Introduction to Elementary and Middle School Robotics

John Heffernan

8/17/2014

Introduction

- Elementary and Middle School Engineering Education with a focus on robotics
- Some background
- Activities
- Wrap-Up

Tap creative play

- Are we tapping into the so important creative play of children in school, especially the kind associated with building?

Tap creative play

- It's more fun to actually be building something. If you took a class in robots and just learned about things, if the teacher just drilled information into your head, it would not be as fun as building and experiencing it to learn.
- *Grade 6 Girl 2*

Tap creative play

- Who is tapping into creative play? Are we?

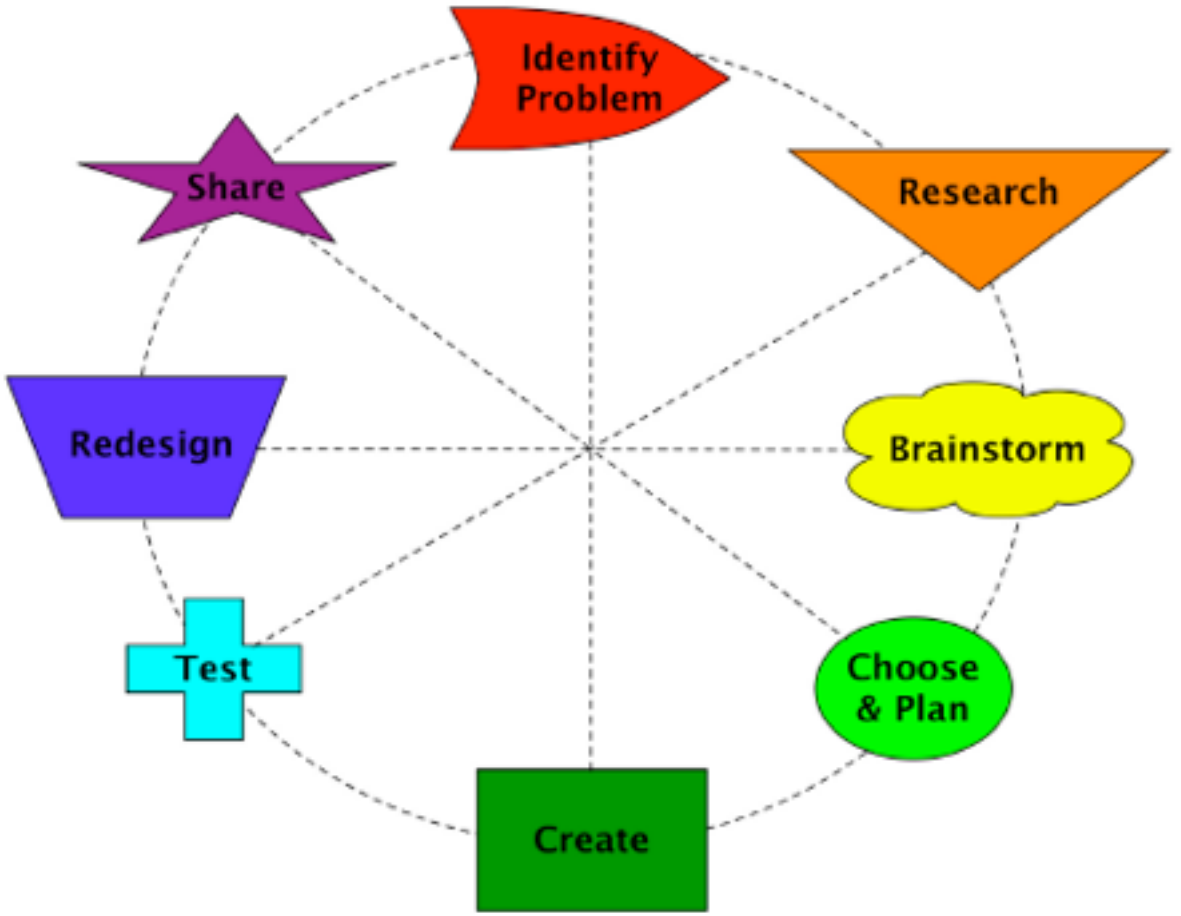

Bell

Lego Robots directly tap into the creative play urge of children in a healthy and educational way. A PK-6 robotics curriculum (such as Elementary Engineering Curriculum) is needed to support and sustain the natural engineering instincts of young children until formal engineering

