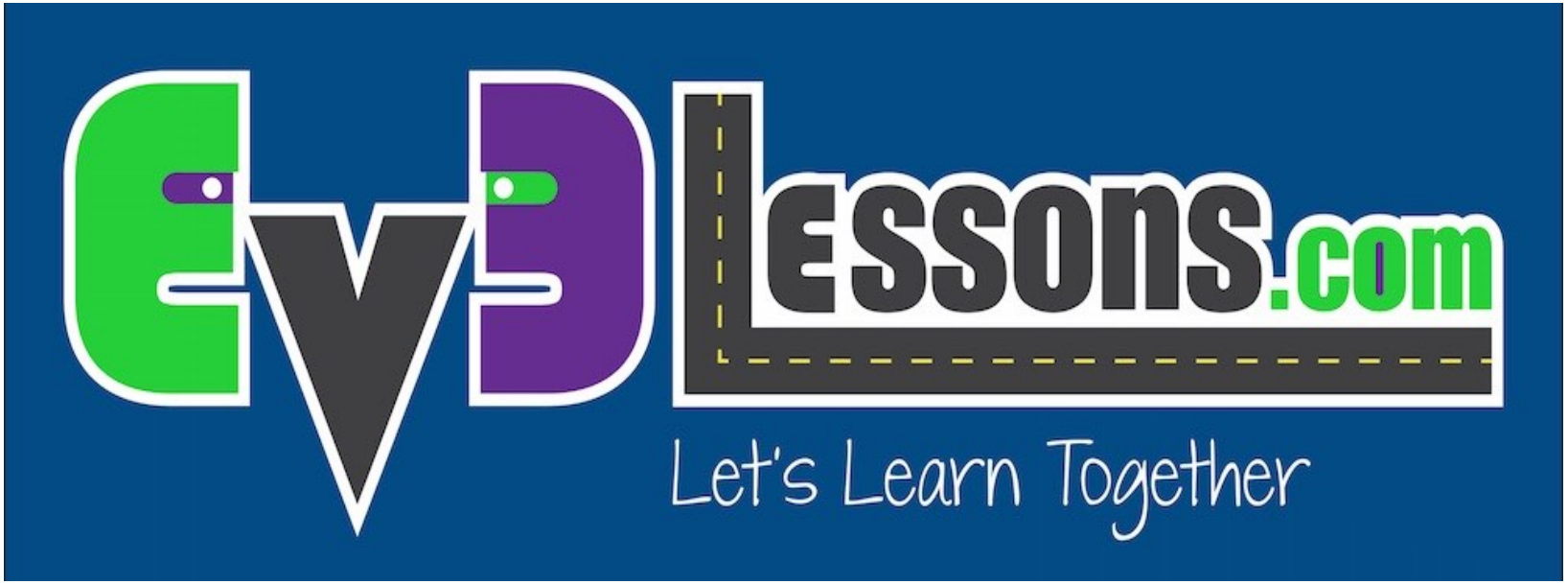


Building a Competition Robot

By Sanjay and Arvind Seshan

ROBOT DESIGN LESSON

OUR RULES FOR ROBOT DESIGN

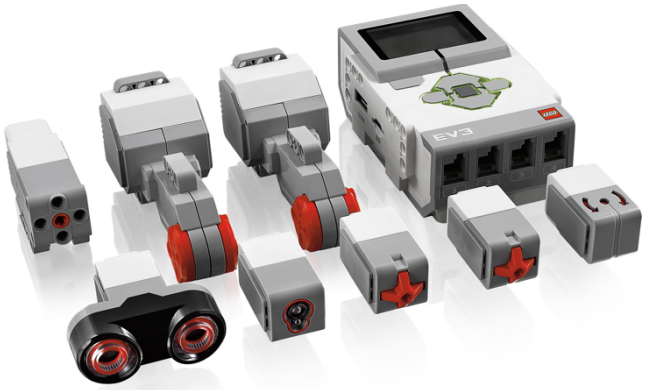
RULE #1: Take your time to build your base robot before jumping into attachment building and solving missions.

