NOTE *The two-and-a-half-minute time frame during which robots attempt their missions is called a* match. *A* round *consists of each team at a tournament completing one match.*

At the beginning of each new FLL season, teams receive a kit that includes a field mat, LEGO pieces, instructional materials, and other supplies to get started. Let's review these supplies, starting with the field mat.

Field Mat

The field mat is a flat, flexible, 4-by-8-foot plastic mat that makes up the area on which the robots compete. Graphics on the mat depict a virtual environment related to the competition theme. For example, the mat for the 2005–2006 Ocean Odyssey season pictured an ocean environment. Figure 2-1 shows the field mat used during the 2007–2008 Power Puzzle season.

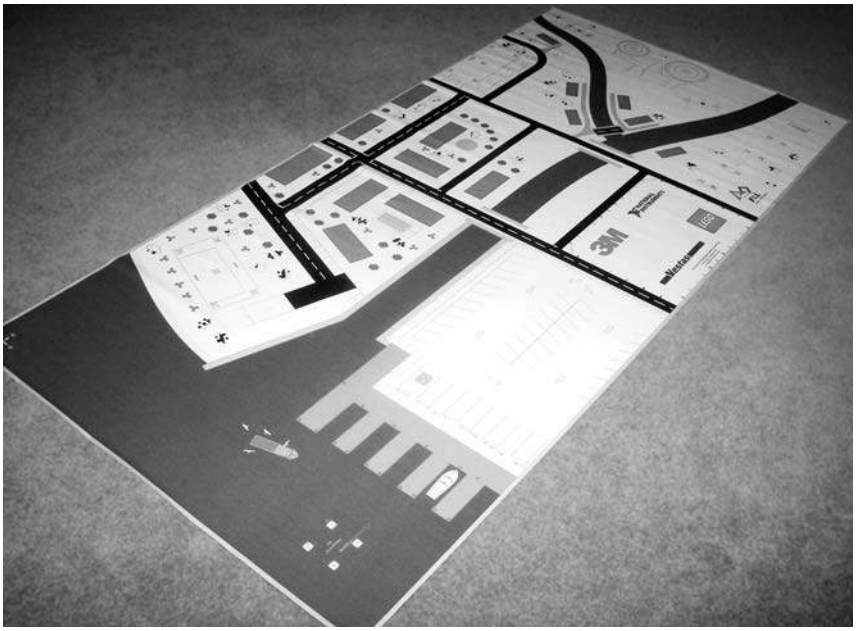


Figure 2-1: Field mat used during the Power Puzzle season

The mat should be set on a hard, smooth, and level surface, surrounded by 4-inch-high black borders (usually made out of 2-by-4-inch pieces of wood). At tournaments, the mats are usually set on custom-made tables, but teams can use other surfaces and borders for practice.

NOTE *It's fairly easy to build an official table. Find instructions for doing so on the "Field Setup" page of the FLL challenge website. We suggest that you use an official table to practice to make your preparation as realistic as possible.*

Although most graphics on the field mat are decorative, some represent *scoring areas* where certain objects (or even the robot) must be delivered to or taken away from to score points. Other graphics are represented for strategic reasons. For example, black lines may be part of the virtual environment (such as roads), but a robot's Light Sensor may also use them for navigation. Look for features on the mat that might help your robot navigate.

Field mats also include an area called *Base*, which is the robot's starting point. The Base is a three-dimensional area 16 inches (40 cm) high, surrounded by graphics and one side of the field. Figure 2-2 shows the Base on the Power Puzzle mat.

At the start of each round, the team's robot must be completely inside the Base area, which restricts the size of the robot and ensures that all robots start each round in the same place. Also, if the robot must be rescued (as discussed in "The Match" on page 16), it must be completely inside the Base before it can autonomously start again.

Figure 2-2: The Base for the Power Puzzle season, bordered by three road graphics and one side of the table

Mission Models

Mission models are the LEGO constructions that are involved in all missions. For example, a mission might require robots to push a lever on a building made out of LEGO pieces, which is a mission model.

The Field Setup Kit contains a bunch of LEGO pieces that make up the mission models, as well as a CD with instructions on how to build them. For example, Figure 2-3 shows the mission model components for the Power Puzzle season.

Building the mission models is a great activity for a first team meeting as a warm-up or introduction. The building itself can take a few hours, so it might be helpful to print out the instructions so multiple people can build at the same time. On the other hand, if the team wants to start on the robot right away, one member may want to build the models during spare time.

Once you build the mission models, attach them to the field mat with Dual Lock—a fastening material similar to Velcro—which comes with your Field Setup Kit. The field mat shows where to place the mission models and the Dual Lock.

NOTE *If you're not sure how to use Dual Lock, FLL has instructions on how to use it, along with other useful field setup instructions, on its website.*

Figure 2-3: Mission model LEGO pieces for the Power Puzzle season

Mission models create a variety of challenges for robots, which usually have to perform the following four types of actions with the models:

- Transfer the model
- Activate the model
- Deliver an object to the model
- Remove an object from the model

Transferring a Model

This action involves moving a mission model from one location on the mat to another. When a mission involves this action, the model that will be moved is not attached to the mat with Dual Lock—it simply rests in a specified position. For example, in the Power Puzzle season, the Hydro-Dam had to be moved on the mat from Base to a river so that the model touched both banks of the river without touching any of the houses nearby.

Activating a Model

Activating a model involves doing something to make it react in a specific way. For example, in the 2006–2007 Nano Quest season, the Self-Assembly mission required the robot to flick a lever on the mission model to start a chain reaction. Models that require an activation action are usually attached to the mat with Dual Lock so the robots can activate them without moving the entire model.

