FIRST Lego League 101 – "How we did it"

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FIRST Lego League (FLL) Robotics program explained

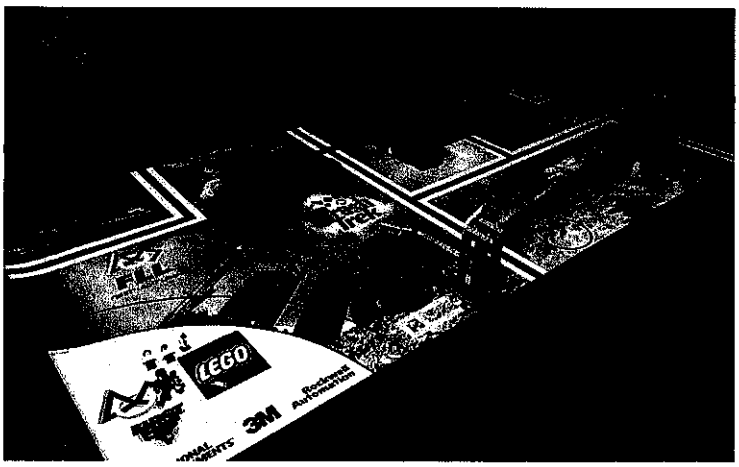
1. The FLL season runs annually each fall, starting approximately when the school year begins and ending in November/December for a total of 12-15 weeks. Each year, the FLL robot challenge and research project are designed around a specific theme which is the same for all teams.
2. There are four main components to the FLL competition where teams will compete for awards:
    a. Robot performance competition (2 ½ minutes each x 4 chances)
    b. Technical presentation on robot design (10 min.)
    c. Research project presentation (5 min.), followed by Q&A (5 min.)
    d. Core values/teamwork exercise and interview (10 min.)
3. **Robot Performance**. Students design, build, program, and test a robot to compete in a specific challenge that is given to all teams – everyone does the same challenge to see who can score the most points in a series of timed competition events. The challenge is composed of a collection of independent tasks designed to be too difficult to complete in the allowed time, so teams may choose which elements of the challenge (tasks) they wish to attempt given the time constraints and points awarded for each. Teams have four chances to get their robot to perform as many tasks as possible and score points in 2 ½ minute timed rounds. The best of the four attempts is used for the team's robot performance score (all others are ignored except in cases of a tie, which is rare). To advance to the State Championship, the robot performance score must be roughly in the top 50% of teams participating at the event (the exact percentage may change from year to year). Robot performance score is a "go/no go" qualification requirement.
4. **Technical Judging**. Teams are given approximately 10 minutes to demonstrate their robot, discuss how they approached the challenges, and show their programs to a panel of judges to be eligible for any of three different categories of technical awards.
5. **Research Project Judging**. Teams are asked to do a research project in association with the theme each year designed to engage students in finding problems and proposing solutions in real world scenarios. Teams are given 5 minutes to present their project problem and solution with a panel of judges to be eligible for any of three different categories of research project awards.
6. **Core Values Judging**. Teams are given a short (2-3 min) teamwork challenge and asked to work together to accomplish a task while the judges observe. The specific task is not disclosed in advance and often is designed to test how the team responds under pressure. Following the task, the team will be interviewed by the judges on their experience with the task and their overall experiences with the FLL program. The FLL Core Values are a key component of the interview. There are three categories of awards given for core values judging.
7. Overall tournament scoring is based on a composite of all 9 judged categories (3 each for technical, research, and core values). Teams with the highest overall judged scores advance to the State Championship, as long as their robot performance score meets the requirements (among roughly top 50% at the event). Therefore, judged award performance is the primary ranking for teams to advance. Robot performance is not included in the overall "ranking" of teams.
8. Awards. FIRST has a philosophy regarding award distribution that gives each team the opportunity to win only one judged award per event, regardless if they would have placed high in multiple categories. Teams that win the overall championship award do not receive any first or second place awards for various judged categories.