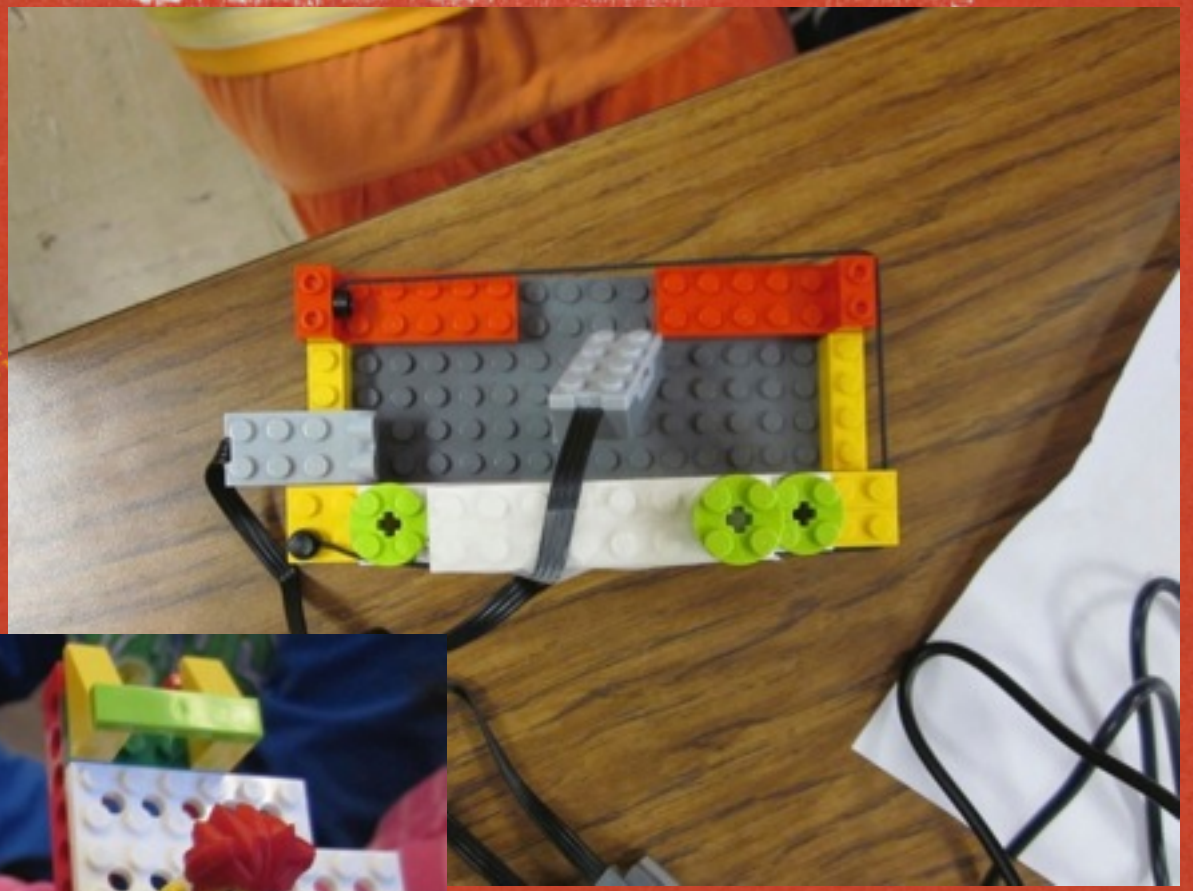
WHY ROBOTS?

- Engineering can be taught in many ways, why Lego Robots?
- Familiar, fun, fantasy
- They can be programmed, adds “life”
- Tech component built in
- Math, science, ELA as well

Engineering Design Process



Courtesy - Dr Merridith Portsmore, Tufts CEEO



Grappling

Year 1 Clever Solution

Open Ended Challenges

Depth of Learning

GRADE 5/6 LEGO LESSONS #2 – MOTORS – NO SENSORS

TEAM DATE 4/6/11

Follow the checklist below.

- ✓ The car turns clockwise for 5 seconds.
- ✓ The car turns counterclockwise for 5 seconds.
- ✓ The car goes in a straight line for 3 seconds.
- ✓ The car goes forward for 2 seconds, makes a 90-degree turn, goes forward for 2 seconds and stops.
- ✓ The car follows a taped square on the floor.
- ✓ The car follows a taped path on the floor.

GRADE 6 VELOCITY WORKSHEET

NAME Corie DATE

- ✓ Measure 10 feet and mark the distance in some way.
- ✓ Create a program that goes indefinitely. Set the motor power to 75%.
- ✓ Using the wall clock's second hand or a stopwatch, record how long it takes to go 10 feet. 11 seconds

Calculate the velocity (rate) of your robot in feet per second. Distance = rate x time.

Rate = 1.1 feet/second

Compare your results with others.

Why are results different for different teams? lighter robots

What was the fastest speed? 1.016 sec

Extra credit

What is the velocity of a robot car with the power set to 100%? 8sec per 10 foot or .8 in 1 foot

What is the slowest speed you can get the robot to go?

Motivating

Fun

It was hard so it made us jump up and down when it finally worked. *Grade 5 Girls Team 1*

How is it different?

- [It's] Absolutely! [different from other schoolwork.] It's more interactive because mostly what we are doing in school is paperwork. With this you get to experiment, instead of just doing something, like math, you got a question, you figure it out. With this you can, change it up, experiment. *Grade 6 Boy 1*

- It's fun and different in a different way. I just think it is more fun. The way you think - easier is some ways, harder in some ways. The way you think is more fun to think that way than the other way. *Grade 4 Boy Team 2*

More Quotes

- I didn't think you would use all that math and science to build that robot. Grade 6 Girl 2
- It's more fun [than usual schoolwork.] It's a lot different – sometimes mathematical. You have to think in a different way. This would make this, would make this, happen. Each step is connected. Grade 4 Boy Team

What did you like about robotics?

- What did you like about robotics?

- 24 Mentioned the project as fun
- 15 Got to build/hands on
- 8 Different than other school work/special/exciting
- 7 Liked the programming even though it was hard
- 5 Cool
- 4 It was satisfying/exciting getting things to work
- 2 Liked the trial and error
- 2 Had to learn to compromise, work together
- 2 Got to move around, not stay in seat

RESEARCH - Interview results

- Student very aware of how they are being taught
- Prefer hands on activities and believe they learn better that way

Grade 6 Robots – Pre-Survey

NAME [redacted] DATE 3-30-11

What is a robot? a robot is a Mechanical divice that you can Program to do different thing's.

