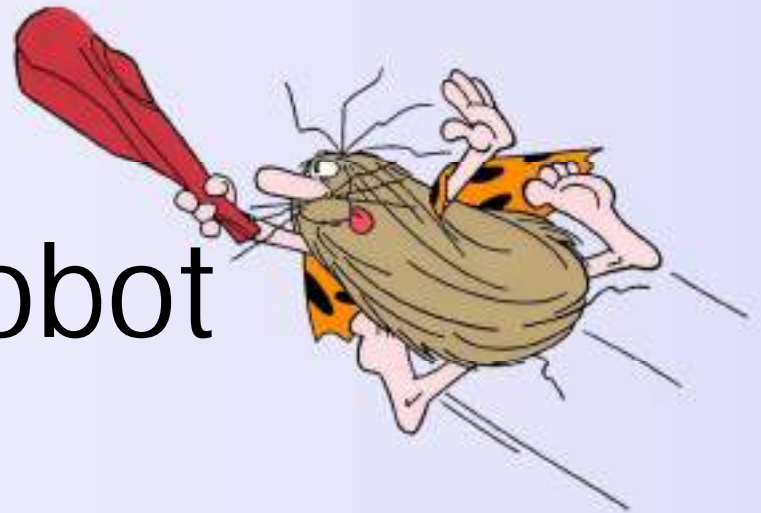


Troubleshooting your LEGO robot

- Attila Faragó -



Key sources of trouble to “shoot at” 

1. Programming errors
2. Mechanical errors
3. Strategy errors
4. Connection errors



Mechanical errors



Mechanical errors

Some possible causes

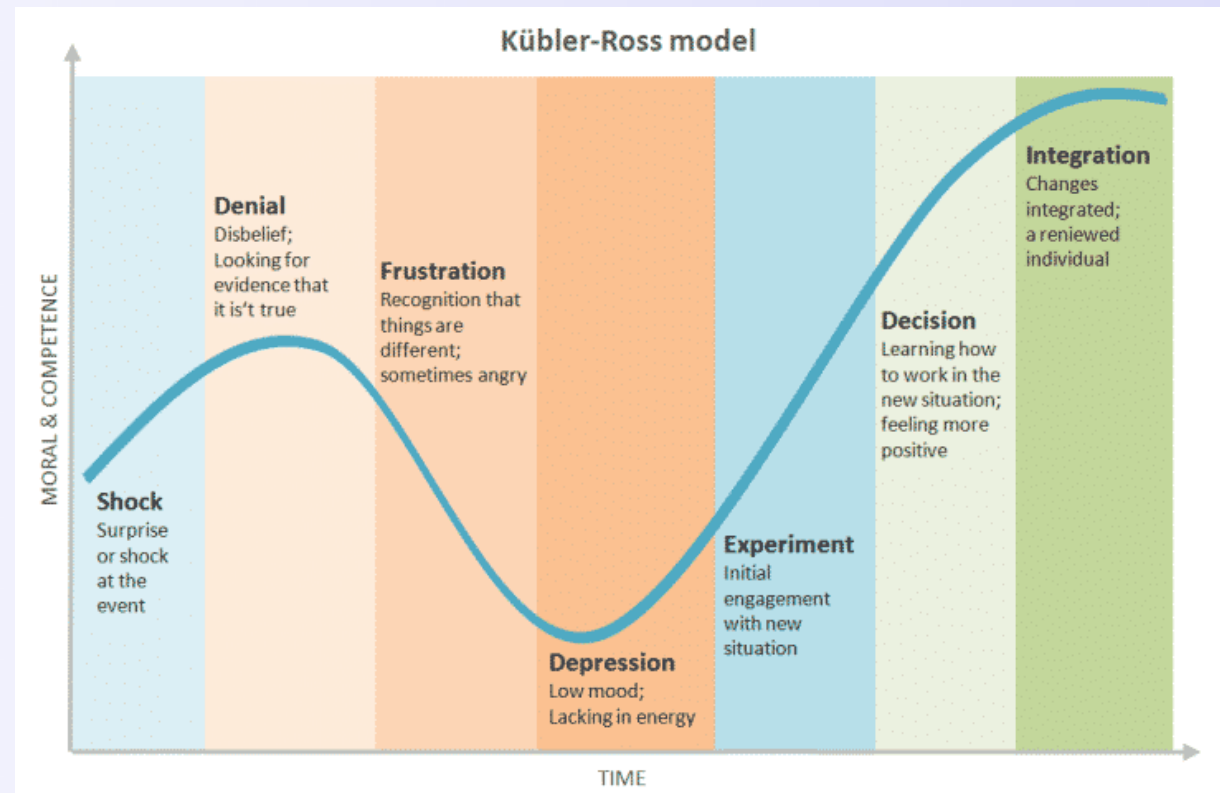
1. Robot assembly at site
2. Center of gravity
3. Improper structural integrity
4. Gaps
5. Motor „play“