The only exception is robot performance. Robot performance is always given to the team with the highest robot performance, regardless of receiving a judged award.

9. All teams may attend one competition where their total overall score may qualify them to advance to the State Championship event. Approximately 25% of teams advance to the state level. Only 1 team from each state advances to the World Championship.
10. For more information: http://www.firstinspires.org/robotics/fll

What you'll need to run a team

1. **A host home or space – a place to set up shop for 3+ months** – We used our basement, some teams get space in their schools, etc. Wherever you do it, you'll want space enough for the 4x8 table to be set up and left up for 3+ months. Setting up and tearing down is possible, but it takes time and can wear on the field after a while. In addition, you'll need table space to work beside it (build, design, program, etc.).



2. **Mentor(s)** – the person or group of people responsible for planning and running team meetings, guiding the students through the process of building their robot, brainstorming the challenges, and doing their research project. The mentor does not need to be the host. Sometimes teams are run by a mentor who doesn't have space in their home, but is willing to lead, while someone else is the host home for the team.
3. **Lego Robotics Kits (Lego Mindstorms EV3)** – The key to our survival with 8-10 students on the team was to have multiple robotics kits so that most of the students had something to work with during meetings. You technically only need one, but having more makes life easier and gives the students more time working with the robot. The only trick with multiple robots is that you have to keep them the same design (only one robot is allowed in competition).

4. **4x8 competition table for practice** – simple to build out of a 4x8 sheet of plywood and 2x4s, instructions/specifications are provided by FIRST via this link: http://www.firstlegoleague.org/challenge/teamresources#Preparation
5. **Extra Lego parts** – The more parts, the better! A great source (if not your own personal inventory) is eBay. Specifically look for "Lego Technics" parts (the use the peg connections which are more robust). You'll get enough to get started in the robotics kits, but not enough to let the students be truly creative.
    a. Extra motors/sensors @ Lego Education: https://education.lego.com/en-us/middle-school/shop/products?replacementparts=42
    b. Extras of a specific part @ Brick Owl: http://www.brickowl.com/
6. **PC for programming** – It's ideal to have a laptop or a PC located close to the table in your practice area, laptop is essential for competition if you need to tweak a program. Multiple laptops or PCs are better than one, but not required. For running several students through the programming tutorial, the more PCs the better.
7. Student mentor from the high school ThunderChickens robotics team - (jacob.palmer@uticak12.org or ronald.arscheene@uticak12.org). Typically, student mentors start helping 3-4 weeks into the season.
8. Up to 10 energetic kids! Teams are limited to 10 students, but we've found that 10 is difficult to manage. At that size, it is hard to keep them all engaged. 6-8 is optimal.
9. Resources – Tons of information exists online... http://www.firstlegoleague.org/challenge/teamresources

Costs (per season): New Teams: $1,500-$2,000; Existing Teams: $1,000+

1. 2016 Team Registration: $225
2. 2016 Field Kit: $85 w/ shipping (set of specific Legos used for the annual competition theme)
3. Lego Mindstorms Robotics kit options:
    a. FLL Team Version: $560 w/ shipping (through FIRST); ***best option for new teams*** – has the most parts and sensors to get you started and includes the education version of the software with 48 tutorials. Note that you can only purchase this version AFTER you have paid your team registration fee of $225.
    b. Lego Education Version: $379 "core set" (541 pcs) + $100 "expansion set" (853 additional parts); includes the education version of the software with 48 tutorials; https://education.lego.com/en-us/middle-school/shop/products. This is a great alternative way to get started early, as you can buy this kit independently (not contingent upon registration being paid like the FLL Team Version).
    c. Retail Version: $350 from Amazon.com; Toys R Us, etc. (550+ pcs); great option for a 2nd robot or tight budget. Less parts and sensors than Lego Education version through FIRST. Does **NOT** include the Lego Education version of the software.
    d. Used on eBay (sometimes with lots of extra parts). Depends on who is selling and when. Not always much cheaper than new.
    e. *Note that Lego Education sells individual motors, sensors, cables, etc. VERY USEFUL to add to your robot kit additional parts you may need! Be careful, not all motors/sensors sold on Lego Education are legal for use in the competition – read the rules carefully.*
    f. *Note: Check which software license you get with each – some come with or without software, some with multi-use licenses (up to 10 PCs, for example); "store" version software is not the same as Lego Education version – tutorials are important!!*
4. Table: ~$75 to buy materials needed to build
5. Team shirts: ~$10-15/kid (teams wear team shirts with their name, logo, sponsors, team number, etc.)
6. Presentation materials: ~$50 – project display boards for pit area to show research project, profile team, etc. Materials for skit/presentation of research project. This is small stuff, but it can add up.