What is engineering? Engineering is a type of work that involves Mechanics

How much do you agree or disagree with these statements? Circle One.

I want to be an engineer or scientists when I am older.

Strongly Agree Agree (Neither Agree or Disagree) Disagree Strongly Disagree

I like using computers and other technology.

(Strongly Agree) Agree Neither Agree or Disagree Disagree Strongly Disagree

Teacher Interview

Student Interview

Curriculum Sequence

- PK – BeeBot Introduction, Counting, Letters
- K – BeeBots – E&M, +/-, Letters, Challenge
- 1 – WeDo - Getting Started, Dancing Birds
- 2 – Drumming Monkey, Spinning Top, Ride Challenge
- 3 – Amazing Adventures (ELA), Car Challenge
- 4 – Soccer (Math), Burglar Alarm Challenge
- 5- NXT Introduction – programming movement, dragster challenge

LEGO MINDSTORMS EV3

- Grade 5 - Build basic car
- Grade 5 - Follow lines - no sensor
- Grade 5/6 - Build basic car
- Grade 5/6 - Calculate velocity
- Grade 5/6 - Use sensor to stop/avoid obstacle
- Grade 5/6 - Challenge - build faster car using gears

Driving Base

- Use online directions
- Start EV3 software
- Go to Robot Educator -> Hardware -> Driving Base

EV3 Orientation

- 3 basic modes (program, experiment, content editor)
- Take tour of Lobby (model expansion, model core set, quick start, file, robot educator)
- Projects -> Programs - Each can have multiple tabs

System Cycle

- Build, Program, Test, Reprogram, Test, etc
- Compile and download
- Try it with a sound

Ports, Sensors and Motors

1, 2, 3, 4 = Input ports used for sensors.

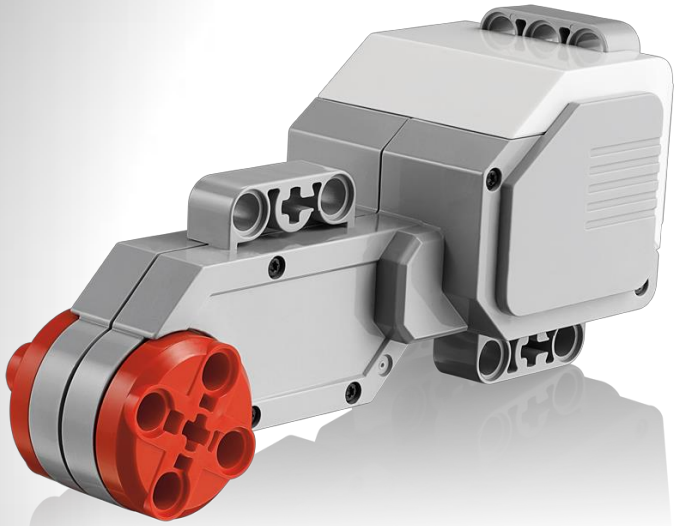
A, B, C, D = Output ports used for motors.

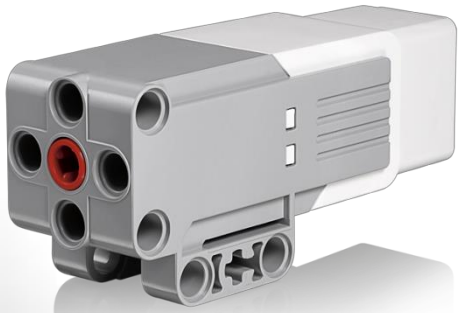
Large Motor

Medium Motor

The PC USB port is used to connect to The PC so you can download the Programs into EV3 Controller

EV3 Motors





- Two types of motors
- Redesigned to allow easy construction
- The Large Motor is a strong and powerful full motor.
- The Medium Motor is a less powerful motor but runs at a higher revolution rate.
- Both motors have tacho feedback enabling 1 degree resolution.
- Both motors are Auto ID–supported.
- The Medium Motor is smaller and lighter to allow more construction options.

EV3 Ultrasonic Sensor

- Detects distance
- Accurate to 1 cm or 0.3 inches
- Can listen for other ultrasonic sensors
- Improved design for easier build solutions
- Eyes light up to identify which mode the sensor is operating in
- Auto ID

EV3 Color Sensor

- Detects eight different colors
- Detects ambient light, from dark to sunlight
- Detects reflective red light
- Built-in cancelling of backlight makes sensor more reliable
- Improved design for easier build solutions
- Auto ID

Gyro Sensor

- Angle mode
- Gyro Sensor mode
- Angle and Gyro Sensor modes
- Can reset accumulated angle value
- Improved design for easier build solutions
- Auto ID

Touch Sensor

- Detects pressed
- Detects released
- Detects bumped
- Improved design for easier build solutions
- Auto ID

EV3 Navigation

Open a previously saved project

Lobby Button

Open New Project

Open New Project or previously saved ones

Model Core Set

Quick Start

File

Robot Educator

Design Engineer...