What can you do?



What can you do?

1. Talk about it
2. Accept
3. Cool down and chill out
4. Prepare!
5. Experiment
6. Improve



Suggested Practice Exercises

- Practice robot assembly including drive straight tests
- Practice routine of basic moves
 - drive 10cm, 100cm, rotate 90deg * 8, measure
 - learn to correct this before any program change
- Calibrate centre of gravity
- Add proper back/caster wheels – check ability to turns, check under weight
- Experiment with main wheels
 - width of grip vs spinning, need of acceleration and deceleration
 - experiment with different wheels expansion vs stiffness
 - experiment with size and discuss importance of speed, preciseness
 - <https://flltutorials.com/translations/en-us/RobotGame/Wheels.pdf>
- Are the base structure, actuators, claws stable enough to last a full day?
- Validate motor „play“ or sloppiness
 - Experiment with backing up to wall or moving the wheels simultaneously
 - Different motors have different plays – EV3 large vs EV3 medium motor

Troubleshooting at competition

1. Start mechanical validation after assembly!
Try basic move straight and 4x move, turn routine – check and adjust until perfect
2. Clean wheels regularly
Tape or cat fur cleaner



Learn all about your motor from Philo

<https://www.philohome.com/motors/motorcomp.htm>

Weight

											
2838	2986	71427	43362	5292	47154	NXT	E-Motor	PF Medium	PF XL	9V Train	RC Train
48g	10g	42g	28g	55g	40g	80g	50g	31g	69g	72g	53g

											
PF Train	PF Large	EV3 Large	EV3 medium	PUP Train	PUP medium	Boost Ext.	Boost Int.	Control+ L	Control+ XL	Spike M	Spike L
57g	42g	82g	39g	57g	34g	43g	-	53g	76g	49g	71g

Supposed to be equivalent to 71427, 43362 motor is 30% lighter. This is generally an advantage, except when the motor is used as a counterweight, or to balance the structure, for example in COG-shifting walkers.

No-load characteristics

Test conditions: motor is powered by a variable, regulated power supply. An ammeter measures current flowing through the motor, a voltmeter monitors tension across. The rotation speed is measured by a RCX equipped with a light sensor, looking at an [half-white half-black cylinder](#).

9 V supply												
Rotation speed (rotations per minute)	4100 rpm	35 rpm	360 rpm	340 rpm	1700 rpm 1240 rpm	460 rpm	170 rpm	780rpm	405 rpm	220 rpm	2000rpm	2000rpm
No-load current	35 mA	6 mA	3.5 mA	9 mA	160 mA	31 mA	60 mA	17.5mA	85 mA	80 mA	90mA	90mA

9 V supply												
Rotation speed (rotations per minute)	1900rpm	390 rpm	175rpm	260 rpm	1760 rpm	380 rpm	255 rpm	350 rpm	315 rpm	330 rpm	228 rpm	213 rpm

⚙ Motor sloppiness

<https://www.youtube.com/watch?v=I3RidtCDjtY>

**This is the
formula for
"slop distance"**

...