Delivering an Object to a Model

Sometimes a mission model includes an object that isn't attached to the main model. Instead, this object usually starts in Base, and the robot has to deliver it to a specified place on the main model. In the Nano Quest season, for example, one mission required robots to deliver an object from Base to a mission model and drop it onto a lever that then caused a wheel on the model to spin.

Removing an Object from a Model

Some missions require robots to remove one or more objects from a mission model. For example, the Oil Drilling mission of the Power Puzzle season required robots to move three oil barrels from an oil platform and place them safely ashore. Points were deducted from a team's score if the barrels touched the water (ocean).

The Match

At a tournament, tables are set up with two field mats next to each other and their four-inch-high borders connected. The mission models are placed on the mats.

Two teams compete on a table—one on each field mat. Although they are next to each other, the teams only interact on one mission model that is on the border between their field mats. Sometimes, the two robots compete to accomplish the mission first (with the winner scoring more points). Other times, the teams work together to accomplish the mission, with both teams scoring the same number of points if they succeed.

Each team may have two members act as *drivers* of the team's robot. The drivers set up the robot in Base before the match, run the programs, and manage the robot during the match. Drivers can change places with other team members, but only two drivers can be at the table at once.

When the drivers are ready, the announcer counts down, "3 . . . 2 . . . 1 . . . LEGO!" and the teams start their robots. The robots have exactly two-and-a-half minutes to accomplish as many missions as they can.

MULTIPLE RUNS

Teams commonly program their robots to perform a mission or two and then return to Base, where the drivers can set it up for more missions. This strategy proves very helpful in competition. First, it enables the team to continually realign the robot so navigation errors don't accumulate throughout the match. Second, it allows the team to use simpler attachments that need to work for only one or two challenges (as discussed in Chapters 10 and 11). And third, it enables drivers to modify their strategy during a match based on the robot's performance; for example, retrying a failed mission or skipping a low-point mission to make time for one with a higher point value.

If a robot gets stuck, the drivers can rescue it by picking it up and returning it to Base, though they risk losing points. They may grab their robot without penalty if any part of it is already touching Base—whether to modify it, reposition it, run another program, and so on.

The winner of the Robot Game can be determined in different ways. Sometimes teams compete in three or more competition rounds for the highest single or combined score. Other times, the top scorers move into elimination rounds in which teams compete in pairs and the winners of each pair move through successive rounds until one team wins. It's very exciting to watch the Robot Game—and even more exciting to compete in it.

The Project

The Project is one of the two nonrobotic categories of the FLL competition and has a bit of a science-fair style. Teams research and solve a real-world problem based on the challenge theme and present their research and solutions to their community. *Community* refers to local organizations, governments, companies—anything. The teams are also encouraged to impact their community in their research area (discussed in the "Presentation" section) and will typically be asked about this during a judging session.

At the beginning of the FLL season, the details and rules of the Project are posted on FLL's website at *http://www.firstlegoleague.org/* (click the link for your country, go to the current year's challenge page, and click **The Project**). The rules describe the Project's theme, general topic, and any special activities the teams have to do as part of the Project.

Research

Once the Project rules are posted, each team needs to choose a topic related to the theme. For example, in the Nano Quest season, in which the general theme was *nanotechnology* (the manipulation of atoms and molecules), a team might have chosen "Nanotechnology in Medicine" as its topic.

Once the topic is chosen, research it. For many Projects, you need to suggest a solution to a problem. For example, in the Power Puzzle season, the Project required teams to come up with ways to make a building more energy efficient.

You can perform your research anywhere, but keep in mind that judges like to see original research, such as personal interviews with scientists or information discovered during the team's experiments. Be sure to take good notes because you'll include your findings in a presentation that you give to members of your community and, ultimately, the FLL judges (learn more about the research portion of the competition in Chapter 15).

Presentation

Once your team has enough information, create a presentation for the judges at your tournament(s). The only requirement is that the presentation is shorter than five minutes (including setup), but otherwise, teams can give

just about any kind of presentation they want. Possible presentation styles include PowerPoint presentations, plays, videos, speeches—even operas!

Whatever your presentation, include as many team members as possible to demonstrate good teamwork and to show that the entire team contributed to the Project. The number of participating team members will probably affect your score. If many or all of the members participate, your score will most likely be higher than if only a few participate.

During the presentation, identify the real-world problem you researched and your proposed solution, and discuss the research you performed. Make sure the team members know the material well and can clearly and smoothly present their pieces without reading from notes.

The judges will then ask the team members questions related to the presentation. Among other things, they look for evidence that the members did all the work and have a good understanding of the information related to their presentation.

Sharing Your Project with the Community

In addition to presenting your Project to the judges, remember that part of the Project includes presenting your research and solutions to the community. One of the goals of FIRST is to get students interested in science and technology, so judges like to see evidence that a team has reached out to the community—the more, the better. Presenting scientific and technological results is important to scientists or engineers, and this aspect of the challenge gives team members valuable real-world experience in public speaking.

You can share your Project in several different ways. One common and effective way is to give your presentation for a group, such as a school, club, or even a senior living facility. Many seniors love seeing students learning about breakthroughs and accomplishments in science and technology that weren't around when they were young.

You might also consider adding some extras to your presentations. For example, give a short talk about FIRST and FLL, or offer more detail than you are able to give in the tournament (where presentations are limited to five minutes). You could even demonstrate your robot to make things more exciting.