7. Regional Tournament Fee: $40 – No charge for UCS teams attending ThunderQuest
8. State Tournament Fee: $75 – if you qualify, this has not typically been covered by UCS.
9. Cart (optional) – useful in competition to have a cart to put the robot and attachments on at the table. There is nowhere to store items except in "base" and that can get crowded quick and slow you down. Plus, pushing a robot on a cart is much safer than carrying it by hand (really bad when someone drops it)
10. Bins for sorting parts (optional) – we used toolboxes for carrying robots and major attachments, cords, etc. to competition; and small fishing tackle boxes (parts boxes with dividers) to hold all of the small fasteners and keep them organized.

EXAMPLE BUDGET FOR NEW TEAM

Amount	Expense
$ 560.00	FLL Lego Mindstorms EV3 kit
$ 87.98	FLL 2015 Field Kit - Lego Education (incl. shipping)
$ 225.00	FLL Team Registration
$ 75.00	Home Depot - table materials (estimate)
$ 150.00	Team T-shirts (for students); parents pay for extras for family members
$ 75.00	Cart for robot and parts at competition
$ 150.00	Misc extra motors, sensors, Lego parts
$ 40.00	Handouts at competition (give aways)
$ 50.00	Presentation Materials (printing, poster boards, props, costumes, etc.)
$ 75.00	State Championship Registration (check)
$ 1,487.98	**TOTAL**

Sponsorship – How to fund your team

1. UCS does not sponsor FIRST Lego League. Some elementary schools will pay for team registration and possibly provide the robot kit, but it varies by school. Our school no longer provides any funding, but the non-profit parent group provides a small amount of money each year to teams. Our first year coaching, three families received support from their businesses and we raised $900 for the team. That year, the school paid for registration and the initial robot kit. So, the $900 covered an extra robotics kit, the competition table materials, and much of what is outlined above under "costs". In more recent years, costs have increased. We ran another rookie team in 2014 and spent $1,300 for the season (which included a new EV3 robot kit). After the initial investment of the robot kit, subsequent years are less expensive (no need to buy the robot, build the table, purchase a cart, etc.). Each school seems to do things slightly differently, so ask! Ask companies to help...for only a few hundred bucks, a company can be a primary sponsor of your team. You would be surprised how many companies are willing to give to support the program. Recognize sponsors by putting their names on the team t-shirts!
2. New teams may be eligible for grants to help defray start-up costs. Grants vary from year to year, but below are links to a few resources:
3. Link to Michigan's FIRST 2015 season's grants. FLL is in the bottom left corner. Grants will be updated each season, so look for information that applies to this coming season. One frustration is that grants are often "late" relative to when costs need to be incurred. I've seen grants come four weeks into the season...after registrations are already paid long ago. http://www.firstinmichigan.org/Documents/2015FIRSTgrants.pdf
4. Alternate link: http://www.firstinmichigan.org/fll/start_a_team.html

