FIRST LEGO League Coaches' Handbook

3rd Edition, 2007 printing

FIRST LEGO League

200 Bedford Street

Manchester, NH 03101

usfirst.org

firstlegoleague.org

FLL is the result of an exciting alliance between *FIRST* and The LEGO Group

FIRST LEGO League Core Values

We are a team.

We do the work to find solutions with guidance from our coaches and mentors.

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 in everything we do.

We have fun.

A Special Thanks:

We would like to thank Patrick S. Sweeney for his generous content contributions to the *FIRST LEGO League Coaches' Handbook*.

FLL Coaches' Promise

As the coach of a *FIRST* LEGO® League (FLL) team, please read the information below for further understanding of FLL core values. As coach, you are responsible for honoring and communicating FLL core values to team members, team volunteers, parents, and others affiliated with your team.

All teams are expected to abide by FLL rules and guidelines as they exist now and as they may be set forth during the season. Team rules, guidelines, and policies and procedures are detailed in this handbook. Any updates, additions, participant consent forms, volunteer recruitment, screening, and supervision guidelines for the team will be communicated to FLL coaches via email and posted on the *FIRST* LEGO® League section of www.usfirst.org.

MY PROMISE AS COACH:

1) The children come first. FLL is about the children having fun and getting excited about science and technology. Everything my team does starts and ends with that principle.

2) The children do the work. This is their opportunity to learn and grow. The children on my team do all of the programming, research, problem solving, and building. Adults can help them find the answers, but cannot give them answers or make decisions.

3) My team is comprised of ten or fewer members (all team members participate on only one team), registered as an official FLL team, and all team members are no older than 14 on January 1st of the Challenge year.

4) FLL communicates with my team via my primary email address, and I am responsible for reading and relaying all aspects of FLL guidelines and rules to my team, other coaches, volunteers, and parents.

5) I will encourage my team members, other coaches, volunteers, parents and team supporters to develop and practice a set of FLL Values that reflects *FIRST*'s goal to change culture in a positive way by inspiring others through our team's actions and words.

TABLE OF CONTENTS

Chapter 7 – The Tournaments

Chapter 8 – Awards & Judging Criteria

Chapter 9 – Checklists & Schedules

Appendix A: Rubrics

Appendix B: Additional Resources

ABOUT *FIRST*

"…to create a world where science and technology are celebrated… where young people dream of becoming science and technology heroes."

Dean Kamen, Founder, FIRST

FIRST

FIRST (For Inspiration and Recognition of Science and Technology) was founded by inventor Dean Kamen to inspire young people's interest and participation in science and technology. Based in Manchester, N.H., *FIRST* is a 501 (c) (3) not-for-profit public charity.

A volunteer-driven organization, *FIRST* is built on partnerships with individuals as well as businesses, educational institutions, and government. Some of the world's most respected companies provide funding, mentorship time and talent, and equipment to make *FIRST*'s mission a reality. As a team coach, you join over 45,000 committed and effective volunteers who are key to introducing over 130,000 youths to the joy of problem solving through engineering.

FIRST provides two well-known programs, the *FIRST* Robotics Competition (FRC) for high-school-aged young people and *FIRST* LEGO® League (FLL) for 9 to 14 year-olds. *FIRST* also offers the Junior *FIRST* LEGO League (JFLL) for 6 to 9 year-olds and the *FIRST* Vex Challenge (FVC), an intermediate robotics competition that offers students the traditional challenge of a *FIRST* Robotics Competition but with a more accessible and affordable robotics kit. Also located at *FIRST* headquarters is the research and development facility called *FIRST* Place. *FIRST* Place is integral to FLL game design, new program development, evaluation, and professional development of *FIRST* mentors.

Since 1992, the *FIRST* Robotics Competition (FRC) has challenged high school students — working with professional mentors — to solve an engineering design problem in an intense and competitive way. The program is a life-changing, career-molding experience — and a lot of fun. In 2007, the competition reached more than 32,000 students on over 1,300 teams in 37 regional competitions and one Championship event. Our teams come from Brazil, Canada, Israel, Mexico, the Netherlands, the United Kingdom, and every U.S. state.

In 1998, *FIRST* Founder Dean Kamen and The LEGO Group's Kjeld Kirk Kristiansen joined forces to create *FIRST* LEGO League (FLL), a powerful program that engages younger children in playful and meaningful learning while helping them to discover the fun in science and technology through the *FIRST* experience.

As of 2006, children in 44 countries are active in FLL. We are thrilled to have teams in Australia, Austria, Bahrain, Belgium, Brazil, Canada, Chile, China, Denmark, Egypt, Faroe Islands, Finland, France, Germany, Greenland, Hong Kong, Hungary, Iceland, India, Israel, Japan, Jordan, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Nigeria, Norway, Palestine, Peru, Portugal, Saudi Arabia, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Turkey, United Arab Emirates, the United Kingdom, and the United States.

"We want to change the culture by celebrating the mind. We need to show kids that it's more fun to design and create a video game than it is to play one."
Dean Kamen
Founder, FIRST

Dean Kamen is President of DEKA Research & Development

Corporation, a dynamic company focused on the development of revolutionary new technologies that span a diverse set of applications. As an inventor, physicist, and entrepreneur, Dean has dedicated his life to developing technologies that help people lead better lives. Founding *FIRST* is among Dean's proudest accomplishments.

"FLL encourages children to design, construct, and program their own intelligent inventions. This allows them not only to understand technology, but to become masters of it."
Kjeld Kirk Kristiansen
Owner & Deputy Chairman, The LEGO Group

Kjeld Kirk Kristiansen is the principal shareholder of the 100% family-owned LEGO Group. He is the Vice Chairman of the Board of Directors of LEGO Holding A/S and also Chairman of several of the largest companies in The LEGO Group, which today consists of 50 companies in Denmark and abroad, employing around 7,300 people.

Dean and Kjeld have a shared belief that when FLL teams research, build, and experiment, they live the entire process of creating ideas, solving problems, and overcoming obstacles, while gaining confidence in their abilities to positively use technology.

Chapter 1: Building a Foundation

FIRST LEGO® League (FLL) relies on volunteers to run the program at many levels, from managing a region to coaching an individual team. We call our volunteers in each region FLL Operational Partners, or FLL Partners. These FLL Partners fundraise, run tournaments, hold workshops and demonstrations, market FLL locally, handle public relations, and recruit volunteers and teams. They are a tremendous resource for you as a team coach, and FLL would not exist without them.

CORNERSTONES

Our FLL Partners agree to maintain certain standards relative to tournaments, the Challenge, and overall program administration. At the same time, the resources of each FLL Partner vary from region to region. Some FLL Partners are affiliated with major corporations that support *FIRST* and FLL. Others are based in a non-profit that has a complementary mission to FLL, and some are individuals with a passion for our cause, operating out of their homes. For all FLL Partners, their most important goal is to share the FLL program with as many individuals as possible.

FLL Values

We ask all who participate in FLL to uphold the following values:

- Respect each other in the best spirit of teamwork
- Behave with courtesy and compassion for others at all times
- Honor the spirit of friendly competition
- Act with integrity
- Demonstrate gracious professionalism
- Focus on the experience and not the awards
- Remember that the children do the work
- Encourage others to adopt these values

Gracious Professionalism

Dr. Woodie Flowers, National Advisor for *FIRST*, speaks about gracious professionalism in this way: “The *FIRST* spirit encourages doing high-quality, well-informed work in a manner that leaves everyone feeling valued. Gracious professionalism seems to be a good descriptor for part of the ethos of *FIRST*. It is part of what makes *FIRST* different and wonderful.

Gracious professionalism can and should mean different things to each of us. It is possible, however, to outline some of its meanings:

- 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.

In the long run, gracious professionalism is part of pursuing a meaningful life. One can add to society and enjoy the satisfaction of knowing that you have acted with integrity and sensitivity. That’s good stuff!”

FLL is a child-centered activity and is about giving children a unique and stimulating experience. We want them to learn the value of teamwork and to respect everyone’s ideas and contributions to the team. FLL values are about appreciating our differences and learning what those differences add to our lives. FLL succeeds most fully when team members bring the FLL values they learn back to their communities.

The FLL Challenge

Each September, we provide FLL teams around the world with an annual Challenge. The Challenge is based on a set of real-world problems facing scientists and engineers today. It has two parts: a **robot game** and a **project.**

In the **robot game,** teams design, build, program, and test autonomous robots that must perform a series of tasks, or missions.

In the **project,** teams conduct research and create a technological or engineering solution to an aspect of the Challenge and present that solution.

For roughly eight fast-paced weeks, each team is guided by at least one adult coach and works as a group to overcome obstacles and meet challenges while learning from and interacting with their peers and adult mentors. Teams work to find creative solutions to the problems presented to them in the Challenge. They then compete in optional local and regional tournaments where they celebrate their accomplishments with other FLL teams, family, and friends.

After the hard work and a lot of fun, children come away with a greater appreciation of science and technology and how they might use it to positively impact the world around them. In addition, they cultivate life skills such as planning, brainstorming, collaboration and teamwork, as well as research and technical skills.

Chapter 2: Building a Team

Coaching an FLL team can be one of the most rewarding experiences of your life. And like any great reward, it involves a commitment of time and energy.

THE FOUNDATION

To succeed, both the coach and the team members must commit to the entire process. Above all, it's important to remember that the children need you to give them guidance and provide structure, encouragement, and most of all, a fun experience.

Teams require at least one adult coach. As the coach, you must be 18 years or older. Lots of people make good coaches such as parents, teachers, engineers, college students, and scout leaders. It requires no special skill, just patience, dedication, and a willingness to learn alongside the team. You will need to direct the process the team follows to solve the Challenge without providing the solution yourself.

In addition, you must be willing to acquire some basic knowledge of the programming environment and LEGO robot building. We encourage you to enlist the support of a technology mentor or guest speakers for additional assistance. We also recommend that you invite people with backgrounds in engineering, programming, and the science of the Challenge to share their knowledge and experience with your team.

Advice for Coaches

Don't take this too seriously! We want you to enjoy the experience. Our goal is for you to help the children have fun with robots while they get comfortable with technology and learn something about a real-world problem. Whether or not your team scores high marks at a competition, team members win just for participating. If you throw in a discussion about friction while they eat pizza, you're doing a great job.

If it is your rookie year, enjoy it for what it is: a survey of the course. Your goal should be to simply take a lap around the block with FLL. With a fun experience and meeting realistic goals under your belt, you and the children will be brimming with ideas about what you plan to do next year.

The Children

Your FLL team will have up to ten children, ages 9 to 14. For a true team experience, we recommend a minimum of three children per team. To be eligible, a child cannot be older than 14 on January 1 of the year the Challenge is announced. For example, a student who turns 15 in May of 2007 would be eligible to compete in the 2007 season, whereas a child who turned 15 in December 2006 would not.

Children come to the team from many different avenues such as schools, after-school programs, home-school groups, Girl Scouts, Boy Scouts, Girls Inc., Boys & Girls Clubs, YWCA, YMCA, Big Brothers-Big Sisters, religious groups, and neighborhood groups.

The Mentors

A mentor is any person who works with the team in his area of expertise for at least one team meeting. Mentors help provide valuable one-on-one interaction and serve as resources in their specialties. Here are some mentor types and possible team contributions:

- **Engineer –** Teaches the necessary skills for the robot's design or the project presentation.
- **High school *FIRST* Robotics Competition member –** Helps team work through a practice programming challenge, shares strategizing methods, serves as a possible youth role model.
- **Science professional –** An expert in this year's Challenge subject, presents real examples of science in practice, advises the team on the project research and its solution, recommends new sources of information for the team.
- **Graphic artist –** Provides advice on the team logo and T-shirts.
- **General volunteer –** Schedules meetings, provides transportation and snacks, helps with fundraising, and provides carpentry assistance for building table borders.
- **Programmer –** Teaches the team about programming principles and helps the team troubleshoot programs.
- **Marketing expert –** Teaches the children about marketing the team to others.

When recruiting a mentor, be sure to consider diversity. Children from diverse backgrounds may be more comfortable if there are adults with backgrounds similar to their own. Below are just some of the sources to recruit a diverse group of mentors. You can visit their national websites to connect with someone from a local chapter:

- Society for Women Engineers (SWE)
- National Society of Black Engineers (NSBE)
- Society of Hispanic Professional Engineers (SHPE)

Other sources for mentors include organizations that strongly encourage their members to volunteer in the community, such as:

- Local chapters of the American Society of Mechanical Engineers (ASME)
- IBM On Demand Community
- Leading corporations in your community
- Senior Corps

Be sure to use the search engine on the *FIRST* website (usfirst.org) for a variety of mentor documents, resources, and links.

The Parents

Parents of team members often volunteer to help. Their cooperation and support are invaluable. They can help with fundraising, logistics, team building, mentoring, or opening their homes for a team meeting. A parent could handle all of the paperwork for tournaments or coordinate the team's travel arrangements. Another could coordinate the materials and resources the team needs throughout the season by finding how-to guides and expert resources on the FLL Challenge topic, or leading brainstorming practice and teambuilding activities.

If your team has more than one parent volunteer, make the most of your good luck by asking a parent to read the FLL team forum on the Web. And don't forget the most important volunteer duty — organizing refreshments so your team never runs out of fuel. As coach, you can perform all of these tasks, but sharing the workload makes your team more efficient, reduces stress, and increases team spirit and cohesion.

TEAM DYNAMICS

Team Size

There are advantages and disadvantages to any team size, but teams must not exceed the maximum of 10 members. Some coaches believe small teams may concentrate better, work as a unit more easily, and provide team members with more opportunities for attention from the coach or mentors. Other coaches believe that larger teams have an advantage because they share the workload and can break into sub-teams to work on tasks.

Breaking larger teams into smaller workgroups works well with this age group as it encourages collaboration. One group can work with a coach or mentor on mechanics while others learn software or work on research. Some coaches believe rearranging members into sub-teams from meeting to meeting helps avoid cliques, builds appreciation of all the team roles between members, and bonds the team. Regardless of your team size, the most important thing is to give your team the best experience possible with the resources you have.