Another kind of community outreach involves working with government or private organizations to impact your community in the area of your research. For example, if a team picked "Nanotechnology in Medicine" for its Project in the Nano Quest season, they could have talked to an area hospital about implementing some of the technology they researched. Even if the organization doesn't use your suggestions, the simple fact that you worked with them and tried to make an impact on the community is a nice addition to your Project. It will help your score, and best of all, it is a tremendous learning opportunity for the team.

Robot Design

In the Robot Design category of the competition, judges give a subjective score of the robot's design.

The judges will ask about the design of your robot in an interview called the *technical interview* (or *Robot Design interview*). For example, they'll probably ask how your robot works, how you built and programmed it, and how you overcame obstacles with its design. Many times they have a table set up with a field mat so you can show your robot in action. The judges look for well-designed robots that can accomplish missions in consistent, clever, and/or unique ways. They also look for evidence that the team members did all of the work on the robot (without the help of coaches or mentors) and evaluate the ways the team approached their particular design challenges.

Teamwork

The Teamwork category focuses on team dynamics—how team members work together. Your score for this category is partly based on how well you perform in an interview with the tournament judges. In evaluating teamwork, the judges consider the following categories, taken directly from the FLL rubrics (each is explained below):

- Team roles and responsibilities
- Gracious professionalism
- Problem solving
- Enthusiasm and member participation
- Understanding of FLL values

Judges have multiple ways of determining how well teams do in each category. For example, in the Teamwork interview, they may give the team a challenge, then make an evaluation based on how the team tackles that challenge. They also watch teams throughout the tournament and sometimes interview a team at their pit area (the team's home base).

Team Roles and Responsibilities

When evaluating the team in the roles and responsibilities category, the judges like to see teams that assign specific roles and distribute work among the members. For example, is there a Lead Programmer or Battery Manager? The judges also like to see members covering for each other as necessary. For example, if one member is sick, does another cover for that person? Chapter 6 discusses ways to determine team roles.

Gracious Professionalism

Gracious professionalism is one of FLL's core values. The *FLL Coaches' Handbook* describes gracious professionalism as follows:

> Gracious attitudes and behaviors are "win-win."
>
> Gracious folks respect others and let that respect show in their actions.
>
> Gracious professionals make a valued contribution in a manner pleasing to others and to themselves as they possess special knowledge and are trusted by society to use that knowledge responsibly.

Put simply, *gracious professionalism* means acting graciously and respectfully to teammates, other teams, and visitors to the competition. For example, if some of the teammates disagree about what to include in the Project presentation, the judges will expect the teammates to listen to one another and professionally resolve the disagreement. Gracious professionalism also applies to interactions with other teams (you might also call this *good sportsmanship*). For example, although this is a competition, the winning team should not attempt to put down the losing teams. By the same token, if one team loses a piece at the tournament and another team loans an extra to them, judges viewing the action will most likely increase the loaning team's score.

Problem Solving/Team Dynamics

The Teamwork judges are also interested in how teams overcome obstacles or solve problems they encounter. For instance, if a robot starts acting strangely the day before the tournament, the judges will probably be very interested in hearing how the team tackled that challenge. They look at how the members work together as a team, regardless of whether or not they ultimately solve the problem. The judges like to see evidence that all the members helped to solve the problem, working together and respecting one another's ideas.

Enthusiasm/Participation

During the interview, the judges look at how teams answer questions to see how enthusiastic and confident the members are. They also consider how many team members participate in answering questions; the more, the better, of course.

Understanding of FLL Values

Finally, judges consider how well team members understand FLL values and how much they learn from the FLL experience. For example, they listen for a demonstrated interest in science and technology on the part of the team members. They also want to hear that the team has learned useful things from participating in FLL, whether they learned how to build and program robots, how to present to large groups, or anything else.

Team Challenge

As mentioned earlier, sometimes the Teamwork category includes a surprise challenge that the team first learns about only in the Teamwork interview. These challenges differ for each tournament and can include just about anything. For example, one challenge in a tournament during the Nano Quest season required teams to build the tallest possible structure out of (uncooked) spaghetti noodles and mini-marshmallows. Teams have a limited amount of time to attempt the challenge. As they work on the challenge, judges look at how the members interact, how many participate, and how they perform in other aspects of the Teamwork category.

Awards

What's a competition without trophies? FLL tournaments usually give out several awards. They are often made out of LEGO bricks, like the trophy shown in Figure 2-4. Most tournaments give out at least the following five main awards:

- Robot Performance Award
- Robot Design Award
- Project Award
- Teamwork Award
- Champion's Award

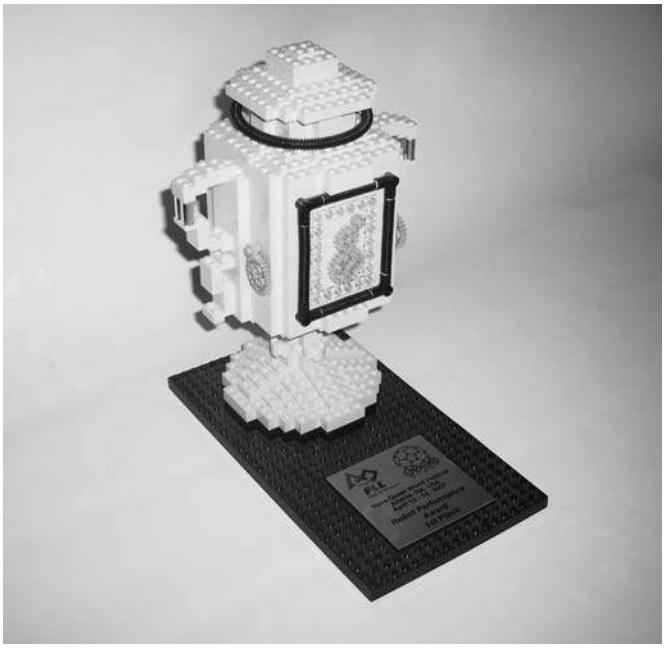


Figure 2-4: An FLL trophy, made out of LEGO pieces

The first four awards are given to the teams who do the best in the respective categories of the competition. The Champion's Award is considered the highest award in FLL, and it usually determines which team moves on to the next championship tournament. It is based on all four categories of the competition, and each category is weighed equally.