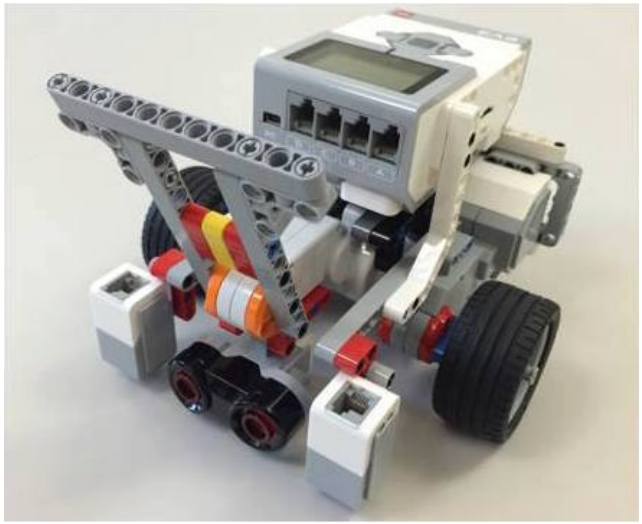
RULE #2: Take time to test your own ideas rather than seeking the "Internet Solution". As you progress through FLL, you will develop your building skills and develop your own style. Don't take shortcuts and skip steps in the learning process.

RULE #3: If you are just starting out, it is okay to start with a solid base robot design from someone like LEGO, EV3Lessons, or a book. Don't start with a robot designed for maximizing points at a contest. Instead, start with a basic design (not made for a competition) that you can add on to so that your team can discover on their own. Be sure you cite the source for your design/strategy ideas.

DESIGN CONSIDERATIONS

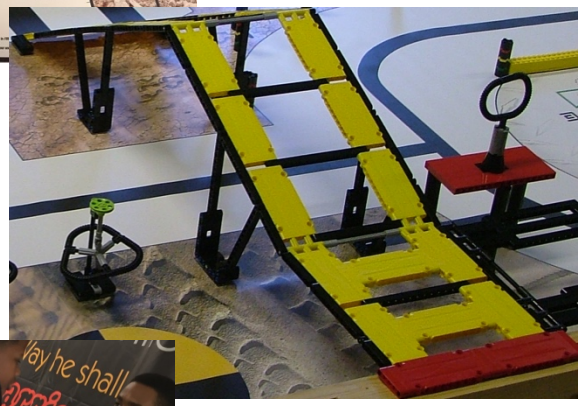
- In the next few slides, we present some key questions you need to ask yourself before building a competition robot
- You should consider the pros and cons of each option
- We firmly believe that you should design and test ideas for yourself – there is no perfect wheel or perfect design for a competition
- We discuss the following 6 factors: Size, Weight/Balance, Sensors & Placement, Arm Motor Placement, Wheel Choice and Other
- Also refer to the EV3Lessons Quick Guides: http://ev3lessons.com/guides.html

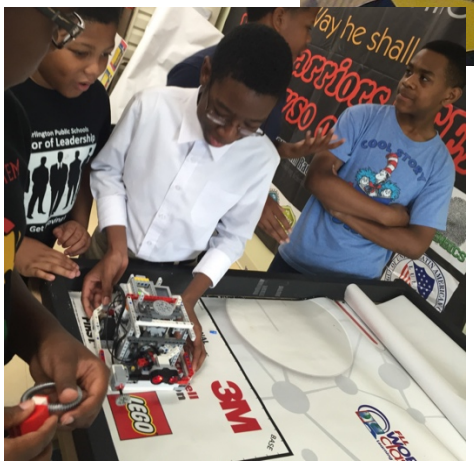




HEIGHT & WIDTH

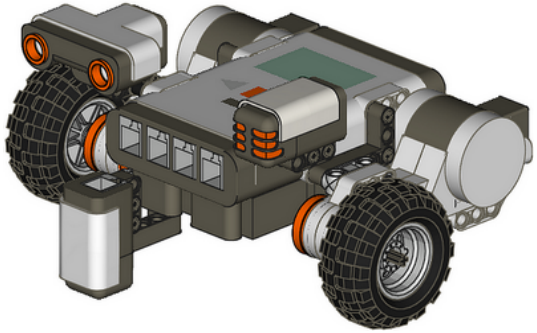
- Always check the height limitations set by the rules about Base (in 2016 the height limit was 12in ~30cm)
- There may be other height limitations caused by the size, shape and location of a mission model (e.g. you may have to go under a bridge)
- Consider width restrictions caused by Base dimensions and narrow openings in the challenge mat