Age Variations

Depending on the age and development of the team members, you may see two distinct developmental phases with mixed-age teams. Younger children often want to take apart and completely rebuild a robot that isn't working, while older children will often want to stick with the current design and alter it. When working together, the two groups may frustrate each other. Neither method is right or wrong; the children are just at different developmental stages. For team members 11 years of age and younger, you and the mentors may consider:

- Presenting problems or explanations visually or with hands-on examples.
- Allowing the students time to understand the game and missions through manipulating and testing

repeatedly.

For team members older than 11, you and the mentors may want to:

- Create a structure that encourages crazier, out of the box ideas.
- Provide older team members leadership opportunities, such as explaining ideas and the next steps to the rest of the team.

Time Commitment

FLL teams meet for as little as one hour to up to ten hours a week. The time commitment will vary due to your coaching experience and your team's dynamics. It is up to you and the team to decide what your meeting schedule should be. A rookie team typically needs to meet more often than a veteran team. A new team can have a learning curve and may need to have longer, more frequent meetings. Set your team's schedule according to its goals. We suggest starting with two meetings per week that are two hours long, and adding or subtracting time as your team's needs indicate.

As the coach, you may need additional time each week to prepare for team meetings. Spend this time coordinating help, maintaining equipment, communicating with your sponsoring organization, purchasing supplies, registering for competition, and reading the forum discussions on the FLL website. Create a realistic meeting schedule and don't forget to consider major holidays and school events. You can refer to the sample schedules in Chapter 9: Checklists and Schedules to see how other coaches plan their seasons.

Some meetings will run like clockwork and others will be more challenging. You must accept both. Learn from everyone's mistakes and continue with a smile.

Time vs. Progress

FLL has seen teams with very late starts, in some cases as late as week five in the typical eight-week season. These teams often do as well as teams who started in week one or earlier. The bulk of FLL work is usually done in a span of three or four weeks, so a team that starts late can still do well. The team that gets an early start takes a while to ramp up and make progress. They often second-guess themselves, and usually go through some sort of crunch time in the last week or two, winding up at the tournament showing about 70-80% effectiveness compared to an average veteran team. This is fine.

The late or rushed team is all business for three or four weeks, maybe with some more pressure and no time to regress, and winds up showing about 70-80% effectiveness compared to an average veteran team. We have lost count of the number of post-tournament reports from teams who were worried they were too late and ended up having a blast.

ROLES AND RESPONSIBILITIES

The Coach

There are as many ways to coach an FLL team as there are teams. Some organizations take conformity to the extreme, but FLL encourages fresh thinking. Let your team celebrate its own style. Do what makes sense for you. With that said, consider certain guidelines.

As much as you might like to build it, the team must design and build the robot, not you or any other adult. If you find yourself pushing a solution, you're doing your team a disservice. Not only are children not thinking for themselves, but you may also suppress a revolutionary idea. Additionally, a coach or other mentor doing the work sends the children the message that they are not capable of doing the work. FLL defines children doing the work as children making all critical decisions in the robot-building, programming, and project development processes.

Does this mean you should stand idly by while your team struggles with the Challenge? Absolutely not! You must be involved, but you cannot be involved in an overtly direct way. Instead of telling the team to "build a gearbox using a worm gear," you could ask the team to brainstorm ideas to make the robot go slower. Or you could encourage the children to run an experiment that may lead them to explore other options.

Coaches differ in how much instruction they give their teams. Some give very little and others give much more. A successful FLL coach controls the process, not the content. You are a facilitator to help your team complete its work and improve the way it works together. One useful coaching method is to reply to a question with another carefully considered question. The following examples force team members to use their knowledge of science and hypothesize logical outcomes:

"What would happen if . . ."

"And then . . ."

"How will that affect . . ."

Children become problem solvers by finding solutions themselves! We understand that adults can be just as passionate about FLL as children, but adults must always remember that **THE CHILDREN COME FIRST.**

Finally, you are responsible for the planning and scheduling of meetings, visits, and trips. You are the liaison between team members, mentors, parents, and volunteers. It is important that you inform children and parents about what is expected of them in terms of their commitment to the team each step of the way.

The Team

Discuss responsibilities with the whole team. It is important for you to be specific when talking about each individual's role and responsibilities. Team members will usually have ideas about what they want to do: programming, building, research, marketing, etc.; but be aware of the child who might be pushed out of doing what he really wants to do. Also, be mindful of those who avoid certain tasks. Remind the children often about the importance of

collaboration and teamwork.

Encourage team members to push the limits of their own comfort level and make sure everyone understands or does more than one job. Rotate roles so everyone has an opportunity to try different things. Children often discover that they enjoy a task they wouldn't have volunteered for on their own. This can also prevent boys and girls from falling into stereotypical gender roles.

Below are examples of the roles or sub-teams you may want to establish within your team. Some children may want to be involved in multiple roles. Do whatever works best for your team, but ensure balanced leadership.

- **Research –** Gather information and prepare the project presentation as described in the Challenge.

- **Building –** Make decisions about building and work to build consensus on the mechanical design among team members.

- **Programming –** Make decisions about programming.

- **Strategy Analysis –** Analyze the robot playing field and formulate various methods for accomplishing the missions. Lead the effort to establish a consensus on the final strategic plan and think about risks and rewards of different strategies.

- **Robot Operators (2) –** Operate the robot at a tournament. Two robot operators are permitted at the playing field at any given time (see Tournament section for details).

- **Project Management –** Get everyone focused, get everyone's ideas heard, find compromises, and keep everyone on schedule with a project timeline.

- **Quality Control –** Conduct independent tests of the robot's performance to identify potential opportunities for improvement. Test for functions that do not work reliably and make recommendations for improvements.

- **Marketing –** Design and create the team logo. Write a press release and contact the local media, surrounding schools, or civic organizations to increase public awareness of the team and how the team benefits from the FLL experience. Communicate a weekly update on the team's progress to parents, sponsors, and organizations.

- **Documentation –** Record and document the entire team's thoughts, actions, failures, and successes throughout the FLL season in a journal, storyboard, video, or other form you can display or present at events. During the season, these efforts help the team organize information for decision making. At events and tournaments, these are an excellent way to showcase the team's activities, teamwork, and spirit for the judges and event attendees.

- **Fundraiser –** Think of ways to raise money for the team. Recruit parents and other children in the thinking, planning, and doing processes.

- **Team Spirit –** Think of ways your team, families, and friends can show their spirit at the tournament. As part of your team's identity, consider designing T-shirts, making pins, writing a cheer, and inventing ways to showcase your spirit.

Team Goals

An early step in preparing to coach a team should be to work with your team to set goals for the season and put them on paper. Include expectations for the group's success at functioning together as a team. As the coach, write down what concepts you expect the team to learn by the end of the season.

FLL events provide excitement and recognition and celebrate each team's accomplishments. The true goals of FLL have nothing to do with winning medals or trophies. If you can look back at the end of the season and say even one of the following, you have achieved the most important goals:

- We learned how useful and fun math and science can be.
- We did something we didn't think we could do.
- We respected and considered ideas from everyone on the team.
- We helped our community.
- We improved over last year.
- We figured out how to manage time, deal with setbacks, or communicate ideas.
- We learned that research helped us better understand a problem and build a realistic solution.
- We had fun!

Chapter 3: Building a Season

For pre-kickoff, there are a number of things we recommend to both new and returning coaches to prepare for a successful upcoming season. If there are any FLL events in your area, consider attending as a spectator. You will see the flow of the day, meet coaches, talk to teams about their experiences, and witness the high level of energy firsthand.

GROUNDWORK

Talk to your local FLL Partner, listed on the FLL website (firstlegoleague.org), to get answers to a lot of your questions and to get in touch with experienced coaches in your area. Try building practice robots, both by yourself and with your team. Try completing some of the programming mini-challenges available year-round on the *FIRST* website (usfirst.org).

Long before the September Kickoff, we offer teasers and announce the theme (see a sample season schedule in Chapter 9: Checklists and Schedules). Take some time with your team to brainstorm ideas about the new theme. As a team, do a little research on how technology is used in the theme's field. Think about project topics that might interest your team and look for mentors who can offer topic insight.

Choosing a Facility

You need a computer, either a Macintosh or PC, with Internet access. This is necessary for viewing the documents for Kickoff, accessing the team forum, and conducting research for the project. You will also use a computer to develop programs for the team's autonomous robot. You will need a valid email address to maintain contact with FLL throughout the Challenge season.

Figure out where to host team meetings. Your host site will need a smooth floor space for the 4' x 8' mat or the optional FLL table. Without the optional legs and lights, the table is simply a 4' x 8' sheet of plywood with a 2" x 4" border around the perimeter of the plywood.

Your team can meet wherever is appropriate. For a school-based program, the school itself is ideal. Schools usually have the computers and space to set up your playing field. For teams not based in schools, you may meet in a private home, a meeting hall, or a company conference room. Find enough space to host your entire team, the competition table, the computers, and all your LEGO bricks. You also need a secure place to store the FLL robot set and partially assembled robots between team meetings. Evening or weekend use of the building may require special authorization. Be sure to ask permission to use the site's computers to program the team's robot and to complete the research for the project. Before installing software, inform the site host.

Working with Your Host

Meet with the person in charge of your host site. Explain the concept behind FLL and

that the benefits of having a team extend far beyond the team members. When you meet the person in charge of the site, ask for a volunteer to act as liaison between the team and host. The liaison should update others at the site on the team's progress. Email your liaison a progress report once or twice a week.

Ask your site liaison to explain any adult supervision and child safety requirements to you and any team mentors. In some schools, adults who meet with students after hours in a non-supervised environment must have a criminal background check and be fingerprinted. This is often done at the school's expense, but not always. Ask all volunteers to submit to this simple procedure if necessary.

Funding a Team

We know some teams will need to do some form of fundraising to pay for participation. Fundraising as a team builds unity and develops enthusiasm for success, and besides the obvious monetary benefit, it fosters a sense of ownership in the team. Brainstorm with your team members for creative fundraising ideas; they'll surprise you with some fresh ideas.

There are many ways to fund your team. Obviously, you could write a check from your personal funds or split the bill between the team members. Splitting the bill may be a large expense for some families, and you run the risk of excluding children if you use this method. Seeking a sponsor and doing other fundraising can spread awareness and support of FLL.

Look for a company in your community to sponsor your FLL team. Many companies that support FLL recognize how it encourages a talented future workforce. To help win them over, offer to put the company logo on your banner or T-shirts to thank them for their generous donations. Update donors or sponsors regularly, and remind them how their contribution helps inspire a life-long appreciation for science and technology, as well as lasting intellectual and life skills.

Sample Budget (based on 2007 costs)

Assuming no in-kind donations such as goods or services.

REQUIRED ITEMS	COST	COMMENTS
Team Registration Fee	$200 USD $235 CAD	Non-refundable
FLL Robot Set (NXT)	$325 USD $435 CAD	**Recommended for new teams; can be reused for more than one year**
FLL Field Setup Kit	$65 USD $78 CAD	Recommended for every team; changes every year

TOTAL (REQUIRED ITEMS): $590 USD
$748 CAD

OPTIONAL ITEMS	COST	COMMENTS
Official Table	$70	Surface and borders $25-$30; sawhorses $30; lighting $10
Tournament Entry Fee	$50 or more	Varies
Tackle Boxes	$10 per box	For storage
T-shirts	$2-$10 per shirt	

TOTAL (OPTIONAL ITEMS): $130+

Other expenses include: shipping, miscellaneous supplies such as markers, paper, toner cartridges, color copies (building instructions), scissors, folders, posterboard, binders, other office supplies, snacks, and travel expenses.

Other Fundraising Ideas

Pick a fundraiser that is appropriate for your team and your community. Make it fun. The more fun you have holding the fundraiser, the more donors will want to be part of that excitement.

When raising money for your team, be sure to ask community groups to support you in any way they can. Think of fundraising ideas that don't require additional volunteers or a greater time commitment. A number of major retail franchises match money raised at their sites, while others offer community groups free or discounted products. Be sure to call local businesses and ask them what they might do to help you. Every little bit you raise is helpful!

Some fundraising ideas include:

- Hold a bake sale or carwash.
- Hold a raffle of items donated by parents or local businesses.
- Write letters or proposals to foundations that support youth programs.
- Sell balloons for $5 each. Some contain donated gift certificates, others have a thank you note from the team.
- Organize a reverse raffle — Guests receive a raffle envelope at the door of an event, with an assignment inside. They have to sing the national anthem — or buy their way out of it! They pay twice as much to assign the task to another attendee.

- Kiss the turtle — Recruit a few volunteers at a school or community gathering. Put out jars with each volunteer's name. Attendees put money in the jar of their choice. The person whose name is on the jar with the most money kisses a turtle, or pig, or silly object of your choosing at the end of the event.

Challenge Kickoff Meeting

The Kickoff date for the FLL season is in mid-September. Be sure to check the FLL website for details. At Kickoff, you can access all materials related to the new Challenge. You can download the Challenge project guidelines, access the rules of the new robot game, and view a playing field. There may also be other materials such as an illustrated story or article to share with your team. See the appendix for a list of Kickoff documents.

Many teams gather on Kickoff day for a team party to celebrate the new Challenge. For some teams, this meeting is a season opener. Download the materials together and come up with a game plan for the new season!

Early Season Meetings

It's time to get started. Use the following list of suggestions to help organize your team meetings at the beginning of the season.

- Give each team member a folder. Have all the children put their names on folders and decorate them. Have team members bring their folders to meetings and use them to hold important papers.
- Play a game to learn each other's names. Do this at the start of each meeting until team members know each other—and until you know their names.
- Hand out the FLL robot kit and, if applicable, the tackle box or other organizational system you plan to use. Let the children sort the kit as they see fit. This is a good time to go over your expectations about how they will keep the kit neat and organized.
- Print and hand out the field setup kit and the mission model (LEGO element) building instructions. Have the children build the models, then place the models on the playing field in the appropriate positions. When done, have other team members look everything over to make sure the models are properly built and correctly placed on the playing field. This is an opportunity for you to talk about quality control.
- After your initial robot brainstorming sessions, the team may have several concepts for the chassis as well as various attachments. Sub-teams can either design or make a prototype during the next few meetings. This allows them to test multiple ideas in a shorter time, then incorporate the best parts of each prototype to make the final robot.
- Start brainstorming ideas for this year's Challenge project.