NOTE *Teams can only win one of the Championship Tournament Awards, unless the winner of the Robot Performance Award, for example, also wins the Champion's Award. Each team may also win awards in only one championship series.*

Many tournaments give other awards as well. For example, some reward outstanding coaches or mentors. Others, such as the Rising Star Award, are awarded to teams that give an exceptional performance in some area even though they're not a winning team.

AUTHOR SNAPSHOT

Many of the suggestions in this book are drawn from Jonathan Daudelin's firsthand experience participating in FLL as the leading member of Team 1221: Built On The Rock during the 2006–2007 season. His team's robot achieved two perfect scores at the state tournament and won the Champion's Award. This award earned them an invitation to the World Festival, where Team 1221 and one other team made history by becoming only the second and third teams to achieve perfect scores in all three Robot Game rounds. Besides sharing the First Place Robot Performance Award, his team also won the First Place Innovative Robot Award.

5

STARTING OR BUILDING A TEAM

Assembling an FLL team can sometimes be as simple as pinning a signup sheet to a classroom wall or asking a group of friends to participate. But the reality of the situation is that there's often much more to organizing an FLL team than a simple show of hands or list of names. Sometimes a team isn't formed as quickly (or easily) as you might think. Recruiting and selecting team members can be time consuming. Sometimes more team members want to participate than there are team slots. Then there's the administrative issue of registering the team.

This chapter provides some suggestions not only for forming a new team, but also for selecting members and building an existing team. The methods discussed are certainly not the only ones you can use, but they are the result of the experience of several FLL coaches and teams that have struggled with these issues.

We start by discussing building a team from the ground up and then move into managing an existing team in which rookies may join veteran members. By the end of this chapter, you should have enough information to form a team and start the season.

Methods for Starting a New FLL Team

Although FLL teams can be created in many different ways, the following covers some of the more common ways.

School Programs

Many schools participate in FLL with students from a math, science, or other class. This is the most common start for an FLL team; schools frequently draw on their teachers to act as coaches, with parents providing assistance. Schools provide resources such as computer labs, robotics kits, and meeting spaces—all of which a team will require during the season.

After-School Programs

After-school programs can take on many forms. Sometimes a school provides a program, but often a nonprofit or other business entity supports an after-school program. Like schools, programs such as this can usually provide resources such as computers and robot kits for the teams to be productive.

Community and Church Groups

Check with your local community centers and churches to determine if they offer a team. Civic organizations and churches often enjoy sponsoring teams as a means of reaching out to the community. Sometimes funding is extremely limited, though, so teams often have to provide their own computers, laptops, and robot kits.

Homeschool Groups

Many homeschool groups and families participate in FLL for both the experience of competition and for school credit. Homeschooled students must not only make certain that they have access to resources the team will need but that they also fulfill any educational requirements (such as tracking the time spent on activities) as defined for homeschool programs.

Motivated Parents or Children

Sometimes a parent or child aware of FLL may be all the impetus needed, many times using one of the above means to assemble and support a team. Parents who wish to involve their children have even created small teams of two or three siblings.

Getting Started

Starting a new team from scratch can be easier than reorganizing an existing team. Existing teams frequently have a “this is how we do it” attitude, and new members may feel overwhelmed and a bit shy about expressing their

opinions and suggestions for improvements. New teams do not have to be concerned with predefined rules or methodologies, which can allow the team some real freedom to explore new ways to work together. So let's build a team.

The following are the steps we follow when forming a new team:

1. Announce that a team is being formed.
2. Begin accepting applications with a well-defined deadline.
3. Hold your first team meeting (covered in more detail later in this chapter and in Chapter 6).

Announcing Formation of a Team

You can announce that you are forming an FLL team in many ways. Some common methods include the following:

- Announcement to parents in a school newsletter
- A community notice in a newspaper
- Phone calls to friends
- An after-school program mailer

No matter which method you use, be sure that it reaches enough people so that you have enough to field a team. FLL teams are limited to 10 students, and depending on your announcement method, too few or too many students may sign up (see "Selecting Final Team Members" on page 46 for help if you find you have more applications than team slots).

Either way, ensure that no students are left out of the application process because they weren't aware of the announcement. Also, depending on how much adult help the coach will have, it may make sense to limit the number of team members for manageability; you don't need to have 10 team members to have a successful season.

When soliciting participation, you may want to include a deadline for receiving and reviewing applications, but be careful about making exceptions. Applicants should feel that all the team members are participating in a fair selection process, and early acceptance of any student applications could bring charges of favoritism.

Finally, briefly explain how you will accept applications. For example, if you will require applicants to write a short essay explaining why they want to be on the team, mention this in the announcement to allow applicants to begin preparing. Likewise, if you will use a simple signup, share that information as well.

Figure 5-1 shows a sample email announcement, including relevant information that an applicant needs to satisfy the application process (download this sample announcement at *http://thenxtstep.com/book/downloads/*).

