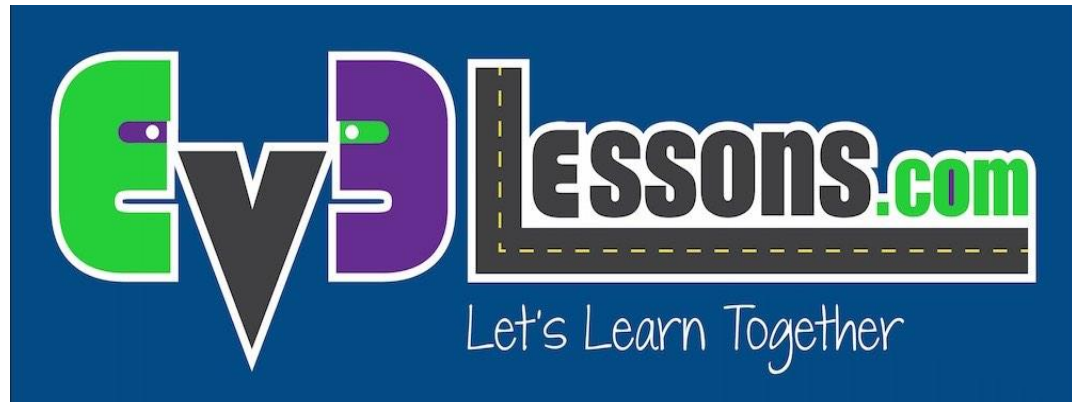


INTERMEDIATE PROGRAMMING LESSON



IMPROVING PROGRAM RELIABILITY

By Sanjay and Arvind Seshan

Lesson Objectives

1. Learn how to make your robot more reliable
2. Learn about common problems you might face
3. Learn some possible solutions

Note: This lesson focuses on reliability issues faced by FIRST LEGO League teams. Many concepts are applicable to non-competition situations, but the terminology in the lesson and the main focus is for competition robots.

Sources of Problems

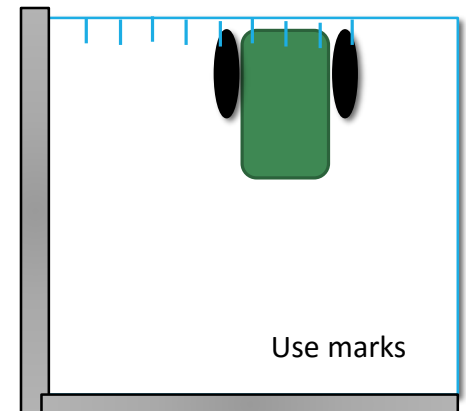
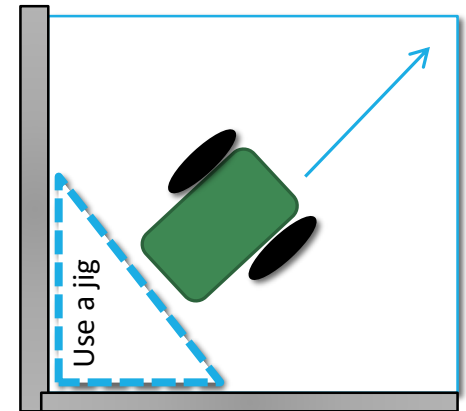
Problem	Impact
Starting alignment varies from run to run	Each run is different and missions sometimes work.
Robots don't travel straight for long or turn exactly the same amount	It is hard to predict the robot location exactly.
Errors accumulate as you travel	Long missions tend to fail. It is hard to do missions far from base
Adjusting motors/attachments in base	First move out of base may behave differently each time. Attachments don't work the same each time
Battery levels impact motor performance	Tweaks that work today fail tomorrow

Starting Points in Base are Critical

In FIRST LEGO League, teams need to figure out where to start in base

- Jigs: a LEGO ruler/wall that your robot can align against them in base
- Same start each time: pick one spot and start there no matter what the mission for easy starts
- Inch marks: Use the inch marks to pick a starting spot for each run
- Words: Base has words. If you aren't near an inch mark, pick a word or letter to start on.

Even better, try to find a way to align the robot using other techniques (see next page)



Errors Accumulate Over Time

By the time you get to the far side of the table, you are no longer in the right position

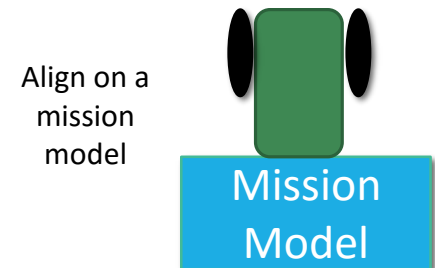
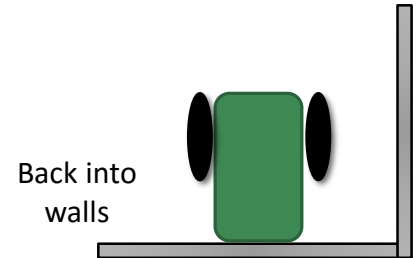
Solution: Repeat alignment techniques multiple times in a run for better reliability (see next slide)



Where Are You on the FLL table?