Basics

Beyond Basics

Hardware

Data Logging

Tools

Building Instructions

Configuring Blocks

Straight Move

Curved Move

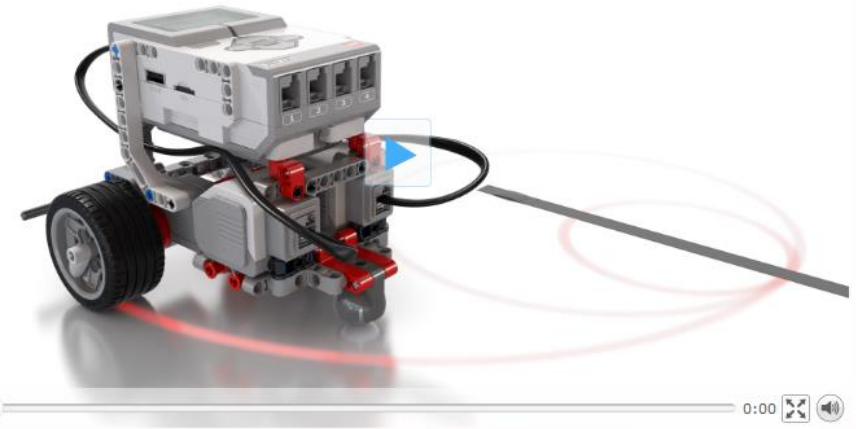
Tank Move

4/9

Move Object

Stop at Line

Stop at Angle



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Tank Move

Use the Move Tank block to steer the Driving Base.