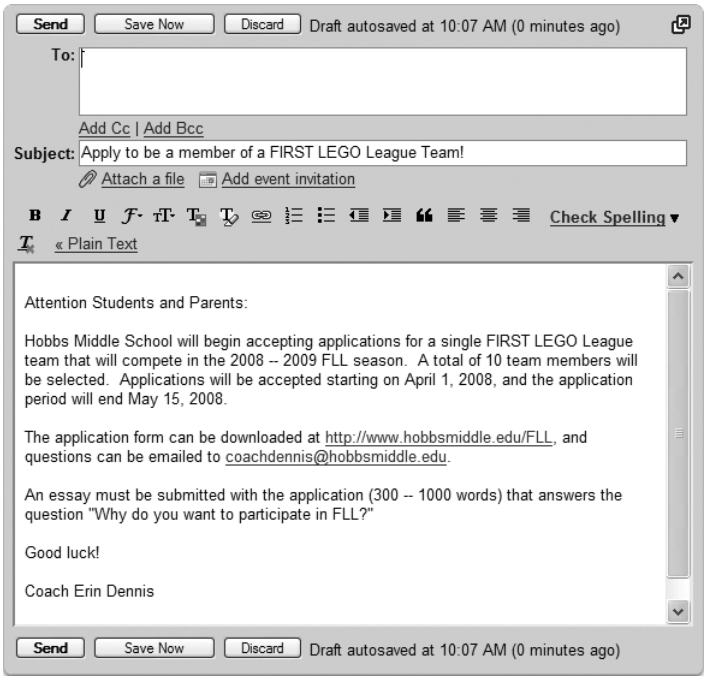


Figure 5-1: An email announcement for a new FLL team

Accepting Team Member Applications

After you announce the team and establish a date for accepting applications, it's time to start collecting applicants. Possible methods for accepting applicants include one or all of the following:

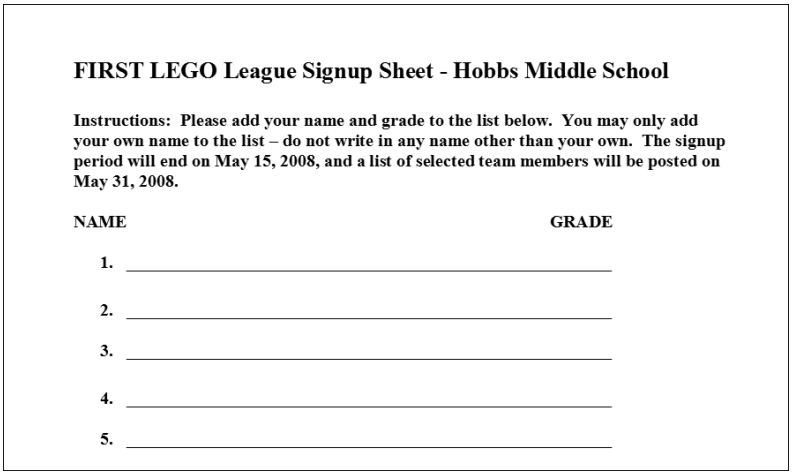
- Signup sheet
- Printed application
- Interview
- Essay

Signup Sheet

A *signup sheet* is simply a list of people who want to become team members. However, using a signup sheet alone can cause some problems. For example, will team members be selected based on the order in which they sign up? If so, what if a student is sick on the day you post the sheet?

Signup sheets also provide little information about the student's skills or commitment to the new team. If you use a signup sheet, use it only as a method to gather information about interest and the potential size of the team. Then allow for other factors, such as an essay and skills assessment (as discussed below), to help select applicants.

Figure 5-2 shows a sample signup sheet (download this signup sheet at *http://thenxtstep.com/book/downloads/*).



FIRST LEGO League Signup Sheet - Hobbs Middle School

Instructions: Please add your name and grade to the list below. You may only add your own name to the list – do not write in any name other than your own. The signup period will end on May 15, 2008, and a list of selected team members will be posted on May 31, 2008.

NAME **GRADE**

1. _____
2. _____
3. _____
4. _____
5. _____

Figure 5-2: A signup sheet is a good start for collecting the names of interested students.

Printed Application

Requesting that prospective team members complete a printed application can help a coach whittle down a large applicant pool by providing insight into each applicant's commitment and skills. This application would request parent names, phone numbers, and email addresses, as well as an additional applicant requirement, such as a written essay (for example, "Why do you want to compete in FLL?") or a checklist of skills the applicant brings to the team. Figure 5-3 shows a sample application.