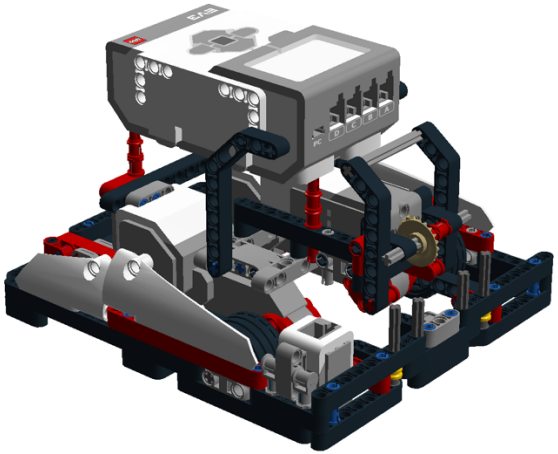




BALANCE

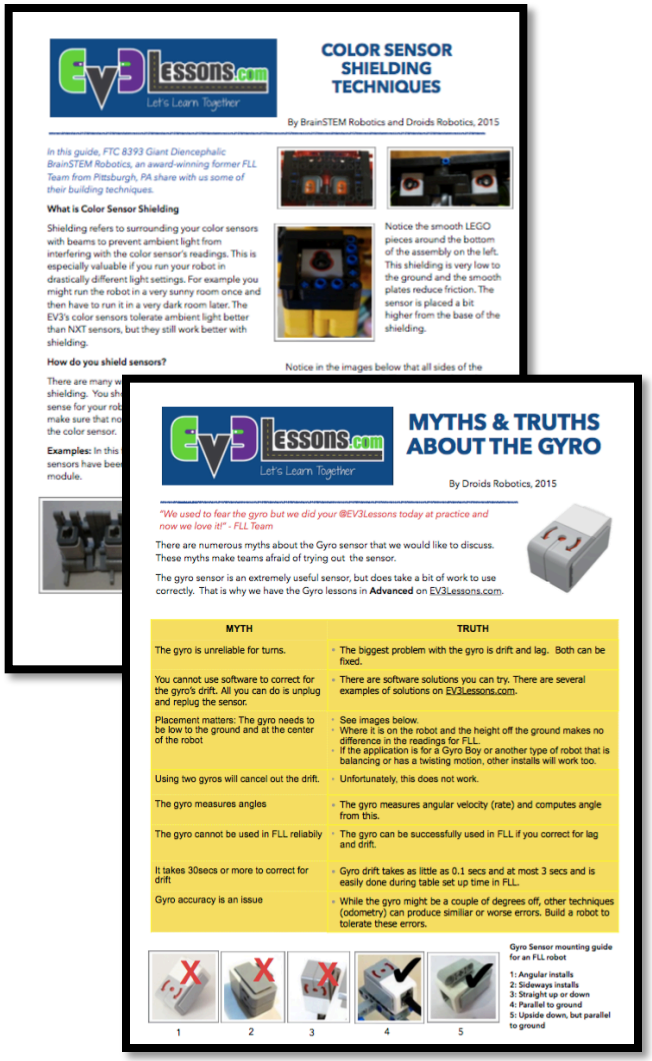
- Questions to ask yourself: Is your robot well balanced? Is the center of gravity in the right location?
- The robot should not be weighted to any one side
  - If it does, your moves will be unreliable, the tires may skid, the robot may veer
  - Once you add the weight of the attachments, this may worsen.
- Carefully consider the placement of the brick and also the weight of the attachments
  - A brick placed too high might be top heavy. A brick placed too much towards the front or back makes the robot imbalanced





SENSORS & THEIR PLACEMENT

- What sensors do you need to add to accomplish your team's goals?
- Where should the sensors be placed?
  - Color sensors need to be a good distance from the drive wheels to line follow. Sometimes placing them too close to the wheel causes problems with the line follower.
  - The gyro can be placed anywhere but must face a certain direction to be used to measure turns.
  - The other sensors need to be placed where they are most useful - on the side of the robot where you will use them the most.
- There are some useful Quick Guides available on EV3Lessons about sensor placement



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COLOR SENSOR SHIELDING TECHNIQUES

By BrainSTEM Robotics and Droids Robotics, 2015

In this guide, FTC 8393 Giant Diencephalic BrainSTEM Robotics, an award-winning former FLL Team from Pittsburgh, PA share with us some of their building techniques.