Team Building

Team building exercises allow members to communicate feelings in a positive and healthy manner and encourage gracious professionalism as they work together toward a common goal. They're also fun. Team building can be difficult with a schedule that is very structured. Sometimes letting children have fun together allows them to develop communication and respect, leading to smoother progress when work resumes. Here are several team-building exercises you can try with your team.

1. Interview activity

Invite team members to interview their teammates and learn something about each other. Have them pair up and ask each other relevant questions.

Sample questions could include:

- What is your favorite activity or hobby?
- If you could invent something to change the world, what would it be?
- Do you have a favorite pet story?
- What is your favorite time of year?
- What is the best advice anyone ever gave you?
- What are three things the whole team has in common?

Consider adding your own questions that pertain to this year's FLL Challenge. Appoint a child from each of the pairs to introduce his partner and share what he has learned about his partner with the team.

2. Host a team-building meeting

This is a time for everyone to become comfortable with each other.

- Work together to come up with a team name and logo.
- Create projects unique to your team such as hats, a handshake, and a cheer.
- Think, pair, and share – have each team member pretend he is the robot. Write down the steps/instructions required to move around an obstacle in the room. Create pairs, and have one child read his instructions to the other child who acts as the robot.
- Same and different – create a task and ask each member to write down how he will complete it. Have each share ideas with a partner, then with the group.
- If you haven't already, start building the mission models and assemble them on the playing field.

PROBLEM SOLVING

Keep it Simple, Silly — KISS

Introduce KISS, "Keep It Simple, Silly" to your team. In the engineering world, simple solutions are much more desirable than complex ones. The complex solution has many more places to fail, is more difficult to repair, costs more, and its operation is less intuitive.

Consider the fate of the high tech electric potato peeling gadget. How many are still in use? Why did they vanish even if they were faster than a normal peeler? Was it the bothersome cord, the difficulty in cleaning, the big fat handle, or perhaps the motor that kept burning out?

Does this mean all high tech devices fail the KISS test? Of course not. For example, microwave popcorn is more high tech than kernels and oil in a pan, but it's much simpler.

Students are sometimes drawn to complex solutions. Keep reinforcing the KISS principle, asking the team to distill their ideas down to make the solution as simple as possible.

Supportive Learning Environments

Once the Challenge is unveiled, the children will often drive the goals of the team. This is perfectly acceptable and gives you a chance to step back and watch their progress. Encourage the children to brainstorm. It's an important part of a team's planning process, and brings out creative ideas and produces better-thought-out solutions.

When you lead discussions or make suggestions, give choices to the team members. Facilitate the process the team follows to reach its goal, but allow choices within that process. One way to do this is to offer options to the team where every outcome is acceptable. That way, there will be no wrong answers. As coach, you then help the team reach consensus in a fair way.

A mutual foundation of trust and respect is critical for a supportive learning environment. Everyone's voice must be heard, and all ideas listened to with a patient and open mind. Part of your role is to listen to team members and keep lines of communication open. While you may not be able to use every idea or suggestion, hear them out. Clear expression of an idea and convincing others is a great learning experience.

Be aware of verbal and non-verbal cues and interpret the conversation to help the team work through communication difficulties. If you validate team members' feelings, they are more likely to discuss problems. Sometimes acknowledgement or positive feedback may be all the response a team member needs.

A frustrated child might cross his arms over his chest and refuse to face teammates. It is your job to help this child re-join the team. Keep in mind that we all deal with stress differently. One child might feel the need to walk away to reclaim personal space and another might attack the conflict head on.

Group Awareness

The coach must be aware of and help regulate group dynamics. Be conscious of personalities and interactions between team members. If a dispute arises, help the team resolve it and then re-focus everyone on a productive task. Effective coaches use the similarities and differences of team members as assets to help the team get work done.

Q1: I have a team of nine boys who love to chatter, and after two minutes without instruction, they kind of get off track. I have some ideas for activities to keep them focused, but the team needs to start cracking down on the Challenge. Any suggestions?

A1: Each meeting, have a practice tournament and have the children run the robot on the table and give their project presentation. It is a powerful way to have them realize how much work is left to do. This year I started doing this from the second meeting. I gave them five minutes to prepare, two and a half minutes at the table, and five minutes for the project. At first, the team objected, but quickly got to work to better their performance for the next meeting.

A2: I had a similar challenge last year with a gregarious 15 year-old mentor. We finally decided, after much discussion, that his role was to ask questions of the team — lots of questions. Why does your robot do this? How? What else? What's another way? We made it his goal to ask at least ten productive questions per meeting.

Q2: Our team is enthusiastic and engaged for entire meetings — until it’s time to clean up. Any suggestions for getting housekeeping in order?

A1: Cleanup, of course, is the least favorite part of all meetings. Who wants to clean up? Who wants to stop working on the robot? Who wants to go home and take a bath or go to bed? On our team, each member picks a cleanup job. When that team member’s job is done, he takes a seat so I can see the progress and send help if needed. This way, they don’t distract each other.

A2: One way to encourage cleanup is through a point system. Working in pairs during cleanup, children can vie for awards or recognition.

Chapter 4: Materials & Mechanics

In this chapter, you'll find an overview of the key hardware and software components for FLL. You will learn what each element does, why it is important, and how it can help your team.

MATERIALS DEFINED

Playing Field

The playing field consists of the LEGO mission models on the mat, bordered by black 2" x 4"s, on a smooth, flat, hard, uncarpeted, level surface (usually a piece of 4' x 8' plywood).

Support for the playing field and borders may vary. You can use the floor, but most teams use plywood. Some teams put their surface and borders on sawhorses or milk crates, others build a supporting structure. Of course, none of this matters to the robot: only the surface and borders do.

Every team must decide whether to add lighting to its playing field. Instructions for lighting are provided with the table building instructions. There is no way to ensure that your lighting will be the same as the lighting at a tournament, and no way to ensure that the lighting at one tournament will be the same as the lighting at another. That being said, your team can mimic the conditions somewhat by building a table with the recommended fluorescent lighting hanging above it. Teams that use light sensors on their robots need to test in a variety of conditions and be prepared for changing lighting conditions. The basic details of tournament lighting are available on the FLL website.

Kits

The FLL Field Setup Kit includes:

- Mission models set: exclusive collection of several hundred LEGO elements required to build the mission models to place on the playing field
- Field mat, a 4' x 8' roll-out mat
- Sheet of 3M Dual Lock fastener for attaching LEGO models to the mat
- Building instructions for the mission models on CD

2007 FLL Robot Set Choices

There are two **FLL Robot Sets** available in 2007. Each one contains all components needed to build and program a robot to participate in FLL. Robot sets are the LEGO MINDSTORMS RCX or the new LEGO MINDSTORMS NXT. Each FLL Robot set

includes software, the programmable LEGO brick that is the controller of the robot, hardware to download programs from the computer to the controller, instructions for sample robots, three motors, a selection of sensors, and over 700 LEGO elements including gears, axles, wheels, beams, connectors, and much more.

You can purchase the robot parts necessary to participate in FLL through LEGO retail or educational suppliers, however the FLL Robot Set is offered at a discount to FLL teams. The details of the robot sets are included online at www.firstlegoleague.org.

Software

For the NXT, there is one software package that combines elements from RIS and ROBOLAB. There are two different types of software (RIS 2.0 and ROBOLAB 2.5.4) provided in your RCX set that allow your team to program your robot. Using one or the other is a personal preference to be determined by your team. Additionally, ROBOLAB 2.9 may be purchased separately for use with either the RCX or NXT kit. All three packages allow you to program your RCX in a drag-and-drop manner. You download programs into your robot through the IR tower connected to your computer or to your NXT, using the USB cable provided.

Programming

We chose to omit programming tutorials from this text because there are a number of terrific online resources available, including materials created by Tufts University and Carnegie Mellon University. See the appendix for more information.

The RCX or NXT

The RCX or NXT is technically not a computer, but rather a microcontroller. A computer is a general-purpose device that has a keyboard, monitor, and mouse. You can usually play games or store recipes on a computer. A microcontroller, on the other hand, is an electronic device that is dedicated to some specific task. Your microwave oven has a microcontroller in it to read time and power entries you make and then to control the magnetron that generates the microwaves. Your RCX or NXT may not necessarily do what you want it to do, but it will always do what you tell it to do. We will simply refer to the RCX or NXT as “the controller.”

The controller allows your robot to perform autonomous tasks based on the programs your team creates. Convey to your team that the controller can control (talk), sense (listen), and execute instructions but it really has no thinking capability. Thinking requires a degree of consciousness that the controller does not have. What it can do is follow programming instructions really well. This is a challenging concept, especially for younger children. Often, a younger child will blame the robot when it doesn’t execute a task as hoped.

When a controller communicates, or talks, it talks to either a motor or a lamp. It makes the motor run forward, backward, or turn off. It also drives the motors at various power levels. When talking to a lamp, the power level translates to brightness of light.

When a controller listens, it listens to its timer and/or sensors. Other sensors, such as temperature, are available but are not sanctioned for FLL. Each of these sensors speaks to the controller in a different language. The controller needs to be told which sensor is connected to which port. It can then listen with the right language interpreter. In NXT and RIS, the connection between sensor and port is made from the checkboxes on the various commands. In ROBOLAB, the association is made by wiring the proper modifier port number to the command in question.

SENSORS

The Challenge rules limit the number of sensors allowed on the robot. When introducing the concept of sensors to your team, you may want to relate sensors to everyday objects and activities.

For example, you may ask children if they would want to use a touch sensor when giving someone driving directions to the grocery store. At first thought, the children often think a touch sensor would be a fabulous addition to a car. Probe a little deeper and find out how their imaginary cars might use touch sensors. “So, would you tell your friend to drive until they hit the front of the store?”

The ultrasonic sensor is found in NXT kits. The team may now suggest that their friend could drive until they are close to the front of the store, then stop. Remind them that the ultrasonic sensor cannot tell the difference between the store and a car in front of it along the way.

Then, you might suggest using timing. “Would you drive for three minutes until you get there?” After they have offered a few ideas about using timing, probe deeper by suggesting that their friend drives as slowly as your Great Aunt Ruth.

Next, you may want to ask them about using a light sensor to give directions to the store. The children may suggest that following the double yellow line down the middle of the street is a good idea. Remind them that the yellow line isn’t always available, such as when a car is making a turn.

Finally, introduce the rotation sensor. The rotation sensor measures axle rotations and therefore distance traveled. In some cases, it may be the best singular form of navigation. Use multiple sensors in concert with each other for optimal navigation.

Touch Sensor

The touch sensor is the simplest of the three sensors. It tells the controller when something is pushing the button on the sensor. You can use it with a program that tells the robot to turn around after hitting a wall or some other obstacle. More advanced teams sometimes use the touch sensor like a shift key on a computer keyboard to branch their RCX programs.

Ultrasonic Sensor

The ultrasonic sensor is found in the NXT kits. While it might look like a pair of eyes

and allow your robot to “see,” it actually uses sound waves to detect objects or measure distance. It’s just like an echo, and it is also what dolphins and bats use to find their way to objects.

On your robot, a sound wave that you cannot hear is sent out. The sensor then times how long it takes for it to bounce back. This could be used to see an object and avoid hitting it or to stop a certain distance from a border and make a turn.

Rotation Sensor

Every car has a speedometer and an odometer. The speedometer tells us how fast, and the odometer tells us how far we have traveled. Odometry is the science of using an odometer to determine one’s position. People with visual impairments are often very good at odometry. They have memorized a map of their world in units of steps. They get from place to place by simply counting paces and walking in the desired direction. A MINDSTORMS robot is mostly blind and is a great candidate for odometry.

The foundation of odometry is being able to measure and travel known distances. A simple way to make the robot drive any given distance is simply to turn on the drive motors for a set amount of time. The idea is to turn the motors on, delay, then turn off the motors. By adjusting the time, you can adjust the distance traveled. You can perform turns in a similar way. Simply turn one motor on, delay, and then turn the motor off. It is important to keep in mind that by relying on timing, your team sacrifices accuracy as batteries wear out, slowing the motors and reducing the distance traveled.

You can find a solution to these problems by using a rotation sensor. Adding a rotation sensor to the robot’s drive train will act like the odometer in your car. It keeps track of exactly how far the robot moves. For the RCX, each full rotation of the axle that passes through the rotation sensor increases its count by 16 units, just like the hands sweeping around a clock, which uses 12 units instead of 16. For the NXT, measurements are made in degrees, with 360 for each motor rotation.

Your team members may find the concept of rotation sensors a little challenging at first. Often children think that 16 rotations equal 16 inches. This is not so. The relationship between rotations and inches depends on the gearing and wheels on your team’s robot. You can use the controller to determine how many rotations are needed to move the robot a desired distance.

Using the rotation sensor to make precise turns will provide teams with a challenge. Some teams make their robot turn by leaving one motor on while turning the other off. You can also program one motor to run forward while the other runs in reverse. Test these methods with your robot. What works best depends on your chassis design and the task you want to accomplish.

Rotation sensor odometry has various degrees of accuracy. To increase the accuracy, you want the rotation sensor axle to turn at a faster rate than the wheel.

There are upper limits on the number of RPMs a rotation sensor can measure accurately. A good rule of thumb is to have the rotation sensor rotate at the same speed as the motor, or about 300 RPM.

Q: Is there a good reason our team is not allowed to use additional sensors, because compared to the expense in time and effort spent on FLL, the cost of additional sensors would be trivial?

A1: You could have 50 rotation sensors and not be able to get accurate turns. You could have a radar sensor on your robot and still crash into the wall. There are both mechanical and programming solutions to these issues; encourage your team to come up with different ways to solve the problem.

A2: Perhaps, but a good engineering challenge always has some kind of limitation to make you think hard about out of the box solutions.

Light Sensor

If you look at a light sensor closely, it looks like it has two tiny light bulbs in it. In fact, one is a light bulb and the other measures, on a scale of 1 to 100, how much light is reflected back to the sensor. A dark surface gives a much lower reading than a light surface, a white surface, or aiming the sensor at a light bulb.

Being able to have a robot follow a line on the field mat can be very valuable. To follow a line, the robot must sense it by using a light sensor. Place it just above the mat looking down. The software must now use the varying light intensities reflected back from the mat to turn the robot.