Interview

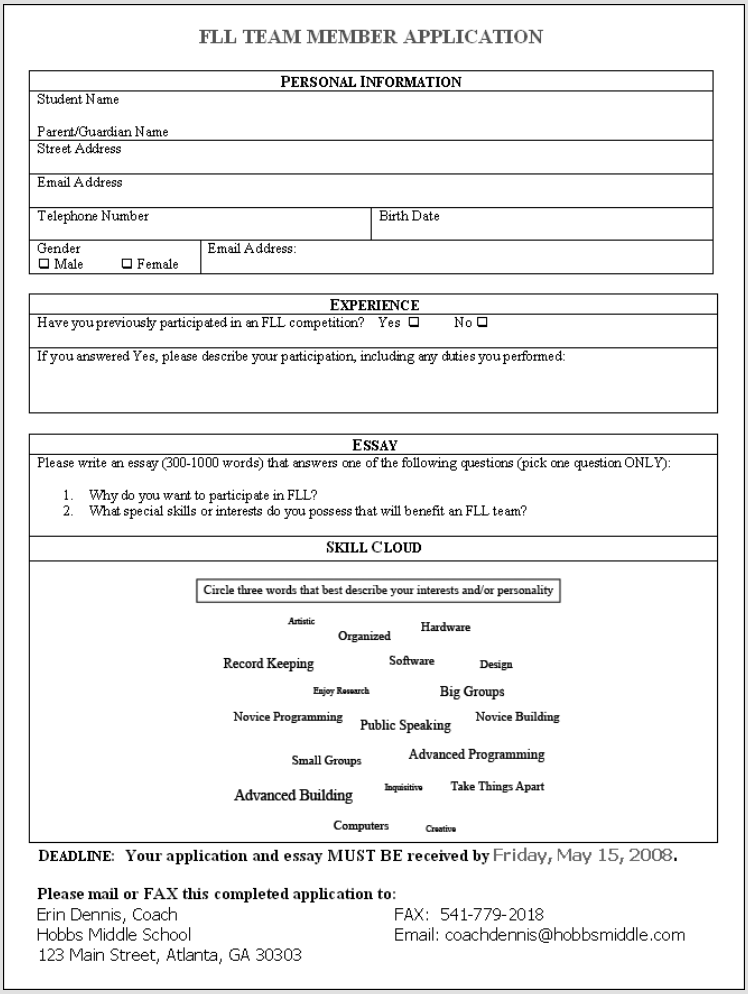
Interviewing applicants is a great way to find the most qualified applicants, but it's also extremely time consuming. For example, if the interviewer grants 10 minutes to each applicant, interviewing 30 applicants will take more than 5 hours. And this doesn't include the actual selection process in which you review your notes and pick the best candidates. If you decide to conduct interviews, do so only if time permits, and be certain to give every applicant the same amount of time and identical questions. Take good notes on each applicant's responses too.

One option in lieu of an interview is a questionnaire (which should supplement the team application, not replace it). Figure 5-4 shows a sample with a list of 10 questions. Applicants are limited to two to three sentences for each response to a question. The reviewer assigns a value between 1 and 10 based on the quality of each of the applicant's responses and then adds up the values to calculate that applicant's total questionnaire score. These scores can then be used as an additional factor in the decision-making process (download this questionnaire at *http://thenxtstep.com/book/downloads/*).

SKILLS ASSESSMENT

Jessica Mallard, a fifth-grade teacher at Wichita Collegiate School in Kansas, suggests including a "skill cloud," which is a list of words the applicant can circle to indicate skills and interests, on the application. See an example of a "skill cloud" in Figure 5-3.

> For students with no experience, I have them circle words in a word cloud that describe them best (logical, artistic, hands-on, mechanical, communicative, etc.) and place them based on whether the answers are more "programmer-like" or "builder-like." More experienced builders and programmers become Builder 2 and Programmer 2 in their respective groups. Less experienced students are Builder 1 and Programmer 1.



FLL TEAM MEMBER APPLICATION

PERSONAL INFORMATION

Student Name Parent/Guardian Name	
Street Address	
Email Address	
Telephone Number	Birth Date
Gender ☐ Male ☐ Female	Email Address:

EXPERIENCE

Have you previously participated in an FLL competition? Yes ☐ No ☐

If you answered Yes, please describe your participation, including any duties you performed:

ESSAY

Please write an essay (300-1000 words) that answers one of the following questions (pick one question ONLY):

1. Why do you want to participate in FLL?
2. What special skills or interests do you possess that will benefit an FLL team?

SKILL CLOUD

Circle three words that best describe your interests and/or personality

Artistic
Organized
Hardware
Record Keeping
Software
Design
Enjoy Research
Big Groups
Novice Programming
Public Speaking
Novice Building
Small Groups
Advanced Programming
Advanced Building
Inquisitive
Take Things Apart
Computers
Creative

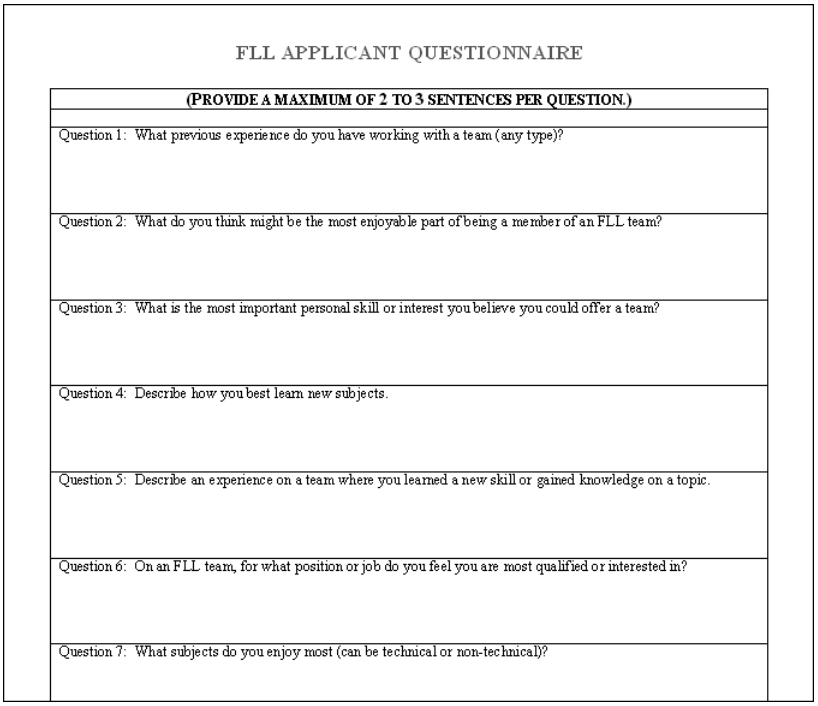
DEADLINE: Your application and essay MUST BE received by Friday, May 15, 2008.