Consider these alignment strategies that are commonly used:

- Align on walls – deliberately back into a wall to straighten out (note: You may stall doing this. See the Advanced: Stall Detection Lesson)
- Square/Align on lines – If you are moving angled, you can straighten out whenever you see a line. (See Advanced: Squaring Lesson)
- Move until a line – travel until you find a line so you know where you are on the mat (See Beginner: Color Sensor)
- Align on a mission model – Mission models that are stuck in one place can be used to align against



Adjusting Attachments in Base

Just like the robot body, you need to set up your attachments in the same way each time for improving reliability

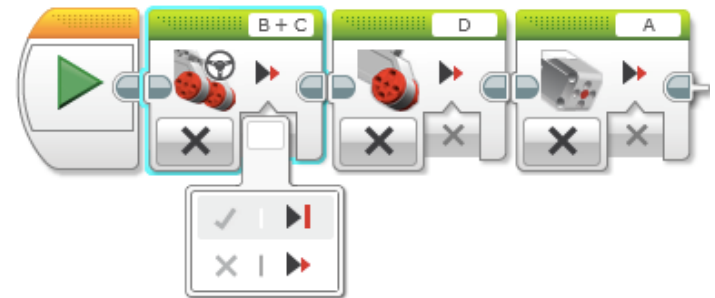
- Jigs that allow the attachment arm to only move to a certain level to make sure the arm is set the same way each time
 - In Senior Solutions, we used a jig to make sure the arm that picked up the pill box always started at the right level
- Indicators on the robot (e.g. bright peg) might help you remember where to reset the arm to
 - In Food Factor, we had a red peg in a hole to remember how far back to move the arm
- You can use a touch sensor to detect the position of an attachment at the start of a run

Adjusting Motors in Base

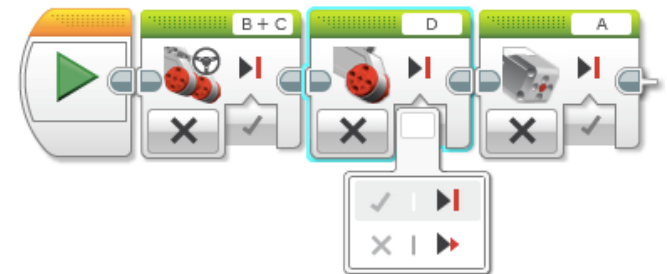
Moving attachments or wheels

- When the program is stopped you can move wheels and attachments easily and it has no impact
- If a program is running, there are multiple steps
 - You need to put the motors into “coast” mode
 - If you move the motors in coast mode, the motors will move back to the original position on the first move!
 - You need to “reset” the motor after an adjustment and before you start your run

1) Put all the motors you use on coast so you can move the motors by hand to adjust



2) Now you have to “reset” the motors




Using Coast

This set puts all the motors in coast mode. You should be able to freely move your motors by hand without any resistance.

When you are ready to start your mission, hit the middle button


We tell motor Arm "A" to move 10 degrees. It will move 10 degrees from where it was when the program last started and not where you moved it to by hand earlier



This code shows that the motor arm (A) will not be predictable no matter how much you reset the arm by hand. It's movement is based on where the arm last was. Move the arm by hand at least 90 degrees to see the difference.

Doesn't work well. Not as reliable!

Using Coast & Reset



The image displays a sequence of Scratch code blocks for controlling three motors (B+C, D, and A). The blocks are arranged in a row, with each block having a small icon of the motor it controls. The blocks are: a green flag click block, followed by three motor control blocks (B+C, D, A), each with a 'coast' mode icon (a red circle with a white 'X'). Below the first three blocks is a text box explaining that this set puts all motors in coast mode. The next three blocks are identical to the first three, but the 'coast' mode icon is replaced by a 'reset' icon (a red circle with a white checkmark). Below these blocks is a text box explaining that a 'reset' step has been added. The final three blocks are identical to the first three, but the 'reset' icon is replaced by a 'move' icon (a red circle with a white arrow). Below these blocks is a text box explaining that the attachment arm 'A' will now move 10 degrees from its current position. The text boxes are: 'This set puts all the motors in coast mode. You should be able to freely move your motors by hand without any resistance.', 'When you are ready to start your mission, hit the middle button', 'Here, we added a "reset" step.', 'This code shows that the motor arm (A) will be more predictable because you are able to set a starting position for the arm in base. Move the arm by hand at least 90 degrees to see the difference.', and 'Now when you ask the attachment arm "A" to move 10 degrees, it will move 10 degrees from where you manually moved the arm when it was in base.'

This set puts all the motors in coast mode. You should be able to freely move your motors by hand without any resistance.

When you are ready to start your mission, hit the middle button

Here, we added a "reset" step.

This code shows that the motor arm (A) will be more predictable because you are able to set a starting position for the arm in base. Move the arm by hand at least 90 degrees to see the difference.

Now when you ask the attachment arm "A" to move 10 degrees, it will move 10 degrees from where you manually moved the arm when it was in base.

More reliable!

Other Factors in Reliability

Battery life

- If you program your robot when the battery life is low, it won't run the same when fully charged
 - Motors behave differently with low battery
 - But using sensors makes you not as dependent on battery

LEGO pieces come apart over time:

- Squeeze in LEGO pieces in key areas before a run – the pegs get loose which means the sensors may not be in the same place as a previous run
- Push wires in for sensors and motors. They come out!

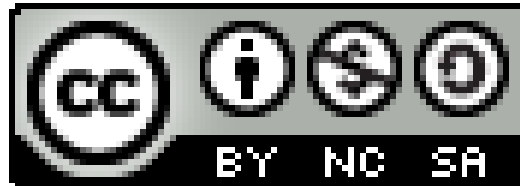
Motors and sensors don't always match:

- Some teams test motors, sensors and wheels to make sure that they match
- You will never get a perfect match so we recommend use other techniques and accept that they will be different

Credits

This lesson was written by Sanjay and Arvind Seshan

More lessons are available at www.ev3lessons.com



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