2016 Season Schedule (Key FIRST events/dates)

1. May – Registration opens (already open now!)
2. Mid May – Orders placed for robots and LEGO accessories will begin to ship to PAID teams
3. Summer – If you have the robot kit, begin having the team work through the software tutorials before the season starts...this is a great introduction to the hardware, programming and available sensors.
4. Late July – early August = Ordered and PAID Field Setup Kits will begin to ship
5. **August 30** – Global Challenge Release – you must go to http://www.usfirst.org/roboticsprograms/fll to download the rules. Download, read, re-read, read with the team! *It's as much about what isn't said as what is said. Be as creative as the rules will allow. Sometimes the intuitive way to approach a task isn't the easiest way!*
6. Mid-late September* - Team Registration Closes / Last Chance to Order Products
7. **November TBD** – Regional Tournament (Thunderquest @ UCS Henry Ford II High School)
8. Early December – State Championship (was in Monroe last year)

Example Team Schedule (from last season)

2015 Season Week	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
1 (August)	23	24	25 Kick Off Build Field Kit	26	27	28	29	Kick Off
2 (August/Sept)	30	31 Discuss Game Strategy	1	2	3	4 Creative Day	5	Robot Design & Challenge Research
3 (September)	6	7 Holiday	8 Creative Day	9	10	11 Design Strategy Challenge Research	12	
4 (September)	13	14	15	16	17	18	19	
5 (September)	20	21	22	23	24	25 Robot Design Complete	26	
6 (Sept/Oct)	27	28 Begin Challenge Integration	29	30	1	2	3 Saturday Workshop	Challenge Designs & Integration
7 (October)	4	5	6	7	8 Field Trip	9	10 Saturday Workshop	
8 (October)	11	12	13	14	15	16	17	
9 (October)	18	19 Research Complete	20	21	22	23 Project Script Writing	24 Saturday Workshop	
10 (October)	25	26 Project Script Writing	27	28	29	30	31	
11 (November)	1	2 Project Props/Visual Aids Complete	3	4	5	6 Challenge Designs Complete	7 Saturday Workshop	
12 (November)	8	9 Practice/ Rehearsal	10	11	12	13 Practice/ Rehearsal	14	Practice/Rehearsal
13 (November)	15	16 Practice/ Rehearsal	17	18	19	20 Practice/ Rehearsal	21 COMPETITION	

The season schedule in a nutshell: Use this as a guide to stay on track. Ask for help from other coaches if you are struggling with anything!

- Week 1 – set up the field and brainstorm! It is very important to have ordered the kit on time so that you get started when the rules are released! Starting late puts you at a disadvantage.

- Weeks 2-5 – build robot (brick, select wheels, sensors – the basic "chassis") and start project research
- Weeks 6-11 – build robot attachments and program missions, complete research project and field trip(s)
- Weeks 12-13 – practice robot missions, prepare for judging presentations (see rubrics)

Registration

1. Registration: http://www.firstinspires.org/node/10626 (new website for 2016)
2. Registration will get you a team number and provide you with additional online resources (such as the coach handbook). AFTER registered, you will be able to purchase the field kit (season specific game Legos and field mat) which typically ships around mid-August – often a few weeks before the challenge is released. Register before August to get your field kit on time. The assembly instructions are only available after the challenge is released.

Meetings

1. Our team met once a week during the summer a few times to build the team, work through the software tutorials (very easy to follow), build various projects we found online, etc. – the aim was to get the students ready (put tools in the toolbox) and begin building relationships among the team members.
2. After the global challenge release in late August, we met twice weekly for 1 ½ to 2 hours (depends on age/experience of kids), plus had a few Saturday "open house" workshops for those who wanted to come and continue working on things. The experience the students take away from the program is directly proportional to the time they have to learn and experiment with the hardware. One meeting per week can work, but twice a week give more opportunity to the students to really explore the challenges and work through their ideas. This is especially true for larger teams or if you have limited robotics hardware (only 1 robot, for example). There are only 12-15 weeks in the season, depending on when the ThunderQuest tournament is scheduled.
3. Students will naturally want to build and program robots at team meetings. Plan time at the beginning or end to talk about the research project, core values, etc.
4. One of FLL core values is sharing what we learn with others. One way our team promoted that is by having the team gather around the competition table for the last 5-10 minutes of each meeting to have team members each share with one another what they worked on that day. Sometimes what is shared is an idea that failed, which gives other students an opportunity to offer suggestions. Other times, students share their successes and the team can celebrate together. This promotes getting the students ready to talk to the judges about their designs and challenges they faced, by practicing it in regular meetings...the students won't even know they're practicing for competition!