In the 2001 and 2002 Challenges, robots could accomplish many major tasks by following lines on the mat. In the Arctic Impact Challenge in 2001, black leads, or ice cracks, could be used as roads to most of the major tasks. When traveling over the ice, the controller reading was a large number, when over a crack, a smaller number. Pointing a light sensor downward allowed the RCX to see or follow the line.

There are numerous ways to write a line following program, or algorithm. Depending on circumstances, some work better than others. The same algorithm executing on different robots operates differently because each robot has varying agility and the sensitivity and placement of the light sensors is different. Just as it's not possible to drive a car forward looking out the rearview mirror, the light sensor must be near the front of the robot as it travels.

Proper positioning of the light sensor is also important. You must have a good variation in return values between differing shades. To work well, a light sensor with an RCX should be about the thickness of two pennies from the surface of the table and it should always be in the robot's shadow. A light sensor that is hidden from the ambient, or surrounding, light of the room works most reliably under most conditions. The light in your practice area will vary from the lighting at the tournament, so it's important to test your robot under different lighting conditions.

The simplest line following algorithm is perhaps the "shades of gray" approach. When you want your robot to follow a black line on a white surface, you see a very sharp contrast between the white and black. The light sensor does not. As the light sensor is moved onto the line, it first sees white, then increasing gray before seeing the final black. This is because the light sensor averages the color over a finite area. When the sensor is properly placed on the robot, this area of light emitted is about the size of

a pea on the surface of the table.

Every team using light sensors is likely to face ambient light challenges. A line following robot works great sometimes and not at all at other times. This does not mean you should avoid using light sensors. FLL has standardized the lighting of the competition tables in an attempt to minimize this problem. As the table instructions on firstlegoleague.org outline, we place a fluorescent light fixture a fixed distance from the playing surface, centered over the mat. This minimizes the variables from site to site but does not eliminate them completely.

Ambient lighting from high-pressure sodium vapor (HPSV) lights in a gymnasium may be quite different from the fluorescent lights in your practice area. Even with the regulation competition lights directly overhead, the light intensity at the table surface differs from venue to venue. It is also likely to vary within the same venue. If one competition table is directly under an HPSV and another is not, the light values returned by the same sensor will differ by a few counts.

Object Manipulation

Besides moving from place to place, an FLL robot has to manipulate playing field objects. Manipulation is perhaps the hardest aspect of the FLL Challenge, especially for newer teams. What looks simple to humans can be extremely difficult for a robot. In the early stages of the Challenge, coaches often hear the team say, “We will simply pick up the gizmo and zoom over there and dump it.” Reality quickly sets in after the first few ideas fail.

Each Challenge requires several types of manipulation against a variety of objects. These may include lifting, dropping, dumping, pushing, dragging, and other actions. One manipulator is unlikely to solve all the missions.

Assuming you used two motors for locomotion, you are left with only one for manipulation. How can you solve all the missions with only one manipulation motor?

There are several solutions:

- You do not have to solve all the missions. One strategy is to solve a few of the high-scoring missions reliably rather than all of them 20 percent of the time. Here is a chance to teach the team members some simple probability or game theory. Strategy matters. Not all manipulations require an electric motor. Some solutions can be remarkably simple using purely mechanical devices. Think in terms of a mousetrap or other trigger activated devices.
- Consider a generic motor assembly to which you can connect various manipulators as needed.
- Modify the robot while it is inside the base. One FLL team rebuilt its detachable manipulator during the execution of another mission. We have also seen a modular robot be radically reconfigured in the base. This is an unconventional, but workable, solution and presents its own challenges.

Q: Does the timed round include time used changing parts, etc?

A. Yes. There is no timeout mechanism, so make sure any attachments are easy to add under

pressure.

The biggest challenge with manipulators is the team members' lack of experience with mechanisms.

Here are some ideas to get them up to speed:

- Many of the LEGO MINDSTORMS books have lots of great designs to use.
- Search the web for LEGO creations.
- Make a field trip to the local hardware store to look at their forklift trucks and scissor jack platforms. If you call ahead, they may give you a demonstration.
- While at the hardware store, look for other gizmos to inspect. Wander the aisles with an open mind.
- Look at cranes, dump trucks, backhoes, and front loaders for inspiration. If you meet in a library, look through books that deal with machines or check out a few books and bring them to your team meetings.

After the team has researched mechanisms for a while, brainstorm, then prototype the selected ideas. Do not waste time trying to get a perfect working model right away. What you learn from the quick and rough prototype may completely change your approach. Try to get multiple sub-teams working on various solutions simultaneously. Competition and learning can be effective motivators.

Try to minimize the weight of the manipulators. Large heavy accessories bog down the robot, waste batteries, and cause navigation to become less predictable and repeatable. Consider building long or tall devices out of axles rather than bricks. LEGO sells bags of axles and connectors that are great for this purpose.

Remember that you may leave manipulators or accessories on the field. They do not have to be attached to your robot and/or returned to the base. Pushing something out on the field and leaving it there is currently an acceptable solution, but be sure to check the rules for the year's Challenge.

Encourage your team to look hard for simple solutions. These solutions will work consistently at a tournament.

RCX Battery Replacement

This section includes helpful information for changing the batteries in the RCX, and does not apply to the NXT. The batteries are a critical part of the RCX. If you're using an RCX and it's time to replace the batteries, you can lose the firmware along with any saved programs (similar to a computer's operating system) if you do the process carelessly. It's easy to download the firmware again, but if you have programs stored on the RCX that are not saved on your team's computer, or the computer is unavailable, such as at a tournament, your team will experience unnecessary frustration. The NXT uses Flash memory and should not lose data if the batteries are removed or drained completely.

If your team is using the RCX, have team members learn the system for changing

the batteries. The children should learn two things:

1. Do not build a robot that must be completely dismantled to gain access to the battery compartment.
2. The second is how to change the batteries fast enough so you do not lose the firmware or the stored programs.

Changing batteries is best accomplished as a two-person job. One person will remove the batteries one at a time. The second person will manage the new and old batteries. Practice this with many team members.

- Open the RCX to expose the batteries.
- Use a permanent marker to scribble over the batteries to mark them as used.
- Change the batteries one at a time to retain the firmware.
  - A. Remove a marked battery.
  - B. Very quickly, add a new one in its place.
  - C. Wait a few seconds before switching the next battery to allow a capacitor inside the RCX to charge, giving it the power to run for the next 15 seconds.
  - D. Repeat this process until you have changed all batteries.

If you leave any individual battery out for longer than about 15 seconds, you risk losing the firmware and programs. If you confuse the batteries during the change, do not panic! Put any battery into the RCX. Now it’s a simple matter to look for the marker scribble to determine the old batteries.

Programming Garage

Using an RCX, programming your robot can be tricky. If your robot is turned on and sitting on your table, a team 30 feet away may not only program its robot but yours as well. You may not realize the problem because humans can't see the infrared light emitted from the towers. (With the new LEGO MINDSTORMS NXT, a USB cable eliminates these issues.)

A programming garage solves the infrared problem. Create one by lining a box with aluminum foil to protect your robot and prevent interference from other robot programs. You can use the same box that you use to transport your robot from the programming area to the playing field. Put your tower and the robot under the box when programming. Make sure the robot is turned on only when it is inside the garage or when it is being used.

Chapter 5: The Project

Note: Championships require that teams participate in the project presentation in order to advance from a qualifier.

The exploration of the Challenge Project is a critical part of the overall FLL experience. FLL is not just about building and competing with robots, and *FIRST* encourages well-rounded teams. To be successful, any engineering project requires a well-rounded team. For example, the Mars rovers would not have been nearly as successful if the NASA team working on them did not know about the conditions the robots would face on Mars. As team coach, you can help the children make critical connections between the Project and the robot game.

PROJECT STEPS

Through the research for the project, your team will learn more about the Challenge theme and better understand the work of professionals in that field. Your team will encounter challenges similar to those faced by scientists and engineers. Exposure to these fields of science and related professions will open your team's eyes to future career choices where they can make a positive difference to society.

Some teams would prefer to concentrate on their robot and eliminate the project. Just as many teams love the project and consider it to be the best part of their FLL season. We believe that every part of the program teaches different, critically important skills. We want children to be excited about science, technology, engineering, and math. Research and problem solving are an integral part of these fields and key to the success of any real-world engineering team, so we hope your team will conduct research as a team of scientists would, with you acting as their leader and facilitator. Before getting started on this year's project, we highly recommend viewing the Challenge Project Training DVD (included with your *Coaches' Handbook*) with your team.

Find a Problem

Your team will be asked to identify a problem related to the year's theme, research the problem, create a unique engineering or technological solution, and share your findings. It is critical to not only complete all aspects of the assignment to qualify for awards, but it is also important to communicate all aspects to the judges.

Create a Solution

As a result of your team's research on the project, you may come up with a number of solutions. The next step is to agree on one unique solution and how to present it.

This solution should not be one that is already in use by someone else—it should be a new idea or improvement on an existing idea that your team develops based on analysis of the problem and existing solutions. Make sure the team solution is new and unique. If your team plans to compete in a tournament, you need to be able to show the

panel of judges that your solution was well researched and thought out.

Prepare a Presentation

If you plan to attend an event or tournament, be sure to prepare for your presentation. If your team needs special equipment, call the tournament organizers ahead of time to see if it will be available. If not, your team is responsible for bringing everything you need. When your team presents its project to a panel of judges at a tournament, they have five minutes, **including setup**. Because the children are supposed to do all the work, be sure the children plan a presentation they are able to set up on their own without adult assistance. Props do not need to be fancy, and they should always demonstrate the childrens' work.

Present your findings in a creative and thoughtful way. We have seen projects presented as songs, skits, radio broadcasts, TV interviews, poems, stories, dances, plays, etc. A judging panel is always interested to see a unique presentation. On the other hand, a presentation without any substance will not receive high marks from the judges. It is a balancing act. Each team must find its own way to show cleverness and demonstrate its knowledge. Refer to the awards chapter and the rubrics in the appendix for more details on how your project will be evaluated.

Many teams prepare a project brochure or other material to leave with the judges. Like the props, these materials do not need to be fancy. It is a great opportunity for your team to present its project in a short, easily readable format that can be passed out at your pit table to specatators and other teams. If you present a project binder, be sure to ask the judges to give it to the pit administration before the awards ceremony so you can pick it up. Including a bibliography for your research is always helpful to the judges.

Share Your Project

In order to meet the third requirement of the project assignment, the team will need to share its findings, solution and presentation with the community, such as an outside organization, your school or the public. Presenting this material will help your team refine their presentation, ensure that the kids have a chance to showcase what they have achieved with their project for the year, and is an opportunity to share the excitement of science and technology with others. It is also a requirement in order to complete all steps of the project.

Prepare Plan B

If your team's presentation includes audiovisual equipment, be sure the members are prepared to present without it if it fails.

Your team will receive only five minutes to present, and the children should be prepared to give a presentation immediately if they experience difficulty with equipment. This applies whether a team is using PowerPoint or a DVD. And remember – the entire presentation is only five minutes long, including setup time. This includes the running time of a DVD or other materials. See a for more information about project presentation judging.

A question and answer session usually follows your presentation. Depending on the tournament, adults may or may not be allowed in the project judging area. If adults are permitted to observe, it is important they do so without interfering. If the judges are unable to adequately judge the children's actions, it will reflect on the team's score. Make sure the team is able to perform the setup and tear down without a lot of fuss or adult help, as the next team will be waiting at the door as your team presents to the judges.

Q: Is the emphasis on the proposed solution for a team's research project supposed to be futuristic or visionary, and do you need to build a working prototype?

A: You could add a twist to take a common device to the next level, and no, you do not have to build a working prototype. A cardboard model or a nice drawing would be appropriate. If your team is interested in building a prototype, it can be helpful during their discussion with the judges.

Chapter 6: Celebrating Your FLL Season

At the end of the *FIRST* LEGO League season, your team should be proud of its accomplishments. Your team members created a unique project, designed and programmed a robot to perform difficult tasks autonomously, and learned how to work together successfully. It's important to celebrate what you've done together.

CELEBRATIONS

Many teams celebrate at tournaments; others celebrate in their own way. Do what works best for your team, but be sure to include a plan for celebration in your schedule.

Host a Local Event

Some teams choose to attend an FLL Championship tournament, sponsored by the local FLL Partner. We outline different types of tournaments in Chapter 7: The Tournaments.

If your team does not attend a qualifying or Championship tournament, you could host your own local event and invite other teams in the area to attend. You may do this in addition to attending qualifying or Championship events. Visit the Tournaments section of the FLL website (firstlegoleague.org) for a Local Event Guide with complete instructions for running your own FLL event from start to finish, including instructions for posting your event on the FLL website.

You can customize local events to suit your team's needs and resources. The flexible format for local events allows you to include elimination rounds, special robot challenges, teamwork activities, mini-projects, and other special components your team develops.

If you host a local event, you may see team members learn new skills and take more responsibility for their work because they are running the event. Kids consider the local event a showcase for their FLL accomplishments, and they love the opportunity to see what other teams have done with their robots and their projects. Sometimes host teams participate in the competition but choose not to be eligible for an award, enjoying it for the experience rather than for competitive reasons. Whatever your team chooses to do, let other participating teams know what they can expect.

Recognize Your Team Members

Plan your own celebration. Invite family and friends to see what your team has accomplished. Ask your school to hold a special assembly or your sponsoring organization to hold a team social. The team can display its project, demonstrate its robot, and showcase team mementos, journals, or photos.

Some teams provide certificates to each team member, with special recognition of the contribution each child made during the season. You can find special FLL certificates with the season's logo on the *FIRST* website (usfirst.org) in the FLL Communications Resource

Center. Be creative when awarding certificates, and be sure each child on your team receives one.

As an end-of-the-season teamwork exercise, ask the team to write down what each member contributed. Then present each child with a certificate showing the contributions that other team members cited. You could also ask team members to vote on the future profession they think each team member is most likely to pursue. One child could be Most Likely to Invent Something to Change the World. Another child could be Most Likely to Create a New Computer Program, Most Likely to Run a High-Tech Company, or Most Likely to Be President of a Research Facility. This kind of recognition helps kids understand how their new-found skills and talents translate to the professional world.