Please mail or FAX this completed application to:

Erin Dennis, Coach
Hobbs Middle School
123 Main Street, Atlanta, GA 30303

FAX: 541-779-2018
Email: coachdennis@hobbsmiddle.com

Figure 5-3: Use an application to let applicants describe their skills and experience.



FLL APPLICANT QUESTIONNAIRE

(PROVIDE A MAXIMUM OF 2 TO 3 SENTENCES PER QUESTION.)
Question 1: What previous experience do you have working with a team (any type)?
Question 2: What do you think might be the most enjoyable part of being a member of an FLL team?
Question 3: What is the most important personal skill or interest you believe you could offer a team?
Question 4: Describe how you best learn new subjects.
Question 5: Describe an experience on a team where you learned a new skill or gained knowledge on a topic.
Question 6: On an FLL team, for what position or job do you feel you are most qualified or interested in?
Question 7: What subjects do you enjoy most (can be technical or non-technical)?

Figure 5-4: A questionnaire can be useful during the selection process.

Essay

An essay can give you just as much insight into a student's excitement and commitment to an FLL team as an interview. An essay can provide more detail about an applicant than the short responses on a questionnaire, but you are typically limited to one or two essay topics. Some possible essay topics include the following:

- Why do you want to join an FLL team?
- What are your expectations as a potential FLL team member, and what skills or talents do you bring to the team?
- Describe a school project or personal project that you worked on; include a description of the types of work you performed and the results of the project.
- What are some of your favorite subjects, and how would you incorporate them into a position on an FLL team?

Prepare for the team member selection process by combining all the applicants' essays with their respective applications, interview notes, skills assessments, or questionnaires.

10

BASIC BUILDING

Building robots is an art. Using a bunch of pieces to form a working robot is quite an exciting accomplishment! As it turns out, you can use many techniques to refine your skill and proficiency at building LEGO robots. This chapter goes over some of these techniques and gives general tips on building good robots.

NOTE *Since NXT is the newest system used in FLL, and since RIS may be removed in future years, the building techniques discussed here focus on the NXT system. However, many methods may apply to the RIS as well.*

Although we discuss several useful techniques in this chapter, the best way to enhance your skills is simply to spend time building and experimenting with robots. The more you build, the better you become at it!

Using Existing Models

Our first helpful tip has nothing to do with building! If you have a hard time coming up with a design or don't have enough time to create a new one, you might want to simply modify an existing basic design.

For example, you probably want to build a mobile robot for the Robot Game. A *mobile robot* is basically just a chassis that uses two motors and three wheels to move forward, backward, and turn.

You may have already built a basic mobile robot or have instructions for building one, such as the TriBot from the Education or Retail Kits. These basic robots are a great beginning because you can modify them to do what you want. For example, you could add a motor that will flip a lever on a mission model or attach an Ultrasonic Sensor to detect an obstacle.

Our point is that you can take an existing "generic" design, such as a simple chassis, and modify it to suit your needs. Not only does this eliminate some of the building, but it can also help you get started. After working on some of the missions, you might decide to return to that starting design and make changes.

TECH TIP: BASE DESIGNS

Use what you know! Why reinvent the wheel when your team can start a robot design using a preexisting robot? The Internet has readily available designs, such as the JennToo (designed by LEGO MDP/MCP Brian Davis), and you can always use the very popular TriBot design that comes with your NXT-G software tutorials. If time is limited or your team is not very experienced with robot design, start with an existing design and modify it as needed.

Building from a "Foundation"

Building a robot from scratch is trickier than modifying an existing design because you don't have anything to build "off of." Rather, you need to put together a bunch of individual pieces.

When building from scratch, consider using pieces like an NXT Brick or motor as the "foundation" of the robot. For example, to build a rover that uses two motors, each of which is attached to a rear wheel, start building the rover with these motors. Connect pieces to a motor so that it turns a wheel, and then do the same thing with another motor. Next, connect the two motors so there is a wheel on each side of the robot. Finally, add the front wheels, the NXT Brick, and any other parts you want.

Sounds pretty easy, doesn't it? This simple starting method gives you a sense of direction because it helps you see which pieces to use and where to put them.

Building with Modular Design

Modular design consists of connecting multiple *modules*, or components, to form a robot. For example, make two modules, each with two wheels and a motor that turns them. Then make modules for a robotic hand and the NXT Brick, and connect all these modules together to form a rover equipped with a robotic arm.

Using modules when you design can help organize your thought process by breaking up the entire robot into smaller, more manageable components (which can also reduce your work). Another example is building a module for two wheels on one side of the robot and then adding the other two wheels by copying the opposite module. Figure 10-1 shows an example of a module for a tread.

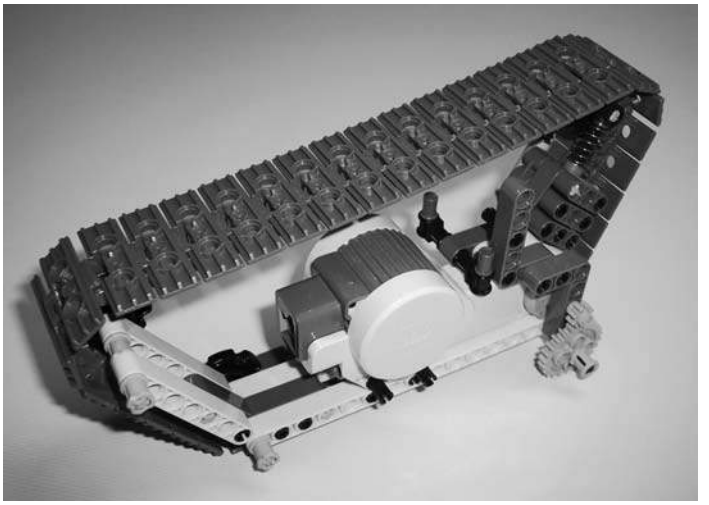


Figure 10-1: A module for a tread

This module consists of a motor that drives a tread. To build a rover that uses treads, simply copy this module on the opposite side, connect the two, and add an NXT Brick.