What is Color Sensor Shielding

Shielding refers to surrounding your color sensors with beams to prevent ambient light from interfering with the color sensor's readings. This is especially valuable if you run your robot in drastically different light settings. For example you might run the robot in a very sunny room once and then have to run it in a very dark room later. The EV3's color sensors tolerate ambient light better than NXT sensors, but they still work better with shielding.

Notice the smooth LEGO pieces around the bottom of the assembly on the left. This shielding is very low to the ground and the smooth plates reduce friction. The sensor is placed a bit higher from the base of the shielding.

How do you shield sensors?

Notice in the images below that all sides of the

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MYTHS & TRUTHS ABOUT THE GYRO

By Droids Robotics, 2015

"We used to fear the gyro but we did your @EV3Lessons today at practice and now we love it!" - FLL Team

There are numerous myths about the Gyro sensor that we would like to discuss. These myths make teams afraid of trying out the sensor.

The gyro sensor is an extremely useful sensor, but does take a bit of work to use correctly. That is why we have the Gyro lessons in **Advanced** on EV3Lessons.com.

MYTH	TRUTH
The gyro is unreliable for turns.	The biggest problem with the gyro is drift and lag. Both can be fixed.
You cannot use software to correct for the gyro's drift. All you can do is unplug and replug the sensor.	There are software solutions you can try. There are several examples of solutions on EV3Lessons.com.
Placement matters: The gyro needs to be low to the ground and at the center of the robot	See images below. Where it is on the robot and the height off the ground makes no difference in the readings for FLL. If the application is for a Gyro Boy or another type of robot that is balancing or has a twisting motion, other installs will work too.
Using two gyros will cancel out the drift.	Unfortunately, this does not work.
The gyro measures angles	The gyro measures angular velocity (rate) and computes angle from this.
The gyro cannot be used in FLL reliably	The gyro can be successfully used in FLL if you correct for lag and drift.
It takes 30secs or more to correct for drift	Gyro drift takes as little as 0.1 secs and at most 3 secs and is easily done during table set up time in FLL.
Gyro accuracy is an issue	While the gyro might be a couple of degrees off, other techniques (odometry) can produce similiar or worse errors. Build a robot to tolerate these errors.

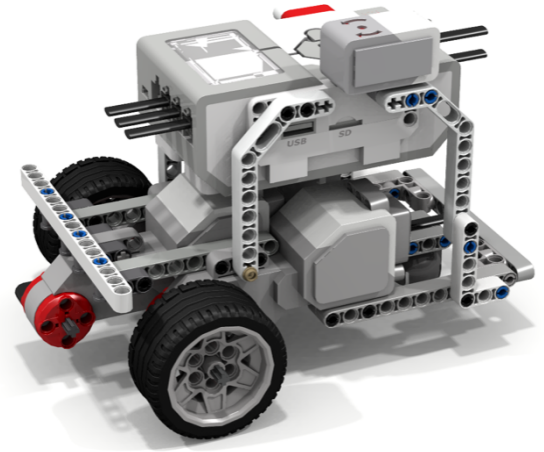
Gyro Sensor mounting guide for an FLL robot

1: Angular installs
2: Sideways installs
3: Straight up or down
4: Parallel to ground
5: Upside down, but parallel to ground