Ask the kids to review the list of FLL values and choose the one that each member best exemplifies. This is a great way for the kids to understand that their contributions to the team are greater than the tasks that each one performed. One child might receive a Gracious Professionalism award, and another might receive the Spirit of Friendly Competition award.

A certificate presentation could be part of a larger ceremony with your team. Take a picture of each child with his certificate. You could hold this ceremony as part of a celebration dinner or pizza party. Whatever you do, make it special.

Applaud Your Sponsors, Mentors, and Volunteers

Be sure your team recognizes the contributions of mentors and volunteers at the end of the season. The team can provide its mentor a framed team or robot photograph or a certificate or letter that recognizes the special talents shared. If you want to give a gift with a *FIRST* logo to volunteers, mentors, or sponsors, visit the *FIRST* online store (usfirst.org) for clothing, awards, and other customized items.

Acknowledge Each Person

Whether or not you attend a tournament, be sure to make some one-on-one time for each team member. Tell each one how she contributed to the team. Remind her of the great ideas she had, the problems solved, the way she supported teammates, and the things learned during the season. This is your most important job as a coach, so take time and be thoughtful about what you say to each child.

Salute the Group

Tell the group how their accomplishments as a team were special, innovative, or unique. Tell them what they did that changed you, or changed the way that you think about them. Sometimes it’s difficult to say the words, but it’s important that the team understands what coaching them has meant for you. Recognizing the entire team, as well as praising each child individually in front of his teammates, will create a lasting memory of working with you and your team on *FIRST* LEGO League.

Now pat yourself on the back. You have had an influence on the lives of these children and expanded their horizons. Congratulations on a job well done.

Chapter 7: The Tournaments

For many FLL teams, the tournament is the reward for all their hard work throughout the season. While there are several types of FLL events, they all offer a fun and exciting way for teams to demonstrate the result of their efforts.

EVENT TYPES

Championship, Qualifying and Local Events – How They Work

The FLL season culminates with local events, qualifying tournaments or events (qualifiers), and Championship tournaments.

Local Events are generally, but not always, smaller than other tournaments. They are run by volunteers (or teams) who have the freedom to choose the format, judging guidelines, and awards. Local tournaments do not qualify a team to attend a Championship tournament.

Qualifying Tournaments (sometimes called Regionals) usually follow judging guidelines and a similar format to Championship tournaments, but have some flexibility in format and awards. Anywhere from one to twelve winning teams from these tournaments advance to that region's Championship tournament. Most tournament organizers only allow teams to qualify for the Championship at the first qualifying tournament they attend. Participating in the Project Presentation is required to advance.

Championship Tournaments abide by certain standards in format, judging, awards, and overall quality. The key volunteers responsible for a Championship tournament are usually FLL Partners. Some Championship tournaments require that teams win at a qualifying or regional tournament in order to advance to the Championship. For many FLL teams and regions, a Championship tournament is the highest level of FLL tournament participation. Championships may include teams from a geographic region, province, state, country, or several countries. One team from the Championship tournament may be invited to attend an Open Championship, if one is held.

Open Championship Tournaments abide by the same standards as Championships, and are hosted by FLL Partners. These events are not held every year, and are invitational events that select Championship winners to attend from selected regions. They represent another great way for FLL teams to get together and showcase their achievements.

The FLL World Festival, held in conjunction with the *FIRST* Championship, is the global celebration of FLL teams from around the world. It is the only event hosted by the FLL program. The selection process for the World Festival will change from year to year, depending upon the number of spaces available and the number of teams participating in FLL. Although some Championship tournaments may be invited to send a team to the World Festival, most will not.

FLL Partners and volunteers plan, coordinate, and run the tournaments. These events allow team members to come together to celebrate their accomplishments. Most events have opening and closing ceremonies, wonderful trophies and medals, teams with personalized
T-shirts, hats, banners, and even some costumes.

Teams are recognized for excellence in various aspects of the Challenge and associated teamwork. The highest honor, the Champion's Award, is determined by performance in four categories of competition and consideration of how the team demonstrated FLL values to all the judges. Additionally, Championship tournament participants all receive an FLL medallion commemorating the team’s accomplishments during the season and showing that in doing their best, they succeeded.

There is no way to describe an FLL tournament and no way to prepare you for what's in store. Expect the unexpected and focus on creating a fun experience for your team members. Talk to them well in advance of the tournament regarding awards. Teach them that their season is about more than one day's results, and that not all teams can win an award. Another team's award takes nothing away from your team's achievements, and those achievements should be the childrens' focus and yours. Be sure the parents of your team members understand this as well, as some parents unintentionally put pressure on their children to win. As the coach, you set the tone for the whole team.

TOURNAMENT APPLICATIONS

Championship Tournament Applications

A complete listing of confirmed Championship tournament sites is posted on the FLL international website (firstlegoleague.org) in September or October. In October, teams apply either online or directly with the tournament organizer for most Championship tournaments. Many FLL Partners coordinate their own application process, so check the FLL website to determine how your team can apply. Be sure that your team's contact information in your team profile is up-to-date and complete before applying for a tournament so you can receive FLL updates during the season.

Applying for a Tournament

- For tournament information, go to the FLL website (firstlegoleague.org) under Teams and Tournaments.
- Be aware that the event schedule may not be complete until the season is well underway. Consequently, the tournament application process is entirely separate from the online team registration process.
- If you are applying for a Championship tournament, determine whether you need to attend a qualifying or regional tournament first by checking the tournament information. If so, confirm what criteria determine advancement to the Championship tournament.
- Confirm event start and end times, parking details, what to bring, food service, etc.
- Collect completed Consent and Release forms from all students and mentors for each tournament you attend. You can find the form on the FLL website under Tournaments.
- Prepare your team introduction pages (found on the FLL website under Tournaments) and make copies.

Important Reminder: Review the policy about adult intervention later in this chapter.

Due to limited site capacity at some tournaments, an application does not ensure acceptance at an event. If you apply for more than one tournament on the FLL website, the application system accepts the most recent application and deletes any prior applications. If you choose to register for more than one Championship tournament, you must apply for the second by contacting the tournament organizer. Refer to the award eligibility policy as your team will only be eligible for any awards at the first Championship tournament you attend.

Once the application period ends, confirmed teams receive detailed information from the FLL Partner hosting the event. This information includes specific details about the site, special instructions, forms, and schedule information. Teams can expect to pay a fee to attend a tournament. The tournament coordinators will inform you of the fees and the payment procedures.

Tournament Logistics

Once you register for a tournament, either through the FLL website or with your local tournament organizer, it's a good idea to check the tournament website regularly for changes and updates. Be aware that every tournament is different in some way. *FIRST* gives latitude to tournament organizers to adjust the format to match their conditions. Always double check with the tournament organizer if you have specific concerns. If you need to travel to a competition, follow your school or other sponsor's procedures. Make sure each driver is properly insured and you have any relevant, completed paperwork, such as permission slips and Consent and Release forms.

Most FLL events are free and open to the public. We recommend that you encourage parents, siblings, sponsors, and friends to attend the tournament and cheer on your team!

Adult Supervision and Safety

Adult supervision is a critical factor for a successful tournament. Whether the team is in the pit, moving about the site, or performing competition rounds, make sure all team members are supervised. Use the buddy system and have each child travel with at least one other person. Remind each person attending with you that the team is expected to demonstrate FLL values at all times.

Rookie Teams

Participating in an FLL tournament is the best way for your team to learn! Even if your team doesn't complete as much as it wants to this season, take part in a competition anyway. Children learn from seeing other teams' robots and projects, and they usually leave an event with great ideas for next year. You will too. You may even discover that the children accomplished more than they thought, and they always have fun. That's what FLL is all about.

TOURNAMENT AREAS

Registration

Upon arrival at the tournament, your team must first find the registration table and check in. Tournament hosts require that you bring a signed Consent and Release form for every attending team member and volunteer. These forms are available on the FLL website (firstlegoleague.org). Submit the completed forms during registration at *each* tournament you attend.

Have a copy of your *Team Introduction* page with you (also available on firstlegoleague.org). This is a résumé for your team, listing the team name and number as well as the names and ages of each team member. It gives you an opportunity to share some fun tidbits or interesting stories about the team to help the judges remember your team during competition. You may need to supply a copy of your *Team Introduction* page at the registration table; however, some tournaments ask you to submit it directly to judges during your session.

The tournament volunteers will tell you where to find your pit station, the competition area, judging rooms, and where you may eat lunch. They will also give you a schedule for your team.

At most tournaments, all of the teams arrive during the same half hour. It can be very chaotic, and lines sometimes form at the registration table for a brief period. Keeping your forms organized, and ensuring that you have all the necessary paperwork when you arrive, can help to reduce your wait.

The Pit

The pit will be your home for the day. You may be assigned a specific location to set up your station when you register, but some events have areas that are first-come, first-served. Check with the officials to confirm that spectators are allowed in the pit, as some facilities allow only team members, coaches, and mentors in the area. Regardless of the size of your station, be gracious and keep your team within the confines of your space.

Generally, a pit table will be provided so you can set up a display for other teams to see, show off your robot, and make minor repairs. If your team has any posters or banners, set them up to showcase your teamwork and team spirit.

Electricity may be provided at the pit, but if you choose to bring a laptop, make sure it’s fully charged. You may want to bring along a heavy-duty extension cord, duct tape to secure it to the floor, and a power strip. Some venues have no power other than a few scattered laptop recharging stations, so plan accordingly. Refer to the Tournament Checklist in Chapter 9: Checklists and Schedules, to be sure you arrive with everything you need. Many tournaments send out a list of “Must Bring,” “Should Bring,” and “Thou Shalt Not Bring” items.

Practice Playing Field(s)

Many tournaments provide access to a practice field where teams take turns running

rounds. If a field is provided, scheduling is often tight and you may have to reserve table time. Please remember to use gracious professionalism when sharing the practice tables with other teams.

Competition Area

The competition area is where the official robot competition playing fields are located and rounds are scored by official referees. Two teams simultaneously demonstrate their robots, one on each side of an 8’ x 8’ table made up of two playing fields.

Technical and Project Judging Rooms and Equipment

Judging for the technical awards and the project generally, but not always, takes place in rooms separate from the rest of the competition. Your team will report to each of these rooms at some point during the day, so make sure you know where they are and when you need to be there. Double check with tournament organizers to be sure that any extension cords or audiovisual equipment you brought along for your project presentation are ready to go. If the tournament organizer is providing these materials, confirm that they are still available well in advance of your interview. If they are not available or not working, prepare your team to present without them.

Time Management

After you set up your pit station, review the day’s schedule with your team members. There is a sample schedule in Chapter 9: Checklists and Schedules. Competition schedules are usually very tight, so it’s important that you are ready and on time. Don’t miss your round or judging session. If the schedule for the day does fall behind, the tournament organizer may juggle your team's interviews to accommodate the changes. Be flexible, and check in with the pit administration or at the registration table if you have questions about your schedule.

As the coach, you will concentrate on getting to scheduled judging appointments and rounds on time. Delegate the responsibility of keeping your team together to other volunteers. Some events hold a coaches’ meeting where you receive up-to-date information and have an opportunity to discuss any robot rule clarifications or judging questions.

HOW THE DAY WORKS

The Opening Ceremony

Usually the opening ceremony is very high energy and sets the tone for the day. At most tournaments, teams have about an hour for registration, setup, and time on the practice fields prior to the opening ceremony. Some tournaments schedule the opening ceremony for mid-day before the robot performance rounds. Judges and special guests are introduced, the Challenge and scoring are explained, and the national anthem is usually played. After the opening ceremony, teams not immediately scheduled for the competition rounds or a judging meeting should return to the pit to listen for queuing or

prepare to meet with the judges.

Rounds

During the day, you typically get at least three rounds lasting 2½ minutes each at the competition tables. The organizers may pair you with the same team each round or mix up the pairings. Some tournaments have runners or team liaisons to take you to a match, but at other events, teams are responsible for their own schedules. Failure to arrive for a match can result in a missed opportunity.

Teams must listen carefully for their queue calls to the designated queuing area to line up for their rounds. Assign two individuals to listen for queuing calls and to keep the team on schedule. Queuing is the process of lining teams up for their robot rounds and judging sessions to ensure that they stay on time. When the time comes, your team will be called to the robot competition table.

Unexpected delays may occur. Remain flexible. The tournament organizers are volunteers, just like you.

When your round begins, have both robot operators move to the table while you get your team settled in the team seating/standing area. FLL expects tournaments to allow team members to rotate out during their rounds, but there are a few tournaments where fire codes prevent switching. Your tournament organizer should alert you if tournament policies do not allow switching.

If you rotate operators in and out between missions, make sure all operators are in place to change. Remember that the clock does not stop for your operators to change. Be aware that some tournaments do not allow coaches or team members who are not robot operators into the area immediately around the table.

Your robot operators should follow the table referee's instructions at the table. Before starting, have them scan the table to make sure it is properly set up. Once the match starts, it is too late to change the table.

Scoring Confirmation

At the end of the match, have the two robot operators witness the referee's scoring of the table. The team's only opportunity to confirm the score is after the referee has recorded the condition of the field at the end of the match. A team member, not an adult, must present any difference of opinion to the head referee. The referee will then confirm your final score. Once your team leaves the area and the competition table is cleared for the next team, you are no longer permitted to dispute the score. As in other competitions, the referee's ruling on the field is final. Graciously accept the referee's decision. When finished, collect all your robot parts.

At the conclusion of the first three robot rounds, some events hold elimination rounds while others may not.

FLL Judging

In addition to points scored during competition rounds, each team is judged on its robot design and programming, teamwork, and project presentation. Judges will ask questions, and team members need to articulate and demonstrate various aspects of their FLL experience during interviews and interactions with the judging panel. Also important to the judges is your team's knowledge of the science behind the Challenge, teamwork, demonstration of FLL values, and the influence of the team's mentors. The focus is on the team members and their ability to express what they have learned.

Usually, teams meet with judges regarding specific awards for a designated time period. The most common format is individual sessions for Robot Design, Project Presentation, and Teamwork, although some teamwork judging is done by observing teams in action. Check with your tournament organizer to find out what format they use if it isn't mentioned in the tournament information materials.

