FIRST*LEGO*League

Building and Programming Overview

Robot Building 101

Equipment

FLL EV3 Robot Set

- EV3 Core Set
 - EV3 "brick"
 - EV3 Electronics
 - Technic LEGO components
- EV3 Expansion Set
- EV3 Programming Software and License
- Robot Educator Bot
 - Recommended first build
 - Directions and tutorials in EV3 Software Education version



What can be used to build your robot?

- Read the Robot Game Rules! (Page 19)
- Everything you compete with must be made of LEGO[®] elements in original factory condition, except LEGO[®] string and tubing, which you may cut to length.
- Exception: You can reference a paper list to keep track of programs and use a bin to carry your robot.
- There are no restrictions on the quantities or sources of non-electric LEGO[®] elements, except that factory-made wind-up/pull-back "motors" are not allowed.



What can be used to build your robot?

- LEGO[®] pneumatic elements are allowed.
- On the robot, marker may be used for owner identification in hidden areas only.
- Paint, tape, glue, oil, dry lubrication, etc. are not allowed.
- Stickers are not allowed except LEGO[®] stickers applied per LEGO[®] instructions.



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What can be used to build your robot?

- The electric elements used must be the LEGO® MINDSTORMS® type, and the total number of electric elements you may use in one match is limited as follows:
- One Controller (RCX, NXT, or EV3)
- Four Motors Must be MINDSTORMS[®] motors
- A fifth motor is not permitted in the competition area (you may have unlimited spare motors at the pit area)
- Unlimited Sensors
 - Must be Touch, Light, Color, Rotation, Ultrasonic, or Gyro sensor
 - Must be LEGO[®] manufactured MINDSTORMS[®] sensors

Rule Changes for 2018

MAJOR

• If you interrupt the Robot while it's transporting something it took from Base during the most recent launch, you can now keep that object.

MINOR

- Border lines are always part of the area they define.
- Disputes related to the thickness of thin lines (such as the border of Base) always settle in favor of the team.
- You need to conform to local event standards regarding the style and size of your Storage trays and carts.
- It's OK to shut off the Robot and leave it in place wihtouth penalty if it's done with intended Missions.

Common Attributes of *FLL*[®] Robots

- Two motors are used for the drive wheels, one on each side for turning
- The third and fourth motors for attachments such as a vertical lift, arm mechanism, or attachments
- Multiple attachments for different missions
- Robots must fit inside the base

Attachments are removable - Mechanisms are not

Chassis Basics



Chassis styles

- 2 wheels and skid(s) usually fine if no ramps to climb
- 2 wheels and caster wheel (3-point design) caster wheel can change robot course (supermarket carts)
- 2 wheels and caster ball (3-point design)
- 4 wheels (4-point design) often one pair is without tires to slide while pivoting
- 6 wheels Larger than most FLL robots, robot must fit in base.
- Treads stable, can be hard to predict turns
- Exotics walking, time consuming to build, inconsistent movement

Chassis mobility

Size of chassis: the robot has to navigate around the obstacles on robot field



Chassis mobility

- A bigger chassis require more motor power draining batteries quicker
- Remember, after the robot is built, you still need to get to the battery compartment or charging plug on the brick
- Chassis will need places for attachments to attach
- Wires from brick to motor and sensors should be tucked away so they don't catch on anything

Wheels, Tracks and Axle tips

• Tracks

- Low Friction/High Slippage
- Motion and Turns not repeatable
- Large wheels go further per revolution
 - Friction varies with different wheels
 - Consider how they pivot turn and go straight
- Wheel Axle Support
 - More support, less wiggle/sag
 - Support from both sides is best

Robot placement

- Jigs / Robot bumpers / Alignment tools
 - Align with solid edges of robot, not by sight
 - Provide three points of contact to get both the angle and front/back positions correct
 - Jig / Alignment tool can't interfere with robot as it begins to move
 - Table walls may vary. South edge of mat is always against the south wall, but east and west are center, and north falls wherever

Online - References and Tools

- EV3 Lessons: http://ev3lessons.com/index.html
- Techbrick: http://www.techbrick.com/
- Wheels: http://wheels.sariel.pl/
- Gears: http://gears.sariel.pl/

CAD for LEGOS®

• LEGO® Digital Designer: http://ldd.lego.com/en-us/

Online - Parts

- Lego Educational: http://legoeducation.us/ Go to the "SHOP" menu and then select "LEGO Spare Parts and Accessories"
- Brick Owl: http://www.brickowl.com/
- Techbrick: http://www.techbrick.com/
- BrickSet: http://brickset.com/browse

FLL[®] Programming

Import additional program blocks



LEGO MINDSTORMS Education EV3 Teacher Edition				
File	Edit	Tools	Help	
			Sound Editor	
			Image Editor	
			My Block Builder	
			Firmware Update	
			Wireless Setup	
			Block Import	
			Download as App	
			Memory Browser	Ctrl+l
			Data Log File Manager	Ctrl+U
			Remove Values from Dataset	
			Create Data Logging Program	
			Export Datasets	
			Import Brick Program	

- If you are using the Home Version of EV3 software, you will need to import the Gyro and Ultrasonic program blocks
- 1. Download the blocks from LEGO[®] MINDSTORMS[®] download website https://www.lego.com/en-us/mindstorms/downloads
- 2. In Mindstorms® application, from the Tools drop down menu, select Block Import, the Block Import and Export dialog displays

What is a Program?



- A program is a sequence (a list in order) of instructions that tells the robot how to perform a task.
- The robot does exactly what you tell it to do, and only what you tell it to do.
- You, the programmer determines what actions the robot will perform by the programming.



Connecting with Bluetooth

- Bluetooth allows you to download programs without the USB cable. This is a great time saver in practices.
- Bluetooth connection also allows you to see sensor data real-time in the Port view, and see what block is executing in your program. These can be great troubleshooting tools





Connecting with Bluetooth



Naming your brick will help prevent others nearby from selecting your brick and accidently deleting or downloading programs to yours.

- 1. Enable Bluetooth on the computer.
- 2. Power on the EV3 brick.
- 3. In the EV3 interface, under settings, select Bluetooth.

Bluetooth must be off at FLL® tournaments.



Design and Programming Principles

KISS - Keep It Simple, Silly

- Minimize robot design complexity
- Make attachments easy to attach and remove. Use common attachment point.
- Minimize number of attachments and use the same attachment for multiple missions
- Minimize starting positions in base (1-2 positions only)
- Use MyBlocks to simplify programs and tasks that are repeated often

Time is the Enemy

Time in Base is Time Not Scoring

- Perform multiple missions in a single run
- Minimize attachment change outs
- Minimize returns to base
- Minimize programs stored on brick.
- Use master sequencer program for program selection
- Avoid interruption penalties

Don't Be in a Rush

- Don't Speed
 - Use appropriate speed on motors, especially in turns
- Stop the robot and wait before making any direction changes
 - Allow for forward momentum to dissipate.
- Perform turns slowly for better accuracy



Consistent, Predictable, Repeatable

- Use jig for alignment in base
- Use sensors for determining location on field and line following
- Use field mission models to help determine location on field
- Create attachments that do not require high degree accuracy to work
- Minimize use of motor rotation sensors for robot or attachment position. Use time or motors in conjunction with wait blocks

Strategy



Great robot design + poor strategy = inconsistent scores



Fair robot design + good strategy = consistent scores

Achieving Robot Performance

- Teams that are consistently top performers are always balanced in robot design, programming, and strategy.
- Teams will naturally be stronger in one area, but to neglect the other areas will result in inconstant results.