Bracing Your Design

Have you ever had a design that was not sturdy or strong? If so, you probably could have fixed the problem by bracing the design. Consider the robot in Figure 10-2.

Figure 10-2: A robot that hasn't been braced can have a weak structure.

What's wrong with this robot? It isn't very sturdy, right? The wheels bend away from it, which will harm its performance: The robot might not turn as accurately, and it might move in a slight curve instead of a straight line.

Fix this problem by bracing the wheels, as Figure 10-3 shows.

The beam connecting the two motors is called a *brace*, which keeps the wheel mechanisms from moving toward or away from each other. Bracing your designs makes them much stronger. This in turn can improve their accuracy, which is usually important in the Robot Game.

Figure 10-3: The robot in Figure 10-2 after being braced with beams connecting the motors

TECH TIP: WHEEL CAMBER

Here's a new term for you: *camber*. *Camber* describes whether the wheels on a vehicle (such as a car) are angled inward or outward. A *zero-camber wheel* is a wheel that is angled 90 degrees vertically, or is perfectly perpendicular to the surface.

For example, Figure 10-3 shows a robot with negative camber, or wheels that bend outward. A robot with the motors and wheels directed inward has positive camber.

You should always try to reduce positive or negative camber because it can prevent a robot from moving in a straight line. Even worse, if only one wheel has negative or positive camber, it will result in an unwanted curving motion.

Types of Braces

You can brace designs with straight or diagonal braces as Figure 10-4 shows.

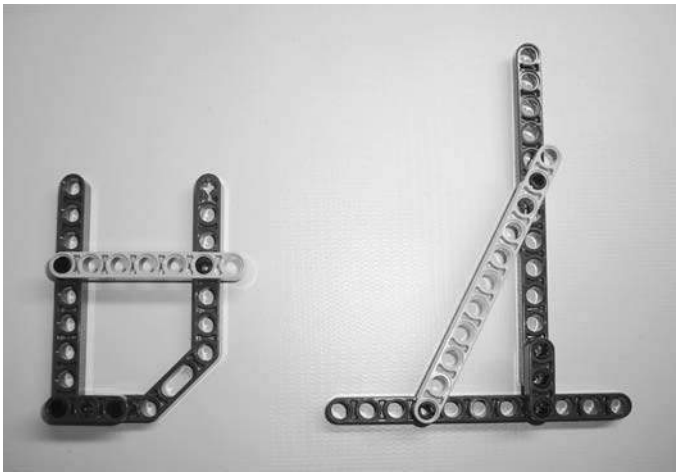


Figure 10-4: A straight brace and a diagonal brace

Diagonal braces are often used to stabilize a long object that is only connected at one end. For example, suppose a sensor is attached to a pole that extends several inches above the robot. If this pole is attached in only one place at the bottom, it will probably bend pretty easily. Adding a couple of diagonal braces to connect the top of the pole to the robot makes it much stronger.

When bracing, it's a good idea to use three or more *contact points* (points where the brace connects to the design) to make the brace stronger, as Figure 10-5 shows.

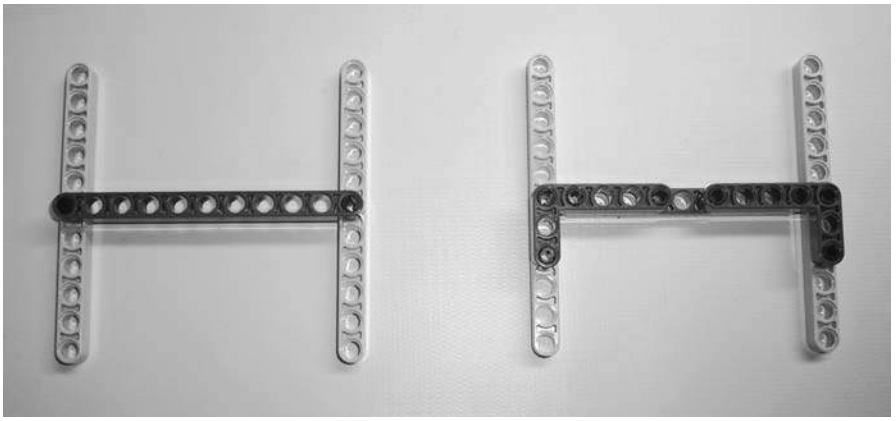


Figure 10-5: Two contact points versus four

The brace with only two contact points doesn't work as well as the one with four, because the beams with two might rotate. Usually, the more contact points you have, the less your connected objects are likely to rotate and the stronger your brace.

Connecting a Brace

You can connect a brace in several different ways. One common way is simply to connect a beam to the desired objects using pegs. However, sometimes this doesn't make a very strong connection, so Figure 10-6 shows two examples of stronger brace connections.

Figure 10-6: Two examples of strong brace connections

Notice how strong these connections are. They won't come off unless you push out those little axles! Also notice that if the other sides of the braces had similar connections, each would have four contact points.