FIRST® LEGO® League TUTORIALS

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Building a Competition Robot

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SESHAN BROTHERS

ROBOT DESIGN LESSON

OUR RULES FOR ROBOT DESIGN

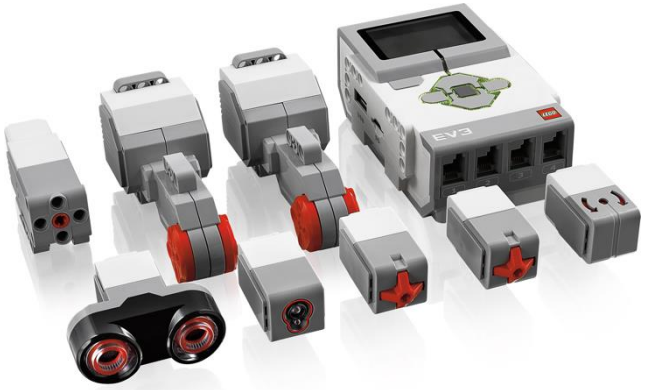
RULE #1: Take your time to build your base robot before jumping into attachment building and solving missions.

RULE #2: 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.

RULE #3: 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.

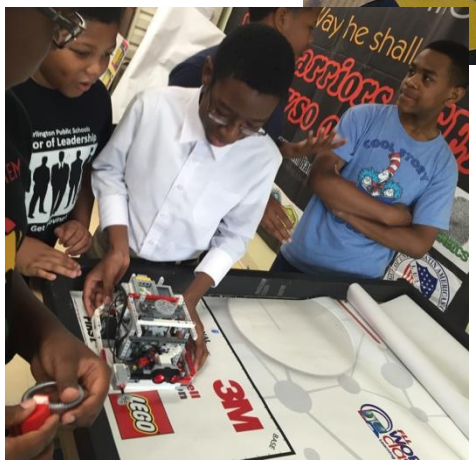
DESIGN CONSIDERATIONS

- 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



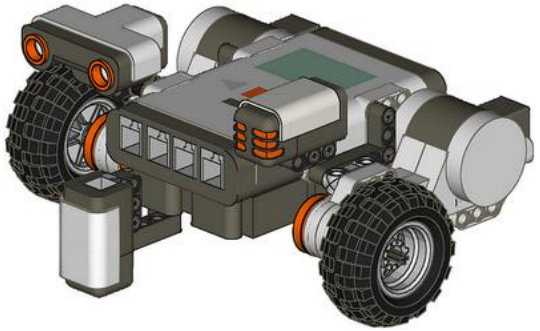
HEIGHT & WIDTH

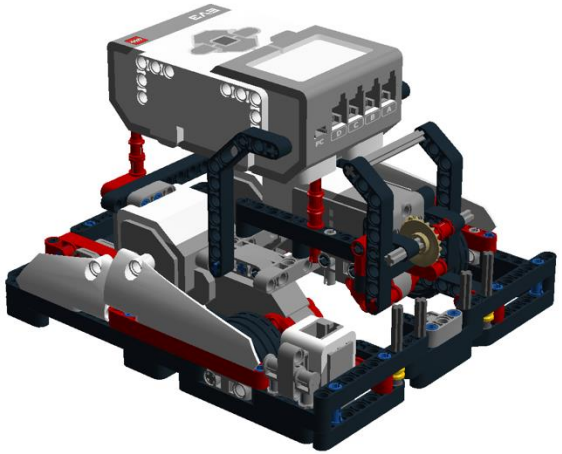
- **Always check the height limitations set by the rules about Base (in 2016 the height limit was 12in ~30cm)**
- **There may be other height limitations caused by the size, shape and location of a mission model (e.g. you may have to go under a bridge)**
- **Consider width restrictions caused by Base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



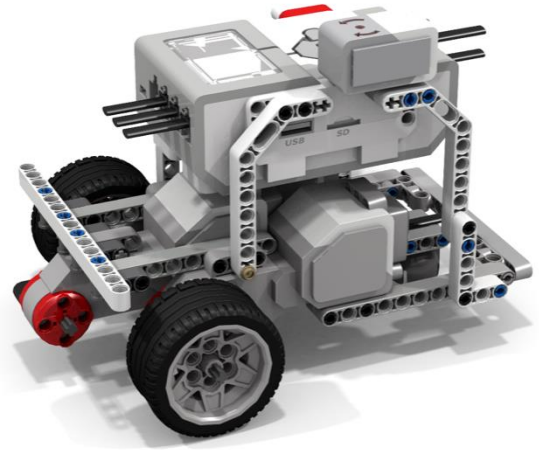


SENSORS & THEIR PLACEMENT

- 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.

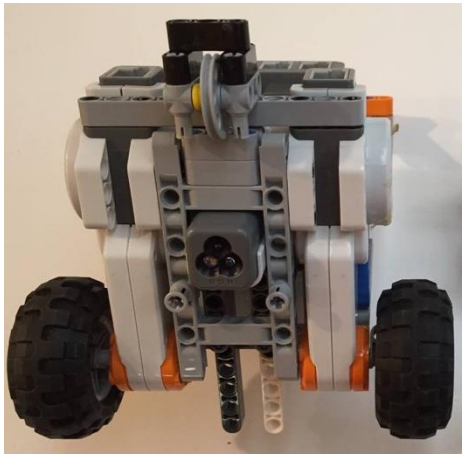
ARM MOTOR PLACEMENT

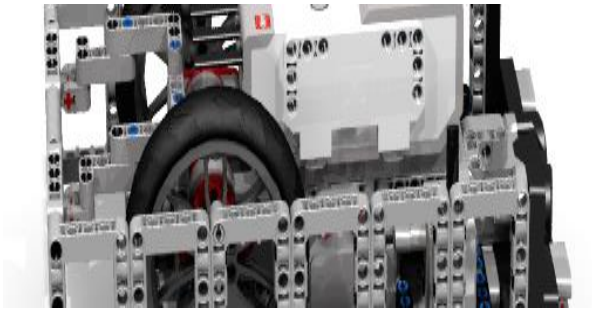
- If you are using the EV3, you can use 2 additional motors (of any type). You need to decide if you like the Medium or Large Motor.
- Where you place them depends on the attachments you build and if you are willing to add gears to your attachment
- Do you have to do a task up high or low to the mat?
- 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 you access your charging port if you use rechargeable batteries?**
- **Can you 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 and www.flltutorials.com**