Open

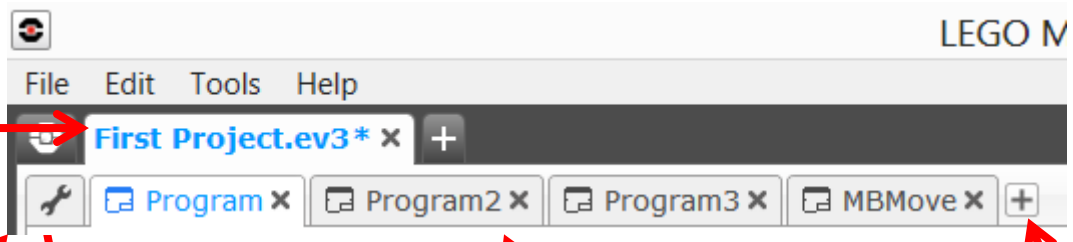
LEGO mindstorms education EV3

LEGO education

Projects and Programs

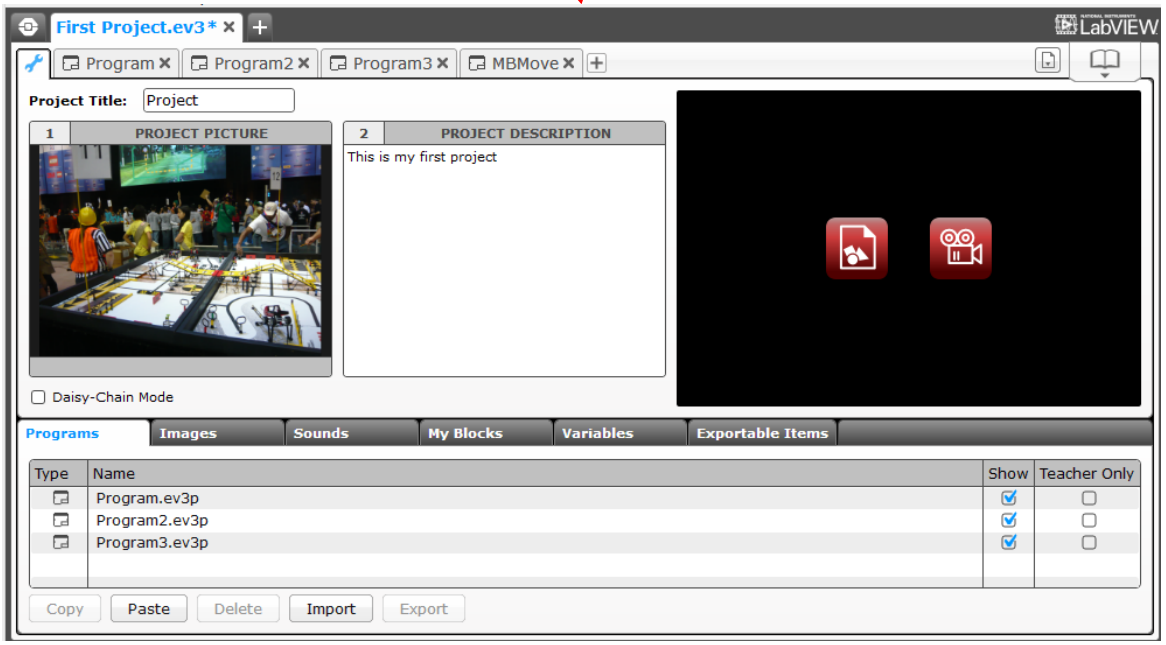
Opened Project

Project Properties



Currently Opened Programs belonging to opened project

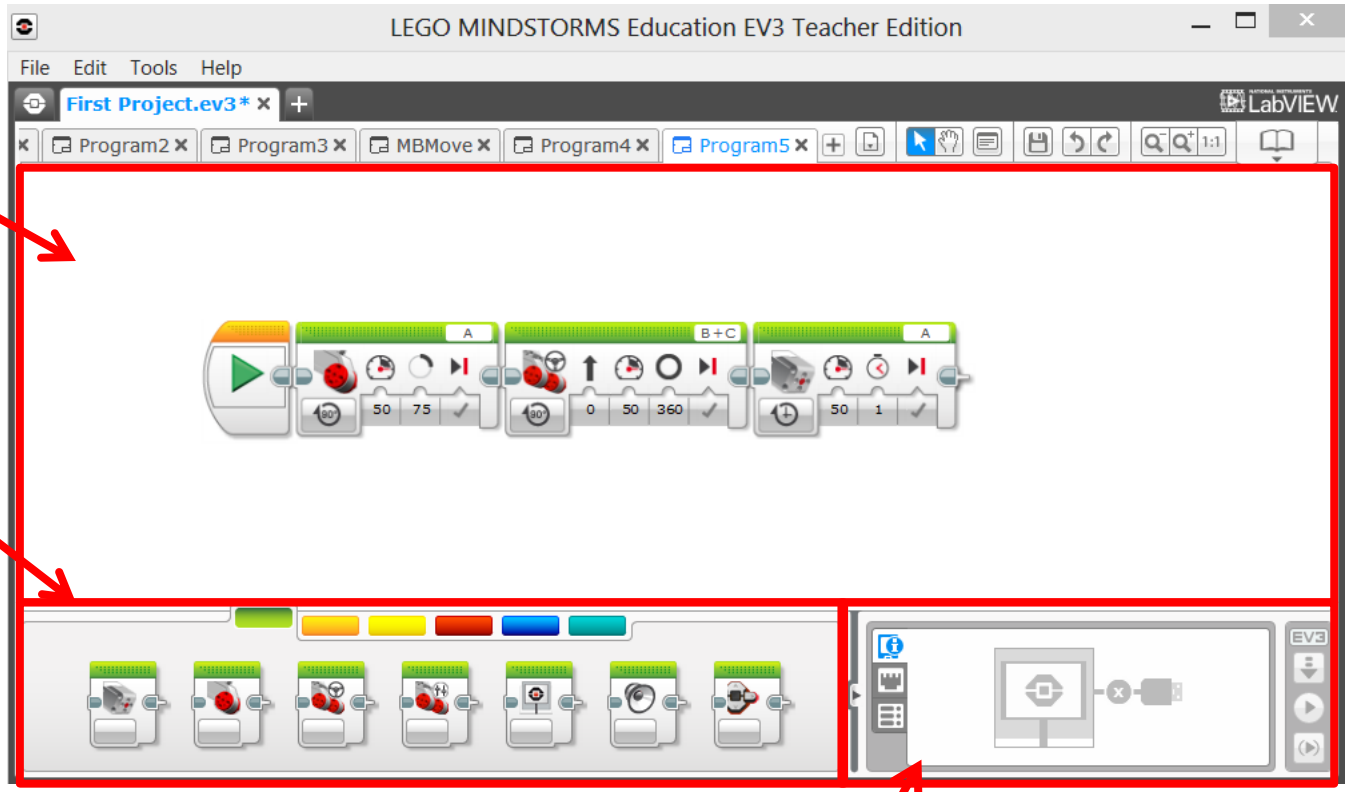
Click to create a new program within the current project



Programming Environment Workspace

Programming canvas where you can lay out the program's blocks / instructions

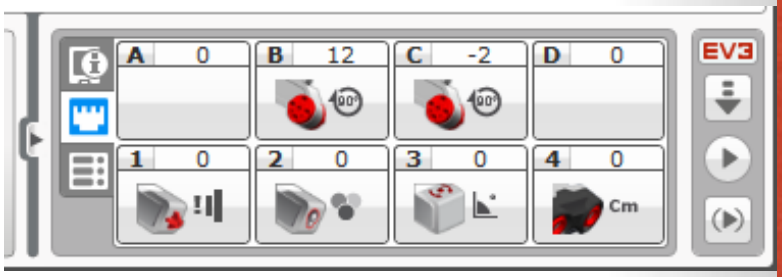
Programming palettes where you can find the various building blocks