Slop Distance = (Wheel Diameter{mm} * pi)

(360 / backlash degrees)



EduCamp: Activities

- Discussion - Talk about mechanical errors with kids // What mechanical errors have you encountered? How did you solve it?
- Practice post-robot-assembly-test on each robot: straight 10-50-100cm, turn 90deg, (straight 30 - turn 90)*8
- Check motor sloppiness together

Strategy errors



Strategy errors

Some possible causes

1. Lack of hardware design
2. Too few sensors or too many sensors
3. Understand the rules and ask – read the FAQ/s
4. All or nothing strategy
5. Surprise rule challenge
6. Second day challenge

What can you do?



Suggested Practice Exercises

- Read all the rules, FAQs, forums and ask in email if you are unsure
- Spend time designing the robot for stability and efficiency
 - Iterate: fail, learn, retry, assemble again – black horse strategy
- Spend time thinking about different mat strategies
 - Print an outline and draw as many different runs as possible – keep it for later
 - Use a whiteboard!
 - Iterate: fail, learn, retry, assemble again – black horse strategy
- Think about how many ports you can effectively use
 - Iterate: fail, learn, retry, assemble again – black horse strategy
 - Try using sensors to get a perfect run
 - Only runs that are reproducible help you – 50% accuracy is your worst enemy
 - Too many sensors are not helpful – sometimes gyro or color sensors win 1 sec and fail 50% time
- it is OK not to solve all tasks, have fun, have 100% reliable runs
- Coaches: shake the table! :D, turn off / on the lights, tilt the table by 1%

Troubleshooting at competition

Surprise rule challenge

- Practice at home, add some funny surprises regularly
- Weight the surprise rule – what is possible, what does not worth it?

Second day challenge

- Practice “speed” strategy assessment
- What is realistic in 1 day?
- Practice aiming for less and achieving it

EduCamp: Activities

- Draw a game map on a sheet of paper
- Draw possible strategy on the mat that could be accomplished on a clean machine (no custom blocks or code) in 60 mins
- Discuss and evaluate each group together – is it realistic? How they compare?



Connection errors



Connection errors

Some possible causes

1. Cable error or connector error
2. Bluetooth issues
3. Streaming “chaos” mode



What can you do?



Suggested Practices

- Spend time with planning cable management, do not force
- Check and test each motor/sensor/cable separately, match motors
- EV3: Check and replace cables, hub can hang on half-connected state
- EV3dev: plan for restart / timing
- Bluetooth:
 - SPIKEV2/V3 reboot hub, restart app, restart computer
 - OS should not be pwd protected from kids - competition problem
 - EV3 practice enable /disable
 - BT interference can cause gyro issues – turn off regularly
- EV3 debug and SPIKE streaming mode is problematic – avoid them for competition, they change a lot!

EduCamp: Activities

- Hide and seek: rotate teams, each one does _ONE_ trick alteration on the other robot, then team needs to find what was wrongly connected / changed
- Practice 4x BT turn off-turn on
- Practice 4x hub-app-pc restart routine