In addition to evaluating teams during scheduled interview sessions, judges may also evaluate teams during conversations and observations in the pit and competition areas. These informal conversations are a wonderful opportunity for judges to hear unique stories and uncover exceptional qualities not readily apparent during the more formal judging sessions. The process is not meant to overwhelm the children, and you should encourage them to feel comfortable speaking with the judges. Judges realize the interview process is stressful for some children.

To keep the schedule on target throughout the event, teams should arrive five minutes before their scheduled judging appointment. There is a break between each judging session so teams can travel to their next locations and judges can properly assess the previous judging session. A timekeeper typically ensures sessions remain on schedule.

How Judging Works

At Championship tournaments, FLL judges use a set of rubrics (see Appendix A) which represent qualities FLL considers important and useful for evaluating team performance. Judges also refer to a list of judging questions and may even add their own questions. The judges are volunteers, and they receive training from FLL or from the local FLL Partner before the event. Review Chapter 8: Awards and Judging Criteria in this handbook for awards criteria.

Adult Intervention

Remember that this is the team's opportunity to shine. Your role is to facilitate, and adult interference during the judging process is prohibited. A team's inability to answer questions, or make robot adjustments without the direct assistance of an adult, will be evident to the judges and may adversely affect your team's score. By tournament day, your job as a coach is done, and your role is to support and encourage the team.

It is often difficult for judges and event organizers to determine if the adults accompanying a team are coaches, parents, or both. Be sure that FLL's rules on adult intervention and gracious professionalism are communicated to all of the adults and children accompanying your team. The behavior of one person reflects on everyone

associated with the team.

Remember, the children come first! When disappointments happen at a tournament, children take their cue from the adults around them. Please remember to model FLL values, honor what the children achieve, and help them focus on those achievements.

In addition, the children do the work! Judges will only reward teams where children show ownership of the completed work, including building, programming, and research. Judges are trained to recognize adult participation and may choose not to give your team credit if they observe or find evidence that adults did the work.

If judges or referees notice adults directing a team's performance, cuing the team, or prompting children, they may ask the adult to leave the immediate area. Some tournaments have restrictions on the number of adults that accompany children into the sessions. Please recognize that these rules are not designed to make the judging or performance process secret, but to ensure fair judging. Your team should be proud of all it has done in FLL, and you and other adults must trust the children to represent themselves.

Sometimes teams assume that another team could not have done the work they present without the direct involvement of adults. Remember that children are remarkably creative, and some are highly sophisticated at programming or software applications for presentations. Don't assume that you know what a team is capable of, and don't let your team members make assumptions either.

Technical Judging

During the tournament day, technical judges will interview your team. The judges want to talk to your team members about the robot they built and the programs they wrote. They will address all of the questions directly to the team members, as the judges want to hear that the students did the work and understand what they did. They want to see and hear about any unique solutions or techniques the team came up with to solve problems. The judges want to know about the design process and what the team considers the best and worst parts of the robot. They want to know what sensors were used and why the team chose them.

In most cases, this is simply an interview, so you will not need any kind of presentation materials. Be advised that some events require formal presentations, so it's a good idea to call ahead or check the tournament website to find out what your tournament requires. We recommend that your team brings a print-out of its best programming, to leave with the judges. This gives the judges a sample of your team's work that they can reference during their judging deliberations.

Make sure the children can demonstrate the robot. Some tournaments have a table set up for this interview. If the team will be expected to run a mission on the Challenge field, pick a mission that is difficult and for which you have a good success rate. Finally, the judges may choose to visit teams in the pit and/or watch the competition rounds to further assess your team's robot capabilities.

Project Judging

Each team performs its project presentation before judges. In some cases only the team and coaches are permitted into the judging room, which may disappoint team parents. This may be due to space restrictions, or because some judges find the presence of spectators distracting. When your team enters the room, set up immediately as the judges may begin timing your presentation as soon as you enter. Have your presenters introduce the team and themselves and then start the presentation. After the presentation, there is usually a question and answer period with the judges.

Be sure that your team has rehearsed setting up and breaking down their presentation. They should not need adult assistance and should be able to do it themselves.

The most common mistake in project presentations is a presentation that exceeds the five-minute time limit. Remember that setup time is included in that five minutes. Some judges will interrupt your team and stop the presentation when time expires, others will sacrifice your team's question and answer period to compensate. Your team will not receive extra time for their session if their presentation runs long or if their audiovisual equipment fails, so be sure that the children plan accordingly.

Judges may interview your team as a whole or may interview team members separately, but in the same room. Have your team members prepared for this so they can best separate into groups.

When your team practices its presentation, use a checklist to determine that all three steps of the project are represented (identified a problem, provided a solution and shared with others). The judges can only evaluate what they hear. Your team members must tell the judges how they shared their project with others in order for the judges to credit them for doing it.

Q: My team kept individual journals and has many pictures documenting our season. We have plans to create a three-panel display for the tournament, but the children are wondering what role the display serves in competition?

A1: Documentation does add to the overall package. These materials go a long way to demonstrate the depth of your project research and teamwork to the judges.

A2: A tri-fold display is great for audiences visiting the pit. It can also help with interviews with judges.

Teamwork Judging

Some people think teamwork judging sessions should consist of observing the team in action, and others think that a full question and answer session gives a better overview of their team’s work for the entire season. FLL is also allowing a new teamwork judging format, where teams are asked to complete a hands on teamwork task for judges in a short period of time. There are advantages to all of these judging formats, and FLL allows

all three types at the discretion of the tournament coordinators. Regardless of the format, the judges are evaluating your team on defined criteria outlined in the judging rubrics (see Appendix A: Rubrics). Prepare your team members for either format, and be sure they know how to demonstrate or articulate important points about their teamwork and ability to work together.

Floating Judges

The tournament may have several judges walking around observing and visiting the pit and competition areas. Be sure to have at least one team representative at your pit table. Judges may not openly demonstrate who they are, but their ears and eyes are wide open. This is the time to remind your team and everyone associated with it about gracious professionalism. One helping hand to a team that forgot to bring something you have in abundance is worth a thousand cheers.

Awards Determination Process

During the end of the tournament, the judges work hard to choose the various award winners. This is by far the most difficult job of the day, and the judges take it very seriously. Every team is a winner, and yet the judges have to select one to receive special recognition. It can take some time for the judges to deliberate, and they make a great effort to be as fair as possible. Be patient during the deliberation period. This can be an ideal time for your team to pack up your pit table and displays and load up the cars to prepare to leave after the awards ceremony. Your tournament may choose to do a demonstration, have a special guest speaker, or run an exhibition round on the robot performance table to keep the crowd occupied during judges' deliberations. If your team will participate in an exhibition round, be sure that you don't pack up your robot!

If your team doesn't receive special recognition with an award, remind the children of all the success and achievement that they have experienced over the season. Not every team can win an award. FLL is about an entire season, not just one day.

The Closing Ceremony

Teams should return to the main competition area for the closing ceremony. Awards and medals are presented and teams are recognized for efforts demonstrated throughout the day. There is plenty of cheering, loud music, and smiling faces to end the tournament and celebrate the childrens’ accomplishments.

Chapter 8: Awards & Judging Criteria

Most *FIRST* LEGO League teams participate in a tournament, or even several tournaments. The awards given at tournaments represent the special achievements of particular teams, but the real achievement for FLL teams occurs during the course of the season. For this reason, every child who participates at an FLL Championship tournament receives a medallion to signify the successful conclusion of an FLL Challenge season.

FLL AWARDS

The FLL Awards represent the highest achievement for FLL teams. Regardless of what country they are from or which Championship tournament they compete in, teams are judged using this group of awards that recognize a standard of excellence for all participants.

FLL divides the awards into four main categories:

- Technical
- Team Performance
- Special Recognition
- Judges' Awards

Each category contains several individual awards, and some larger competitions may offer second or third place awards in some categories. All Championship tournament organizers are required to present Technical and Team Performance Awards, but they may use their discretion when presenting other award categories.

Awards Eligibility

Award distribution is spread as equitably as possible among the teams, with no team winning more than two of the required (Champion's, Robot Design, Robot Performance, Teamwork, and Project Presentation) awards at a Championship tournament. A team can only win a second award if one of the awards they win is for Robot Performance. This policy does not always apply to local events, which are not required to adhere to Championship tournament guidelines. It applies to special local-only awards at the tournament organizer's discretion.

To ensure fairness to teams and provide equal opportunity to win an award at a Championship tournament, teams are only eligible to win an award at the first Championship tournament they attend. Those teams who want to participate in multiple Championship tournaments do so for the purpose of being involved in the fun and excitement of the tournament experience, and not with the intention of receiving multiple awards. If your team participates in more than one Championship tournament, please use the honor system and notify the organizer that your team is not eligible for an award.

Objective vs. Subjective

Team achievement in Robot Performance is score-based, and the other award categories are judged. FLL tournament organizers train their judges and work hard to create a level playing field for all teams. The fact remains that judged awards are inherently subjective. We continue to improve tools and training for our judges, but over the years, FLL has developed judging processes that yield strong, consistent results.

Judging Normalization

We are often asked why we give out awards based on a normalized process rather than raw scores from initial judging sessions. It is critical that judging scores and evaluations be normalized before considering award winners. There are two reasons that analyzing all data and observations gathered during the entire tournament is the best way to determine awards. The first is that raw data doesn't allow for the data from call-back interviews, observation, or other information gathered during the rest of the tournament day. A team that does moderately well in the initial technical interview may later be interviewed again or observed on the performance table, and some truly outstanding aspect of their robot design or programming comes to the judges' attention.

The second reason that raw scores are unreliable is that there may be inherent differences in the way that different judges score. Even among the best-trained judges in all sports or activities, some individuals naturally score higher and others lower. The best way to use raw data is by normalizing judging scores and evaluations. Some tournaments may use a numerical formula to normalize; others use the judging deliberation process created by FLL to achieve normalization. Either method results in a better, stronger judging process for all teams.

Judging Guidelines

For additional guidance on how judges assess your team, please pay careful attention to the rubrics (judging guidelines) found in Appendix A. Use them to your advantage. Pay close attention to the "good" and "excellent" categories in order to understand the definition of a reliable robot design, a creative presentation, and how to showcase your teamwork. Use these guidelines like road maps; figure out where you and your team are and how you can strive to achieve higher goals. You will find rubrics for Teamwork, the Project, and Robot Design. Share them with your team and adult mentors.

Awards List

Championship Tournament Awards

1. Champion's Award
2. Robot Design Award
3. Robot Performance Award
4. Project Award
5. Teamwork Award

Recommended Awards

A. Outstanding Volunteer Award
B. Adult Coach/Mentor Award
C. Young Adult Mentor Award

Optional Awards (at the discretion of the FLL Partner)

A. Against All Odds Award
B. Rising Star Award
C. Team Spirit Award
D. Judges' Award

Champion's Award

The Champion's Award is the most prestigious award that any team can win. It celebrates the ultimate success of the *FIRST* mission and FLL values. A champion is someone who passionately supports a cause. For FLL, our champions passionately inspire and motivate others about the excitement of science and technology, solving problems, working as a team, and demonstrating respect and gracious professionalism.

To be considered for the Champion's Award, teams must perform well in both technical and team presentation categories, which are equally weighted.

The weight value for each of the categories is as follows:

TECHNICAL CATEGORY	
Robot Design	25%
Robot Performance	25%
TEAM PRESENTATION	
Project Presentation	25%
Teamwork	25%

Once teams are selected for consideration, judges convene and review the results of the teams' FLL values assessment, as well as their overall impressions of each team's performance and participation at the tournament. Using these additional parameters for determination, judges decide which team receives this highest honor. The team that wins the Champion's Award is not eligible to receive any additional awards in the other categories, with the exception of the Robot Performance award.

TECHNICAL AWARDS

Robot Design Award

Judges look for teams whose work stands out for innovation, dependability, or both. To assess innovation, the judges watch the robots work, looking for things that make

them say “Wow!” They interview team members to reveal the less obvious unique and inventive ideas. To assess dependability, the judges interview the teams to learn what solid principles and best practices were used to reduce variability and errors, with preference to robots that are best able to “back it up” throughout the matches.

Tournaments may choose to break the Robot Design Award into two separate awards for programming and design, or three separate awards for programming, innovative design, and dependable design.

Robot Performance Award

This award goes to the team whose robot achieves the best score on the competition field or in the elimination round. There are several options judges use to determine the winner:

- If no elimination round is held, the team with the highest score from a single round receives the award.
- If elimination rounds are held, the team(s) whose robot achieved the highest score in the elimination round receives the award.
- If elimination rounds are held, the highest scoring team (using high score between two teams as the factor for advancement to the next round) receives the award.

TEAM PRESENTATION AWARDS

Project Award

FLL presents the Project Award to the team whose quality research, innovative solutions, and creative presentation best reflect an in-depth understanding of the various scientific disciplines and issues involved with the Challenge project.

Judges look for the team’s ability to have as many team members as possible participating in the presentation. Judges assess how your team does the following:

- Clearly defines a question to guide their research
- Clearly and accurately outlines and understands all aspects of the problem
- Addresses the potential impacts if the problem is not resolved
- Captures the judges’ attention with the team presentation
- Presents the team solution, and shows how it assists in resolving the problem
- Shows creativity and innovation in its solutions
- Shares their project with others

Most tournaments break the Project Award into three separate awards:

Research Quality – The use and understanding of diverse resources to formulate an in-depth and thorough explanation of the team's point of view and solution to the Challenge project.

Innovative Solution – Thought-provoking and innovative resolution, including how and why it was chosen.

Creative Presentation – An imaginative, creative presentation demonstrating the team's research and solution.

Teamwork Award

Teamwork is critical to succeed in *FIRST* LEGO League and is the key ingredient in any team effort. FLL presents this award to the team that best demonstrates extraordinary enthusiasm, an exceptional partnership, and the practice of FLL values. For more information, refer to the Teamwork rubric. The team receiving this trophy demonstrates the following attributes to the judges:

- Confidence, energy, and enthusiasm
- Group problem-solving skills
- Understanding of and respect for others
- Positive team interaction and group dynamics
- Demonstrated interest in science and/or technology
- Ability of team members to fill each other's roles when necessary

SPECIAL RECOGNITION AWARDS

The success of the FLL program is a reflection of the commitment and enthusiasm our volunteers display.