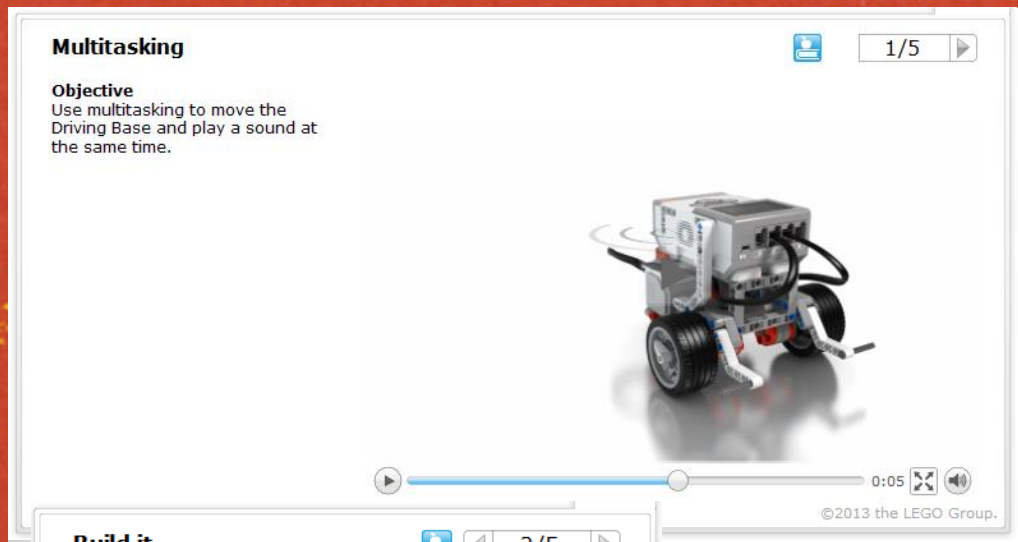


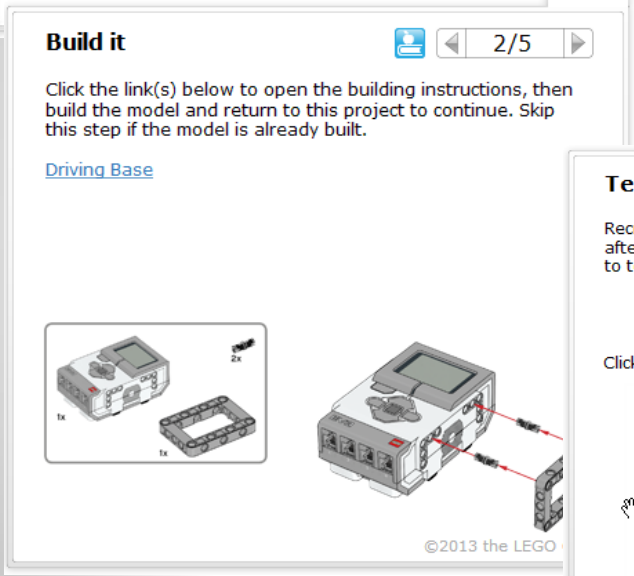
Hardware page establishes communication with the EV3 brick and where you download programs into the EV3, view memory usages, battery level, and to find out motors or sensors and where they are connected.

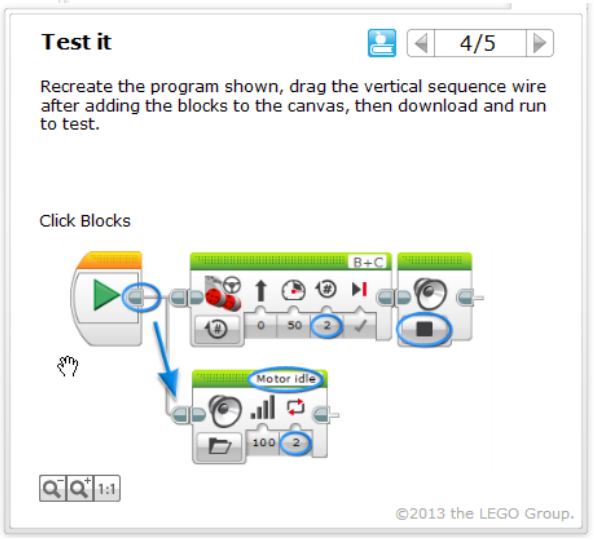
The Communication Pane

- Connection status
- Download programs ready to be run
- Download/play programs instantly
- Download a section of a program to run
- Intelligent EV3 Brick status: name and battery level, etc.
- Port status and sensor readings
- Type of connection between the EV3 Brick and the computer (BT, Wi-Fi, or USB)







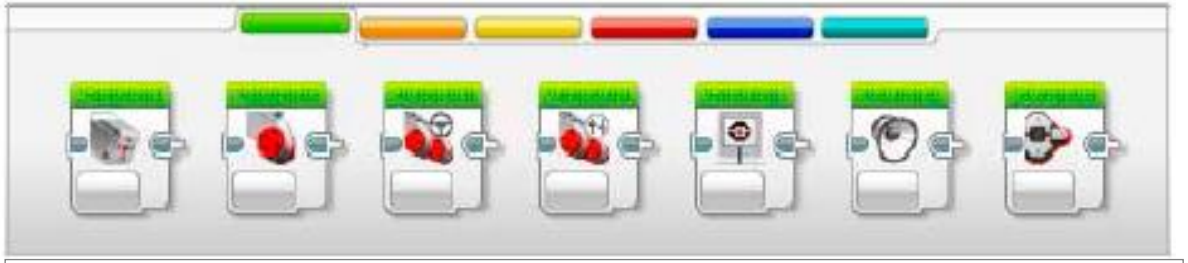


Content Editor

- Animations
- Build guides
- Interactive guides
- Sample programs
- Challenges
- Save as a project
- Teacher and student modes
- Edit facility

Palettes

Action Blocks

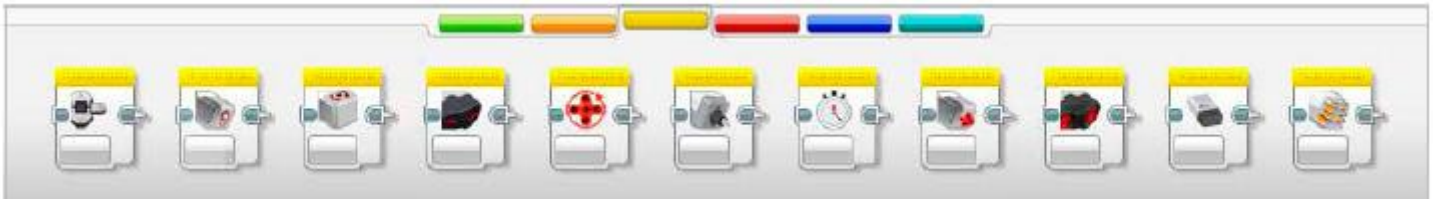


Medium Motor, Large Motor, Move Steering, Move Tank, Display, Sound, Brick Status Light.