Tips & Best Practices

1. Read the rules as a team! Spend an entire team meeting reading the rules and discussing them around the field. The most obvious approach to the missions is not always the only approach or even the best. Note that you may approach many missions in multiple different ways – the only limit is what the rules say you must do or must not do. Read between the lines...look for loopholes. Often, they are intentional. *Note: I recommend that you have the team build the field kit (mission models) before you read the rules. It's often easier to understand after the mission models are built and you can experiment with them to see how they operate. Building the field kit is often an entire team meeting or more as well!*

2. Keep up to date with the online Q&A. If you have a question about a mission, most likely someone else did too. Mission updates in the Q&A often reveal alternatives that you may not have thought of before. Review these with the students throughout the season at team meetings.
3. Review the judging rubric – it is as much of a guide as to what to focus on as it is about what not to! http://www.firstlegoleague.org/sites/default/files/combined-rubrics-2015.pdf (this is for 2015, but remain basically the same year to year)
4. Don't put off working on the research project! It takes more time than you think to do the research, come up with a plan to present it, and rehearse a 5 minute presentation!
5. Practice the technical presentation as much as the research project! Talk as a team about what makes your robot unique, what your strategy is for completing the missions, why you chose to do the missions you did. Consider assigning team members to cover different aspects of the judging rubric. Programming is an area many teams fail to prepare for. Bring printed copies of programs to review and leave with the judges.
6. Review the core values with the team regularly...have the kids repeat them, explain what they mean, and try to live by them. The core values interview will challenge them in these areas, if not ask specific questions about the core values. http://www.firstlegoleague.org/mission/corevalues
7. Have fun, let the kids experiment and be creative. Remind the students that their first idea will probably not be the best idea and encourage them to redesign and improve – make it more repeatable and faster. Success is great, but encourage students to test their solutions 10 times in a row to see how many times it works. Divide by 10 to get percent accuracy. You only have four tries in competition at ThunderQuest (only 3 at State), so you can use your accuracy to predict the chances of getting it to work in competition.
8. The students will have more ideas than you think, and its ok for them to fail and try again...in fact that's perhaps the most important element of the learning process! The robot does not need to look like an adult designed it (though some will, and perhaps were designed by adults). Remember, it's about the kids!
9. You won't complete all of the challenges on the table (robot game). The game is specifically designed so that it cannot be completed in the time limit. Encourage the students to try as many as they are able to or interested in, but tell them up front that not everything they try to do will be used when you compete. About a month from competition, start to focus on what's working and refine it and measure how much time the tasks take (including any changes to the robot between matches). As a team, choose the best of what they've done to go to competition with.
10. I strongly encourage new teams or new team members to build the kit robot and go through the software tutorials before the season begins if possible. This is a great team activity for the summer preceding the fall season. The software has instructions for how to build the robot and each lesson. Use judgement on what lessons to go through, but for most of the basics, it should take 2-3 hours for most students to get through them (we plan 2 meetings just for the software tutorials). What we find is that some students will naturally be curious and begin to experiment with programming while going through the tutorials, trying different things. Keep an eye out for these students and they're likely to be your programmers. Not every student needs to build the robot or program it, that's why you have a team.

General Information

http://www.firstinspires.org/robotics/fll

Resources:

1. Helpful YouTube videos done by a student for students. Great for ideas or alternative to tutorials: https://www.youtube.com/channel/UCuXq-jiU0ANeBcF_Tvq1D7g/videos
2. TechBrick. http://www.techbrick.com/Lego/Lego2015/index.html Lots of resources here, scoring sheets, apps, images, etc. Be careful to use only the FLL website (not this site) for game rules, etc. However, aside from that, this site has a lot of resources that could be helpful. Also note that the site will be updated each year for the new game.