Outstanding Volunteer Award

This award honors the dedication of the volunteer(s) whose assistance and devotion helps change the lives of children in a positive way. FLL relies on volunteers for every aspect of the program. Some volunteers do truly extraordinary things for the children.

Adult Coach/Mentor Award

Many teams reach significant milestones of success thanks to their close relationship with an adult mentor. This award goes to the coach or mentor whose wisdom, guidance, and devotion are most clearly evident in the team's discussion with the judges.

Young Adult Mentor Award

FLL presents this award to the young adult, high school or college mentor whose support, impact, inspiration, and guidance are most clearly evident in the team's discussion with the judges.

OPTIONAL JUDGES' AWARDS

Against All Odds Award

This award goes to the team that improvises and overcomes a difficult situation while still making a respectable showing, and with an attitude that shows, "We can overcome incredible odds if we never give up, no matter what!"

Rising Star Award

At every tournament, there are teams that the judges notice and believe will soon be among the best and the brightest. The Rising Star Award recognizes a team that the judges believe stands out and that we expect great things from in future Challenges.

Team Spirit Award

Some teams really know how to have fun. This award goes to the team that most enthusiastically demonstrates a commitment to getting others to see how accessible, fun, and rewarding science and technology can be, especially when you are part of a great team.

Other Judges' Award

During the course of competition the judges may encounter a team whose unique efforts, performance, or dynamics merit recognition. Some teams have a story that sets them apart in a unique way. Sometimes a team is so close to winning an award that the judges choose to give special recognition to the team. This award gives the judges the freedom to recognize the most remarkable teams for which a standard award does not exist.

Local Awards

Tournaments may also offer local awards, with criteria created by the tournament organizers. Please ask your tournament organizer for more information on any local awards.

Chapter 9: Checklists & Schedules

PRE-SEASON THROUGH TOURNAMENT CHECKLIST

Team Checklist: Starting a new team takes a lot of organization. This is a suggested to-do list for new teams. The information may also provide suggestions and reminders to returning teams.

Before the Season Starts

___ Find a meeting place

___ Meet with site host

___ Create a meeting schedule

___ Look at past challenges on FLL website

___ Determine how the team will cover its costs

___ Find sponsorship

___ Determine which computer(s) the team will use

___ Set up a competition area

___ Build an FLL table, if desired

___ Purchase supplies, i.e., batteries, tackle boxes

___ Purchase a 3-ring binder to store important papers and handouts

___ Review FLL values and gracious professionalism

Team Logistics and Preparation

___ Learn as much as you can about FLL

___ Have team choose a team name

___ Participate in the forum on the FLL website(firstlegoleague.org)

___ Obtain curriculum resources from the *FIRST* website(usfirst.org)

___ If possible, hold the first meeting before the season begins

___ Send a note home to parents requesting team members' emergency and medical information

___ Prepare a 3-ring binder for research, design ideas, and judging information

___ Schedule technical mentors or specialists

___ Schedule weekly preparation time

___ Build a practice robot

___ Install software on computer(s)

___ Make sure the computer and controller communicate

___ Write a simple program, download to the robot, and test it

___ Print Challenge rules, point structure, project assignment, and rubrics

___ Print Challenge building instructions

___ Have team brainstorm for Challenge solutions

___ Have team begin brainstorming and working on the Project

___ Have team work on Challenge missions

___ Have team design team T-shirt and/or button with team's logo

___ Check Q&A page at least once a week

Success Tips for Learning and Teaching

___ Use team meeting time for training sessions

___ Run team-building exercises

___ Learn the basics of making a robot go

___ Add sensors to your robot and try simple programming challenges such as the Try It examples in Chapter 4

___ Teach, or find someone to teach, basic mechanical principles: gears and gear ratios, building with cross braces, and building so the robot does not fall apart

Pre-tournament Preparation

___ Plan for extra meetings to prepare for the tournament

___ Publicize your team and the event sponsor

___ Run a robot and your project presentation as a practice session

___ Invite an audience for a dress rehearsal

___ Be sure you're up to date on the Q&A

Tournament Logistics

___ Go to the FLL website (firstlegoleague.org) for tournament information

___ Apply for an event

___ Determine whether you need to attend a qualifying tournament first

___ Review adult intervention policy in Chapter 7: The Tournaments

___ Obtain information about event start and end times and logistics

___ Collect Consent and Release forms from all students and mentors

___ Prepare team introduction pages

Tournament Checklist

___ Robot and attachments

___ Signed Consent and Release forms

___ Parts kit

___ Print out of programs and robot specification page

___ Materials needed for project presentation

___ Laptop computer with batteries and/or AC adaptor

___ Team scrapbook

___ Extra batteries

___ Team banner, posters, or other paraphernalia

___ Lunches and drinks

___ Storage box for personal items

___ IR tower or USB cable

___ Programming garage

___ Team introduction pages

SAMPLE SCHEDULES

FLL SEASON

May:	Team registration and materials ordering begins
May/June:	Robot Kits and *Coaches' Handbooks* begin to ship
Mid-August:	Field Setup Kits begin to ship
September:	Tournament details posted on FLL website
Early September:	Challenge announced
Mid-September:	Team registration closes and team profile and contact information must be updated for the season
October: (Approx. 2 weeks)	Championship tournament applications accepted
November – January:	Local events and Championship tournaments

Week-by-Week Milestones

Prior to Kickoff (if possible):

Challenge: Open your FLL Robot Kit and experiment with *FIRST* website (usfirst.org) tutorials. Build a robot. Try to program it to go a certain distance, turn, and maybe climb a book.

Project: Familiarize yourself with the general theme and read project guidelines from previous seasons on the FLL website.

Kickoff Week 1:

Practice team-building exercises, choose team name, establish team member roles, and establish seasonal goals.

Challenge: • Begin constructing your mission models from the instructions contained on the CD in the Field Setup Kit.

• Print all Challenge web documents, and give to team members to read carefully.

Project: Brainstorm project ideas with your team.

Week 2:

Challenge: • Continue to build your mission models.

• Make sure practice field is set up.

• Check the Challenge Q&A on the FLL website (firstlegoleague.org) for game-related updates.

• Everyone, including a few designated team experts on the documents, reads the Missions and Rules.

• Finish your selected tutorials and then experiment with chassis designs and simple programming tasks. Brainstorm possible mission strategies and associated robot designs.

Project: Select a project topic to focus on and begin doing your research. Keep in mind that research might be done at the library, on the Internet, or by conducting interviews with people in your community or, most likely, all three.

Week 3:

Check Q&A.

Challenge: Design and program the robot to perform the two missions that the team considers the easiest. Consider designs and strategies for expansion to other missions.

Project: Continue research and decide on a presentation format.

Week 4:

Check Q&A. Agree on reasonable goals for the season (examples: “Just have fun,” “Get our mission in the local paper,” “Do half the missions perfectly every time,” “Do two missions like no one else,” “Incorporate at least one idea from every team member,” “Make people laugh”).

Challenge: Design and program the robot to achieve at least half of your team’s goals related to it.

Project: Begin writing a script and creating any presentation materials needed.

Week 5:

Check Q&A again. Reassess goals. Team experts on the Missions and Rules documents should ensure that all intended scoring strategies are legal and worth points. Remember to change your copies of the Missions and Rules documents as the Q&A is updated.

Challenge: Try to meet 75% of robot-related goals, even if they are not complete.

Project: Finish writing script and do the necessary research to fill in any gaps. Continue working on the visual aids and any props you will need for your presentation.

Week 6:

Check Q&A again. Reassess goals. Save copies and back up your programs.

Challenge: Try to meet 75% of robot-related goals and increase reliability.

Project: Put the finishing touches on visual aids and begin rehearsing the presentation.

Week 7:

Check Q&A again. Finalize goals – By this time the team probably knows what it wants and what it's capable of, and the final goals are meaningful and realistic. Save copies and back-up programs.

Challenge: Try to meet all robot-related goals, most of the time. Test in different lighting conditions. Understand effects of a battery change.

Project: Rehearse! Use a stopwatch to make sure you're staying under the five- minute limit. Practice setting up and cleaning up. Practice responding to questions from the judges.

Week 8:

Check Q&A for the last time.

Challenge: Complete fine tuning. Make sure that all robot-related goals can be met consistently

Project: Fine tune and make sure that you can consistently meet all goals such as timing and presentation skills.

SAMPLE TOURNAMENT SCHEDULE

8:00-9:00am	Team Registration	Building Entrance
8:00-9:00	Team Setup	Pit Area
9:00-9:15	Coaches' Meeting	Auditorium
9:30-10:00	Opening Ceremony	Gymnasium

10:15-10:30	Teamwork Judging Session	Judging Room 1
10:50-10:55	Round 1	Gymnasium
11:20-11:25	Round 2	Gymnasium
11:44-12:00pm	Technical Judging Session	Judging Room 2
12:00-12:30	Lunch	Cafeteria
12:45-1:00	Project Judging Session	Judging Room 3
1:20-1:25	Round 3	Gymnasium
2:00-3:00	Top 16 Elimination Rounds	Gymnasium
2:00-3:45	Possible Judge Callbacks/ Final Judging	Judging Rooms
3:00-3:45	Team Packup	Pit Area
4:00-5:00	Closing Ceremony	Gymnasium

Appendix A: Rubrics* see Excel documents

Appendix B: Additional Resources

Useful Books

Duckworth, Eleanor. The Having of Wonderful Ideas & Other Essays on Teaching and Learning. New York: Teachers College Press, 1996.

Erwin, Ben. Creative Projects with LEGO MINDSTORMS. Boston: Addison-Wesley Professional, 2001.

Ferrari, Mario, Ralph Hempel, ed., Giulio Ferrari. Building Robots with LEGO MINDSTORMS. Syngress Publishing, 2001.

Wang, Eric. Engineering with LEGO Bricks and ROBOLAB. 2nd ed. Knoxville: College House Enterprises, LLC, 2004.

Program-Specific Information

www.usfirst.org
This is the primary site for providing an integrated presentation of FLL within the context of *FIRST*. Be sure to check here for curriculum, programming and building links, and information to share with sponsors.

www.firstlegoleague.org
This site provides all in-season communication such as the annual Challenge kickoff, event information, and forum discussions.

Fundraising Resources

www.fundraising-ideas.org
Loads of fundraising ideas

www.fundraiserhelp.com
Fundraising ideas and resources

www.stepbystepfundraising.com

Programming and Building Advice

www.ceeo.tufts.edu
Tufts University Center for Engineering Educational Outreach (CEEO)

www.legoengineering.com

www.education.rec.ri.cmu.edu
Carnegie Mellon National Robotics Engineering Center

LEGO Parts Resources

www.legoeducationstore.com/catalog.cfm
LEGO Education Division

---

www.bricklink.com
Unofficial LEGO Marketplace

---

www.guide.lugnet.com/partsref
Partsref: A LEGO Elements Catalog

General Engineering & Career Resources

www.jets.org
Junior Engineering Technical Society

---

www.robotics.nasa.gov
NASA Robotics Alliance Project

www.kids.gov/k_careers.htm
Lots of links with career information for children

---

www.engineergirl.org
Created by the National Academy of Engineering

FLL Support

Product Billing, Shipping, Invoicing:
LEGO Education (U.S. teams)

Phone: 1 800 362 4308
Fax: 1 888 534 6784
E-mail: fllhelp@pitsco.com
Address:

LEGO Education
PO Box 1707
Pittsburg, KS 66762-1707

Spectrum Educational Supplies LTD (Canadian teams)

Phone: 1 800 668 0600
Fax: 1 800 668 0602
E-mail: fllinfo@spectrumed.com

Address:

SPECTRUM Educational Supplies Ltd.
150 Pony Drive
Newmarket, Ontario L3Y 7B6
Canada

Damaged or Replacement LEGO Pieces:

E-mail:

Go to www.LEGO.com, click on Customer Service. Refer to set number 9764 for FLL Mission Model Set.

Phone: 1 800 422 5346

Questions on Challenge Missions and Rules:

E-mail FLL Engineering: flltech@usfirst.org

FLL Engineering: 1 800 871 8326

LEGO MINDSTORMS Software (NXT, ROBOLAB and RIS) Support:

E-mail: support@legoeducation.com

Phone: 1 866 349-LEGO or 1 866 349 5346

General FLL Program Support, Registration, Teams, Tournaments:

FLL Team Support
& General Information: 1 800 871 8326

E-mail: fllteams@usfirst.org

FLL websites:

www.usfirst.org

FLL Partner Information:

Go to the “Teams and Tournaments” page on www.firstlegoleague.org to locate local contact information

Forum Uses and Location

We strongly encourage teams to participate in the FLL International Forum found on the FLL website. The forum is a bulletin board where users can post questions and read and reply to existing messages. The forum is not an instant messenging system, nor is it a chat system. Disclaimer: the forum is intended for team use only and is not a source for official FLL postings or replies.

Teams use the forum to get advice about participating in FLL, learn how other teams are approaching the Challenge, exchange technical information, and socialize. Everyone benefits from the free flow of FLL-related information.

Examples: Need help with a rotation sensor? Can’t seem to follow a line? Need help finding that elusive software bug? Run out of fundraising ideas? Having trouble keeping team members focused? Does your team have a strategy you are worried about? Want to learn what a French team is doing for its project? Want to share a neat trick you just learned? Looking for teams to join you for a tune-up tournament?

FLL Forum Requires Adult Supervision

An adult must be present at all times while team members are viewing the web forum. More importantly, you, or another adult are responsible for closely monitoring all team member submissions. FLL and the LEGO web administrator reserve the right to prohibit access to any team not utilizing the forums appropriately.

Post Clearly

The forum is organized in a directory structure and each area targets specific discussion types. Prior to your first posting in the forum, it is important to view the forum tutorial or “Quick Forum Help” folder. Be sure to always put thought and effort into the wording and placement of your question or discussion topic. A well-posed and

appropriately placed question is more likely to receive useful and informative replies.