1 2 3 4 5

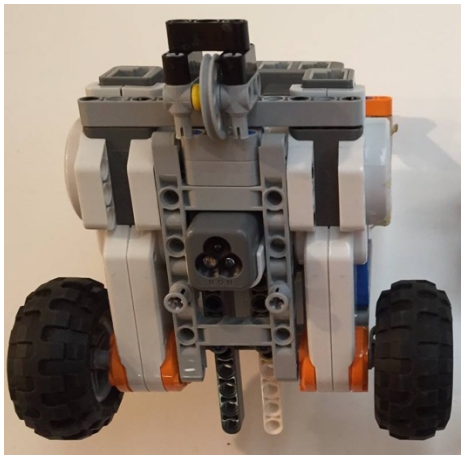
ARM MOTOR PLACEMENT

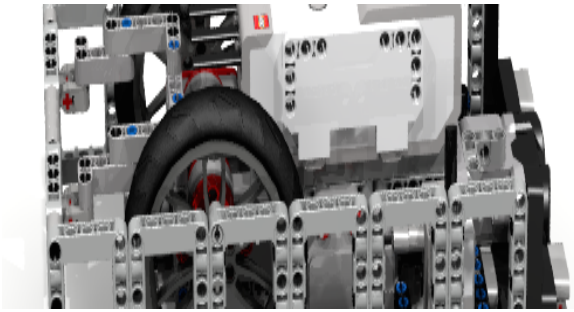
- If you are using the EV3, you can use 2 additional motors (of any type). You need to decide if you like the Medium or Large Motor.
- Where you place them depends on the attachments you build and if you are willing to add gears to your attachment
- Do you have to do a task up high or low to the mat?
- Will you be able to add attachments to the motor quickly and easily?
- Is the robot still balanced after adding the extra motors?



WHEELS

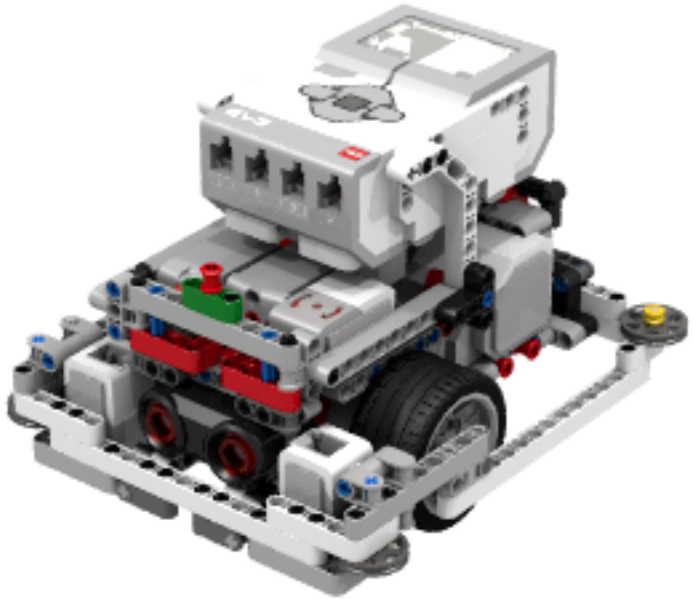
- **Don't listen to anyone who tells you which wheels are best for FIRST LEGO League. Every robot is different. Every year of the contest is different.**
- **Always do your own tests to determine which wheel is best for your particular robot and what the tradeoffs are**
- **Larger wheels may be faster, but are less precise and have more slack**
- **Small wheels are slower, but sometimes are more precise**
- **Firmer tires won't become out of shape or come off the rims.**
- **Back wheels/skids need to be able to move in many directions and be at the same height as the front wheels.**
- **Make sure that your wheels stay in place and do not flex out. If you are using treads, make sure they are installed tightly.**





OTHER CONSIDERATIONS

- Is your robot durable (or do things fall apart easily)?
- When you remove an attachment does something break off on the robot?
- Planning to ride on walls? Consider adding small wheels in the corner of your robot.
- Planning to square/align on lines? You might want a second color sensor
- Can access your charging port if you use rechargeable batteries?
- Can easily access the brick if you plan to use AAs?
- Can you access the USB port to download programs at contests where Bluetooth is not permitted?



EXAMINE THE COMPETITION RUBRIC

- **When you think you have a good design, test out how it moves and turns**
- **Look at the competition rubrics and see how your robot fits**

		Beginning	Developing	Accomplished	Exemplary
Mechanical Design	**Durability**	Evidence of structural integrity; ability to withstand rigors of competition			
	ND	quite fragile; breaks a lot	frequent or significant faults/repairs	rare faults/repairs	sound construction; no repairs
	Mechanical Efficiency	Economic use of parts and time; easy to repair and modify			
	ND	excessive parts or time to repair/modify	inefficient parts or time to repair/modify	appropriate use of parts and time to repair/modify	streamlined use of parts and time to repair/modify
	Mechanization	Ability of robot mechanisms to move or act with appropriate speed, strength and accuracy for intended tasks (propulsion and execution)			
	ND	imbalance of speed, strength and accuracy on most tasks	imbalance of speed, strength and accuracy on some tasks	appropriate balance of speed, strength and accuracy on most tasks	appropriate balance of speed, strength and accuracy on every task

CREDITS

- **This tutorial was created by Sanjay Seshan and Arvind Seshan**
- **More lessons at www.ev3lessons.com**