Flow Blocks

Start, Wait, Loop, Switch, Loop Interrupt

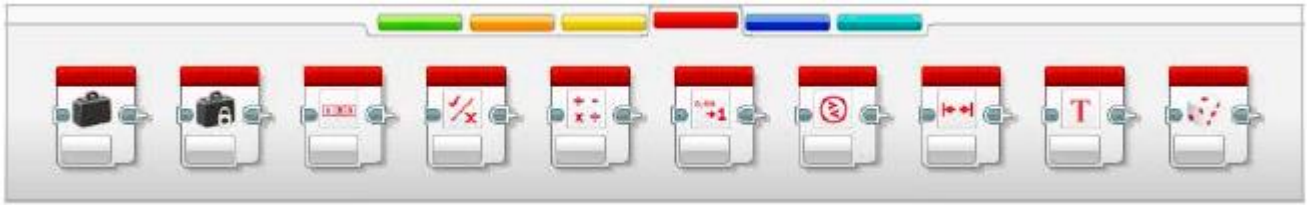
Sensor Blocks



Brick Buttons, Color, Gyro, Infrared, Motor Rotation, Temperature, Timer, Touch, Ultrasonic, Energy Meter, Sound

Palettes

Action Blocks

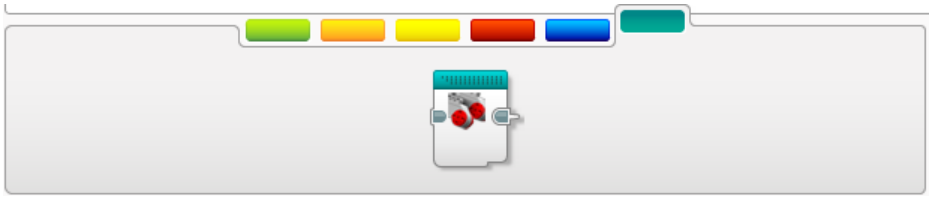


Variable, Constant, Array, Logic, Math, Round, Compare, Range, Text, Random

Advanced Blocks

File Access, Data Logging, Messaging, BlueTooth, Keep Awake, Raw Sensor Value, Unregulated Motor, Invert Motor, Stop Program

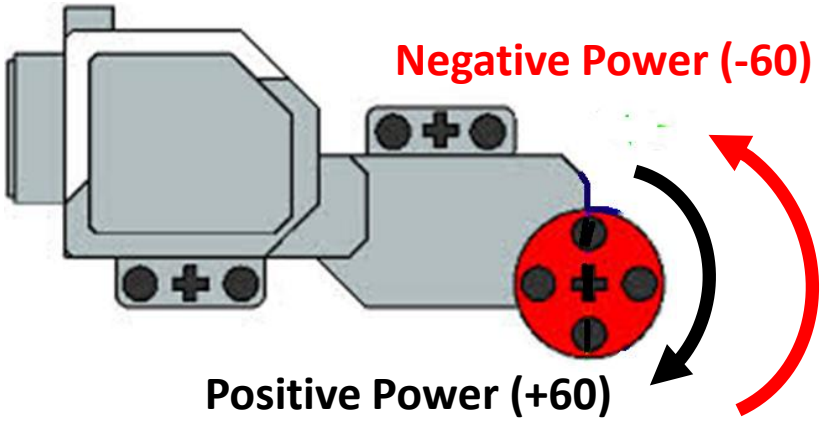
My Blocks



Block you create to repeat same actions in multiple programs. Programmers refer to this as subroutines or functions.

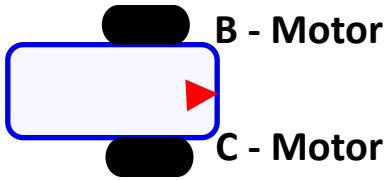
Controlling the EV3 Motors

- Instructing the robot to move and turn is accomplished by the Large Motors which rotate in a predetermined direction where positive amount of power (e.g. 75), will cause a clockwise rotation and negative power (e.g., -45) will cause a counter-clockwise rotation.

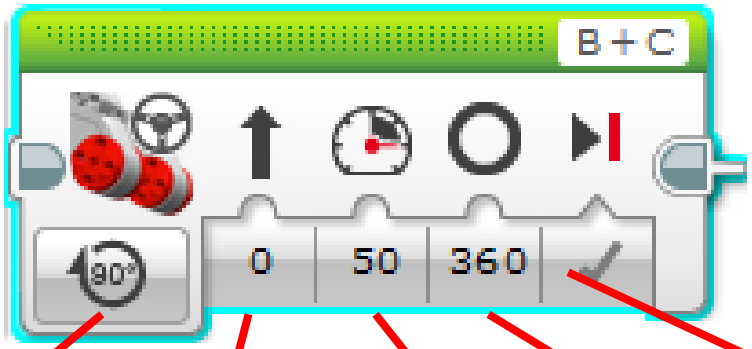


NOTE: the same concept applies the medium motor.