Programming errors



Programming errors

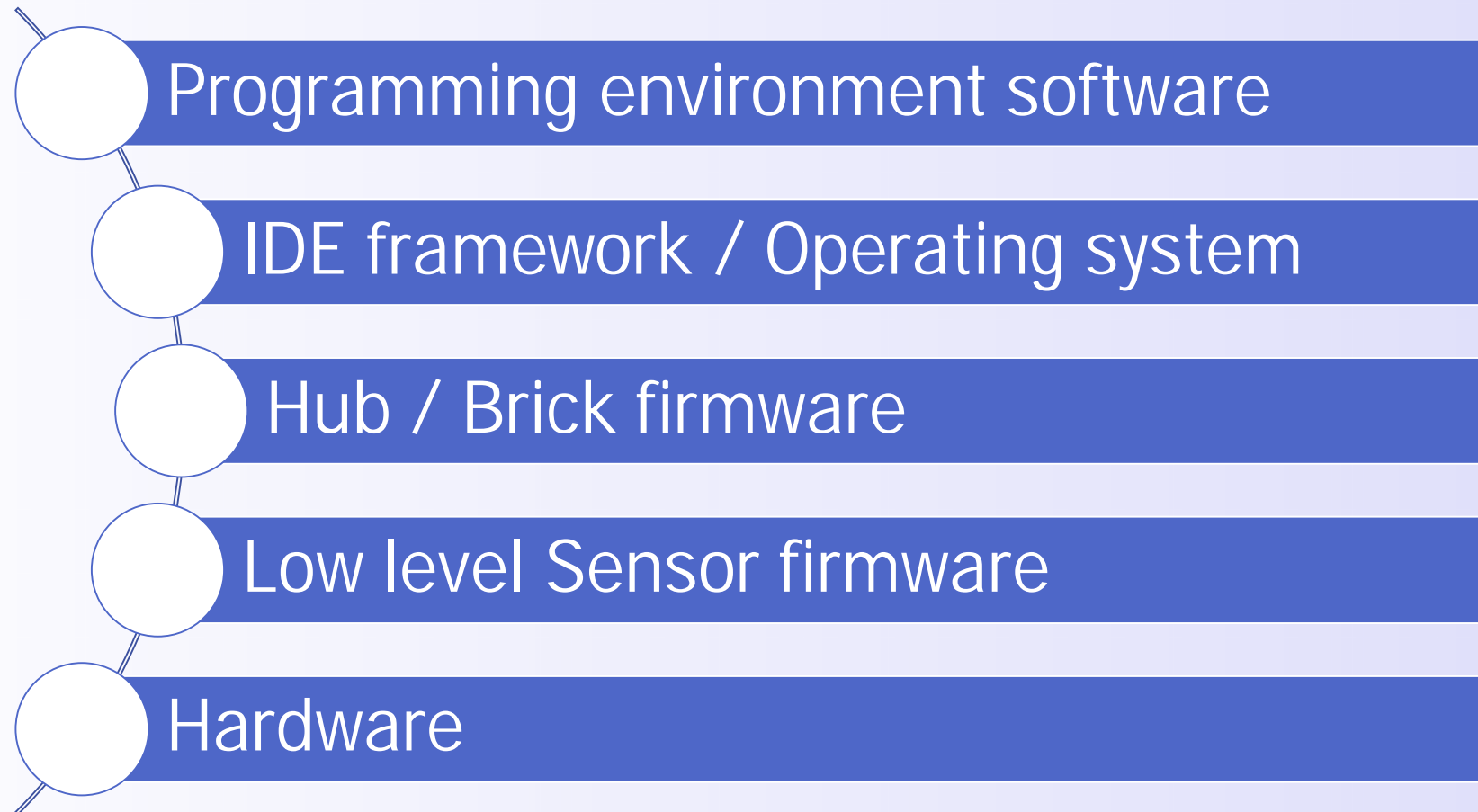
Some possible causes

1. Lack of hardware design
2. Too few sensors or too many sensors
3. Understand the rules and ask – read the FAQ/s
4. All or nothing strategy
5. Surprise rule challenge
6. Second day challenge

What can you do?



Understand the layers



Programming environment software

Primary target IDEs

- SPIKE 2 WordBlocks / RI WordBlocks scratch
- SPIKE 3 WordBlocks scratch
- EV3Lab by NI / LabView EV3G
- Ev3dev python
- (and many more IDEs)

EV3Lab / EV3G

EV3Lab (xml/zip) → LabView → (compile) → EV3lms bytecode → EV3FW interpreter on hub (linux)

1. EV3 VM Instruction Break Error → // resolved <https://www.youtube.com/watch?v=kWw8fI9YPBk>
2. Myblock does not work → myblock testing condition
<https://afarago.github.io/EV3TreeVisualizerPages/features.html#myblocks>
3. File read error → make sure file exists
4. EV3 slow → downgrade to 1.09 (1.10 is for makeblock, but is slower)
5. EV3 slow compilaion / memory low → install education version vs home
6. EV3 crashes → save often, use ev3treevis for decoding
7. Missing myblocks → use ev3treevis, check code
<https://magbuhatrobotics.files.wordpress.com/2017/05/appendix-a.pdf>



Trick: can even insert LabView instructions into ev3g for maximum efficiency, can even create own sensor blocks or separate apps