When you post a question, it becomes a permanent entry in the forum. Other users will log in at their leisure, see your team’s posting, and may respond to it if they have a comment or solution. You may get an answer in just a few hours or you may have to wait a day or two.

Use Specific Headers

On the forum, the first few words of the first sentence become the subject line in the outline view. Make those words meaningful to pinpoint your topic. Your subject line should reflect your question well enough that others searching the forum with a question similar to yours will be able to follow the thread to an answer rather than having to post the question again.

FLL Forum Access Code and

Setup Instructions

To obtain access to the forum each year, all teams must go to the Forum Login Page and set up an account.

1. Click on the “Set up an account to access the Forum” link under NEW USER (Right side of page).

2. Enter the forum access code from the Tip box on this page. You will use this access code only once to access the user account setup page.

3. Complete the required fields and select your own private password. We strongly recommend that a team reuse the personal password selected when completing the online team registration. Use your private

password in all following visits to the forum.

4. Once you have successfully completed your user account page, you can post your own discussion or view and participate in current discussions. In addition, the team's name will appear on a list of forum participants on the "Teams and Tournaments" area of the website. Have fun!

Kickoff Documents

The Challenge is unveiled in September.
The Challenge and associated materials will be available on our website at **www.firstlegoleague.org.** The Challenge materials are provided as portable document format (PDF) files.

Robot Game Related Documents
Important—All teams must read, understand, and refer to the following four main areas that define the "robot game" portion of the Challenge. Information from all four of these sources will serve as the basis for referee decisions and performance scoring.

1. Field Setup Instructions
The specifics about the placement, operation, and care of the field mat and mission models are provided in the field setup instructions. (Instructions for building the mission models themselves are found on the CD that comes in the Field Setup Kit).

2. Rules
The rules define what to expect at a competition, the exact boundaries the team and robot must conform to, and how the referee will govern the action.

3. Missions
The missions identify exactly what results your robot must achieve on the field to earn points in performance.

4. Questions and Answers (Q&A) — Web Postings
Q & A pertaining to clarifications, new or previously missing information, and early referee decisions will be posted throughout the season, so check this area of the site often.

The Project

Project Assignment
The project assignment will outline the expectations for the project. The project gives teams the background information they need to understand the Challenge missions, and it is a part of the judging process for qualifying and Championship tournaments.

Links to useful websites are included as resources for the project.

SAMPLE PRESS RELEASE

FOR IMMEDIATE RELEASE

CONTACT: (NAME)
(PHONE)
(EMAIL)
(LOCATION) "(Challenge Name)"

Teams solve real-world problems through robot design and research at *FIRST* LEGO® League (EVENT NAME), (DATE), (CITY, STATE or PROVINCE). Children from 44 countries and the (CITY) area have been tasked with the challenge and excitement of designing and building an original robot in the *FIRST* LEGO® League program (www.firstlegoleague.org). This weekend, at (VENUE LOCATION), eight weeks of research and design will culminate in the *FIRST* LEGO® League (TOURNAMENT NAME) where teams of children and mentors will demonstrate their problem-solving skills, creative thinking, teamwork, competitive play, sportsmanship, and sense of community. Among the participants are the 9-14 year-old boys and girls of Team # (XXX) from (YOUR TOWN), also known as (TEAM NAME). This action packed event is free and open to the public.

This year's Challenge, "(CHALLENGE NAME)", calls for teams to research and present robotics technology solutions in the field of (INSERT THEME OF CURRENT CHALLENGE). The competition is judged in five areas: research and presentation; robot performance; technical mechanics of the robot's construction; teamwork; and gracious professionalism. The highest honor will go to the team that best exemplifies the spirit and values of the program. Every participant will receive a medallion to commemorate the experience and dedication to the eight-week process.

Founded by inventor Dean Kamen, *FIRST* (For Inspiration and Recognition of Science and Technology) was created to inspire young people's interest and participation in science and technology. *FIRST* LEGO® League is an international program for 9 to 14 year-old children created in a partnership between *FIRST* and The LEGO Company in 1998. Each September, *FIRST* LEGO® League announces the annual Challenge to teams, which engages them in authentic scientific research and hands-on robotics design. Using LEGO MINDSTORMS™ technologies and LEGO bricks, children work alongside adult mentors to design, build, and program robots to solve real-world challenges. After eight intense weeks, the competition season culminates at high-energy, sports-like tournaments.

Since its beginning, *FIRST* has had a positive impact on students and academic communities. "We need to show children that it's more fun to design and create a video game than it is to play one," said Dean Kamen, *FIRST* founder. "In *FIRST* LEGO® League, children discover career possibilities and learn to make positive contributions to society." Currently in its tenth year, the *FIRST* LEGO® League anticipates its largest season ever with over 90,000 children from around the world competing in qualifying events and Championship tournaments.

ABOUT *FIRST*

Accomplished inventor Dean Kamen founded *FIRST* (For Inspiration and Recognition of Science and Technology) in 1989 to inspire an appreciation for science and technology in young people. Based in Manchester, NH, USA, *FIRST* designs accessible, innovative programs to build self-confidence, knowledge and life skills while motivating young people to pursue opportunities in science, technology, and engineering. With the support of many of the world's most well-known companies, the not-for-profit organization hosts the *FIRST* Robotics Competition for high school students and the *FIRST* LEGO® League for children 9-14 years old. To learn more about *FIRST*, go to www.usfirst.org

APPLIED ENGINEERING TERMS & CONCEPTS

This section is included to help your team adopt and understand some engineering terminology — with an emphasis on how the terms apply to the FLL experience of building and programming LEGO robots. Try to use these terms and concepts at the beginning of the process and add others when opportunities present themselves.

Arbitrary

An arbitrary decision is one that is not made analytically, but is based on personal taste or style. Arbitrary decisions in robot design are normally about characteristics that do not affect how the robot performs, such as color.

Autonomous

A robot is said to be autonomous if it is programmed to operate on its own, with no remote control.

Bias

When you hear someone else's idea about something before you have had a chance to think about it for yourself, you are biased. When you are biased, your capacity for original thought is reduced.

Brainstorming

This is a process for generating many varied ideas. One method: a person stands at the front of the room and records everyone's ideas until no one can think of any more ideas. What seems like a crazy idea at first is often seen to have possibility later.

Center of Mass
An object's center of mass is an internal spot under which the object could be balanced.

Circumference
This is the length around the edge of a circle.

Clarifying the Problem
It is important in any problem solving exercise to hear the wording of the problem for what it is, break the problem down, and focus on the real desired outcome.

For example: Someone hands you a tennis ball and challenges you to get the ball in a crate on the ground about 80 feet away. Do you take the challenge? Do you ask how many bounces are allowed? Do you worry if you can throw that far, or how your aim is, or how many shots you get? No! You clarify the problem in terms of the desired results, walk to the crate, and drop in the ball.

In this example, the actual problem was "get the ball in the crate." No one said it had to be thrown. No one said it had to be done from where you were standing. Do not add unnecessary restrictions to the solution approach, and do not take it for face value that you can only do things as they have been done before.

Control
A process under control is one for which you can set parameters, and predict the process outcome. Systems with a lot of variability in them are not under control.

Dead Reckoning
A robot is said to navigate by dead reckoning if it is relying on sensors that cannot detect features of the playing field, or if it is relying on no sensors at all.

Drive vs. Driven
The drive component is the one where torque is coming from, and the driven component is linked to the load.

Dynamic
Changing over time.

Efficiency
An efficient solution is one that works without wasting time, material, or energy.

Energy
This is the ability to do work.

Engineer
Engineers study the sciences and use knowledge to manipulate energy and materials to solve problems and to produce the products and systems we use every day.

Experimentation
Experimentation is the process of learning by trying different things. With enough knowledge and work, a scientist or engineer can make predictions about what will happen under certain conditions. Sometimes it is easier to try each condition and see what happens directly. For example, a chemist may be able to analyze the composition of two different types of paint and figure out which one will dry first, but the easier way get the information would be to just try the paints next to each other, aim a fan at them, and touch them every once in a while.

Failure
Failure is a temporary situation and a learning tool we encounter when things do not work as expected. If we take a lesson from every failure and never quit, sooner or later things will work out. True failure only comes when we give up.

Friction

Friction makes it difficult to slide surfaces on each other. The harder the surfaces are pressed together, the more friction there is between them. Friction also depends on the materials in contact. For example, ice slides on glass easily and rubber slides on ice easily, but it is hard to get rubber to slide on glass. When surfaces slide despite friction, energy is lost in heat and the surfaces also begin to wear out. LEGO axles are designed to spin freely with little friction, as long as they are not bound or bent. When building your robot, make sure that every axle turns freely, otherwise the motors will be working to fight friction instead of producing torque or speed, and your battery energy will be wasted.

Gear Ratio

The gear ratio of a set of linked gears is the big gear's number of teeth divided by the small gear's number of teeth (diameters work too). If the driven gear is the smaller one, you are "gearing up," and if the driven gear is the bigger one, you are "gearing down." Example: 16-tooth drive, 64-tooth driven... the system is "geared down, 4:1" (four to one). In other words, if your robot is a vehicle and you gear it down, it will be strong like a tank with lots of torque at the wheels, but if you gear it up, it will be fast like a sports car with lots of speed at the wheels.

Ground Clearance

The height of the tallest object your robot can go over without touching it or jumping it is your robot's ground clearance. If parts of your robot extend forward beyond its front axle and you want the robot to climb from a level surface to an inclined surface, it is important for the overhanging parts to have plenty of ground clearance.

IR (Infrared)

Infrared is a type of electromagnetic wave. Electromagnetic waves can transmit signals across distances, as the remote control for your television does, without having to travel through cables. Radio is another type of electromagnetic wave. You will use an IR tower to download programs from your computer to your robot.

Iteration

A temporary failure that gets you measurably closer to a solution can be called iteration.

Lever

A lever turns sideways force into torque (see TORQUE). In the example of a wrench and a nut, you push sideways on one end of the wrench, and the other end twists the nut. In fact, the longer the lever you push on, the more torque you can get from the same sideways force. For example: hold a wooden 12-inch ruler level by pinching the first half inch. Now try the same thing with a wooden yardstick. The yardstick exerts nine times the torque on your fingers than the ruler does, because it is three times longer and three times as heavy.

Linkage

A linkage is a sequence of parts that transmits force from where it is produced to where it is needed.

Parameters

The parameters of a system are the things you can set to certain values to control the outcome.

Problem Solving Model

Whether the solution to your problem is a design, an object, a piece of information, or a process, the steps for finding a solution usually look the same:

- Focus on the desired results, and clarify the problem in terms of those results.
- Break up the problem into simpler parts if possible.

- Brainstorm for solution ideas for each part.
- Choose the two or three best solution ideas for each part and develop them in detail.
- Mix and match the solution ideas into the best overall solution.
- Test and improve the solution thoroughly.

Random

Random means by chance only and not controlled. The more variability there is in a process, the more randomness there will be in the outcome. For example, it is harder to predict the outcome from rolling a six-sided die than a two-sided coin.

Reverse Engineering

Sometimes called benchmarking, this is the process of taking something apart and analyzing it to understand how it works.

Robot

Robots are a special class of machines, distinguishable by their human-like abilities to manipulate objects or move about, and the fact that they can perform different functions depending on how they are programmed. A robot is the solution to many precise, strenuous, monotonous, and sometimes dangerous challenges.

Robust

A robust design or process is one that yields consistent results in spite of changing conditions. For example, if you practice in a room with a window, the lighting can be much different at 4:00 PM than it was at noon. In a robust design, the light sensor would be placed and shielded so that the robot would not notice the differences in light.

Scientist

Scientists study the world around them to learn how things happened and what is going to happen next. Their knowledge has accumulated over the centuries to formulate the sciences of physics, chemistry, geology, biology, astronomy, and so on.

Stability

A stable robot is shaped so that it does not fall over easily. Typically, flat, long, wide robots are stable. Tall, short, narrow robots are unstable. Be careful when designing with large wheels. They are a good way to boost ground clearance, but as your robot gets taller, it loses stability. Maintain stability by increasing robot width and length as robot height increases.

Subassembly

A subassembly is a portion of your robot that has a specific purpose, but can be taken off or put back onto the robot very easily.

Stress

An object under stress experiences internal forces that could result in the object deforming or breaking.

Types of stress include:

Tension	as a result of	pulling
Compression	as a result of	pushing
Torsion	as a result of	twisting
Shear	as a result of	bending

Technician

Technicians study the products and systems developed by engineers and are uniquely qualified to run and maintain them.

Torque

Torque is twisting force. Get a broom and hold it level, as if it were the handle of a shopping cart. Your left hand should be near the sweeping part, and your right hand should be at the very far right end of the handle. Now let go with your left hand, and try to keep the broom level. It is pretty hard, right? You just experienced torque. The broom exerts a counter clockwise torque on your right hand, and your arm exerts a clockwise torque to balance it. Torque is often exerted on shafts (like your right arm) by levers (like the broom). In turn, shafts exert torque on levers.

Torque-Speed Trade-Off

The longer a lever is, the farther you have to push its end to make it go around. To turn a 6-inch wrench once around, your finger will push sideways about 38 inches. For a 12-inch wrench, you would have to push 75 inches. It is the same for gears: a 16-tooth gear will go around twice for every time a 32-tooth gear does when they are meshed. Here is what this means:

A small driven gear will spin faster than the gear driving it, but it will make less torque.

A large driven gear will turn slower than the gear driving it, but it will make more torque.

Transport

To transport an object is to carry it to a new location. The need to transport objects is a common FLL Challenge problem. If your robot is designed to transport something, make sure to run tests over a variety of speeds and direction changes, and with a variety of obstacles, to make sure the carried object does not interfere with other robot functions and that the robot maintains possession of the object.

Variability

Variability in a system makes it hard to repeat outcomes. If you were asked to drop a piece of notebook paper into a trash barrel on the ground while you stood on top of a roof, it would take a long time, and you may never see the paper land in the same place twice. But if you crumpled it into a tight ball first, you would reduce the variability of the dropping process, and would probably make the shot in just a few tries. Think of variability sources like playing field flaws, lighting, battery power, wear, dirt, etc., and design your robot and your strategy robustly, to minimize the effects of variability.

Wheelbase

The wheelbase is the distance between the extreme front and rear axles.