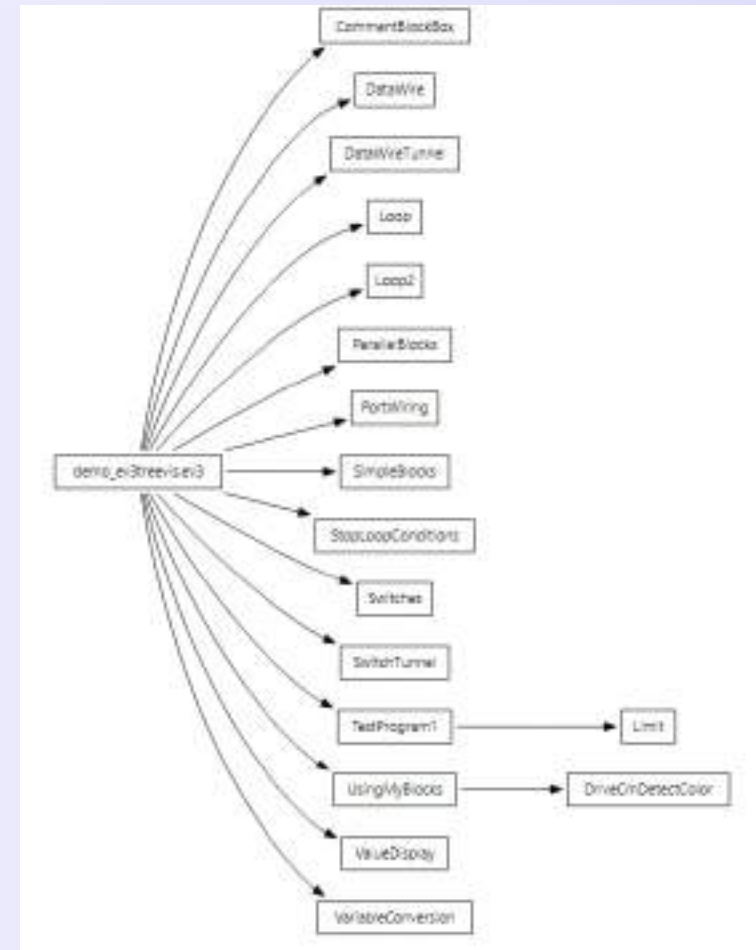
- http://toviscsapat.hu/#robot_tovisblocks+en
- http://toviscsapat.hu/#robot_ev3apps+en

EV3Lab / EV3G

Understand your code and myblocks
better

<https://ev3treevis.azurewebsites.net>

decode compiled code



EV3 sensors

1. EV3 gyro drift
 1. Understand: Gyro \rightarrow integrate deg/sec rate
 2. Firmware calibration happens at init and mode change (~)
 3. Avoid reset – do it only at the very start, use diff afterwards
 4. <https://ev3lessons.com/en/ProgrammingLessons/advanced/GyroRevisited.pdf>
 5. Experiment with N4 (?) second axis
http://toviscsapat.hu/#robot_tovisblocks+en
 6. Consider NOT using gyro when not needed
2. EV3 color sensor reliability
 1. RLI mode \rightarrow shield sensor
 1. Use auto sensor calibration strategies (read/move/store)
 2. COL: Color mismatch \rightarrow shield sensor
 1. experiment with table distance 1.5 units
 2. Use raw mode
3. EV3 does not start \rightarrow check all connections
 1. write auto-detect block / power-on self-test (POST)



```
icon          svg
manifest      json
scratch       ib3
1b8b032b0638da6c7c31d86b... wav
deadcd57500000000000000000... svg
project       json
```

1. Understand: Gyro \rightarrow integrate deg/sec rate
2. interference, problems reported when used with color sensors
3. Energy problems, auto resets sometimes, at 180deg
4. Consider NOT using gyro when not needed

1. Extract and open "Icon.svg" in explorer

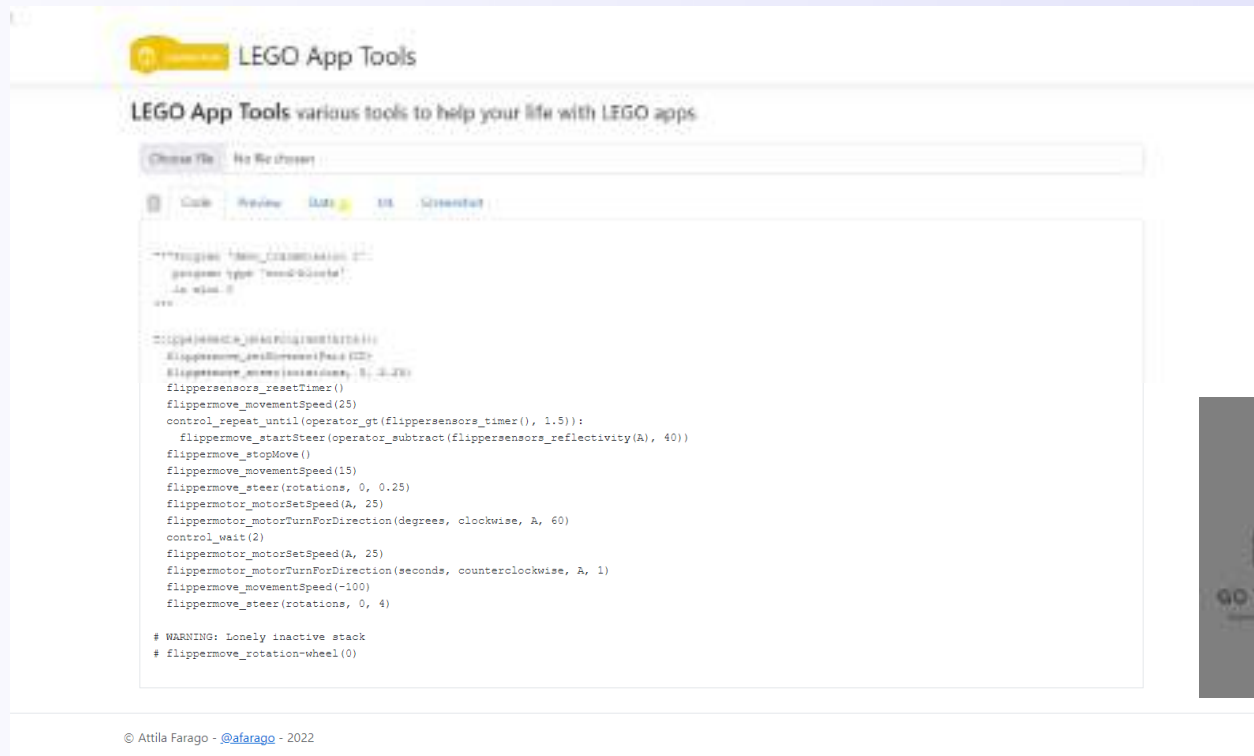
1. RLI mode → shield sensor
Use auto sensor calibration strategies (read/move/store)
2. COL: Color mismatch → shield sensor
experiment with table distance 1.5 units

1. Try textual programming languages such as python
2. Reduce repeated logic (Don't Repeat Yourself – DRY)

[illegible]

SPIKE V2, V3

Understand your code better - <https://legoapptools.azurewebsites.net>



Suggested Practice Exercises

- Practice disconnected, wrong cables with the team
- Check reliability with/without gyro – compare and discuss
- When using gyro, limit speed and rate of turn
- Do not compensate errors in programming
- Create reliable runs and code!
- Split the code and test
testing means several goal–experiment–evaluate–improve cycles
- Document the code
- Save and backup several times
- Use acceleration and deceleration blocks – create or use (SPIKE/RI)

Troubleshooting at competition

Ask “why is it needed”?

- except surprise rule and second day challenge



EduCamp: Activities

- Start activity with empty workspace (no myblocks/custom code)
- repeat 5x: move till black line and back up 30 cm
- Check reliability – create an experiment of 10x of the above, who scores the most reliability points?
- !!! You and other teams can use any creative light conditions to interfere