- **All examples used in this document assume the robot configuration and motor is mounted as shown.**

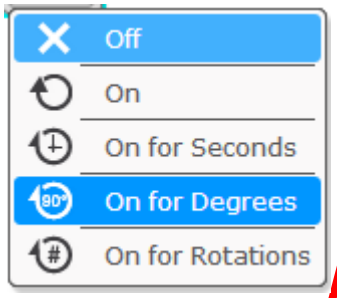


Move Steering Block



Move Steering

- Controls and *regulates* two motors.
- Both motors move either forward (positive power) or backward (negative power)
- Allows steering by applying more power to one of the two motors



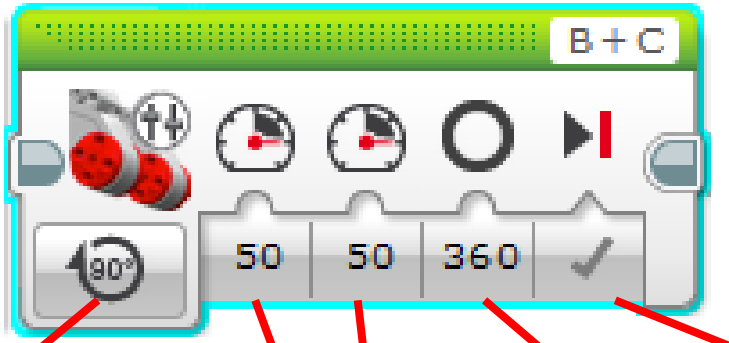
Brake or Coast

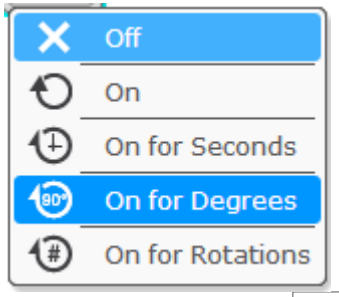
Steering Control from (-100- 100) where
0 = move straight;
Positive# = C more power than B
negative# = B more power than C

Power (100 to -100); positive number is move forward; negative, moves backward.
Note: small amount of power may cause the robot to stall.

Number of motor degrees, rotations or seconds

Move Tank Block





Power (100 to -100); positive number is move forward; negative, moves backward.
<u>Note:</u> small amount of power may cause the robot to stall.

Number of motor degrees, rotations or seconds

Brake or Coast

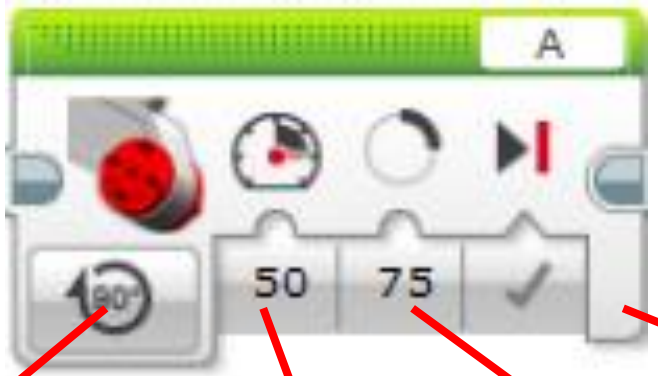
<u>Move Tank</u>

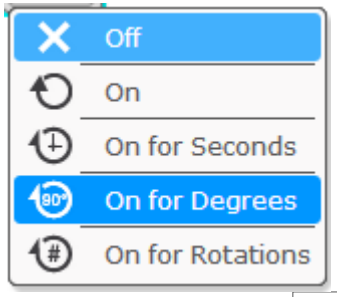
- Control two motors and allows each motor to move with different power level including in different direction for turning or spinning.
- For turning: one motor has zero power; the other has positive (forward) or negative(backward) power.
- When zero power is specified, the motor is locked and will not move to ensure accurate turns
- For spinning, use positive power for one and negative for the other

Large Motor Block

Large Motor

- Control a single large motor
- When zero power is specified, the motor is locked and will not move to ensure accurate turns



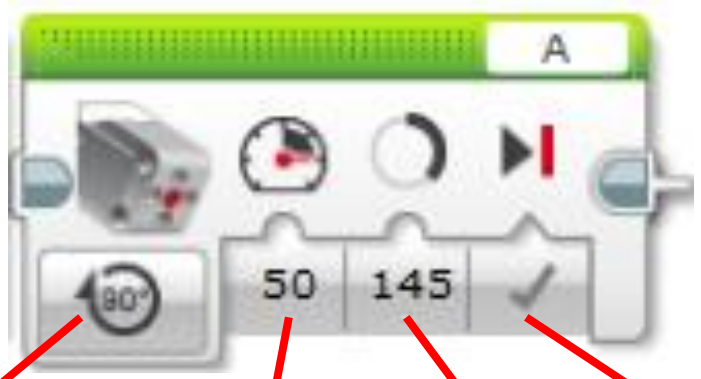


Brake or Coast

Power (100 to -100); positive number is move forward; negative, moves backward.
<u>Note:</u> small amount of power may cause the robot to stall.

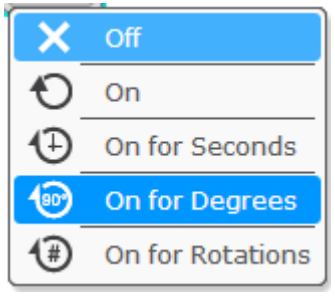
Number of motor degrees, rotations or seconds

Medium Motor Block



Medium Motor

- The Medium Motor block controls the Medium Motor. You can turn the motor on or off, control its power level, or turn the motor on for a specified amount of time or rotations
- When zero power is specified, the motor is locked and will not move
- Use positive or negative power to control direction

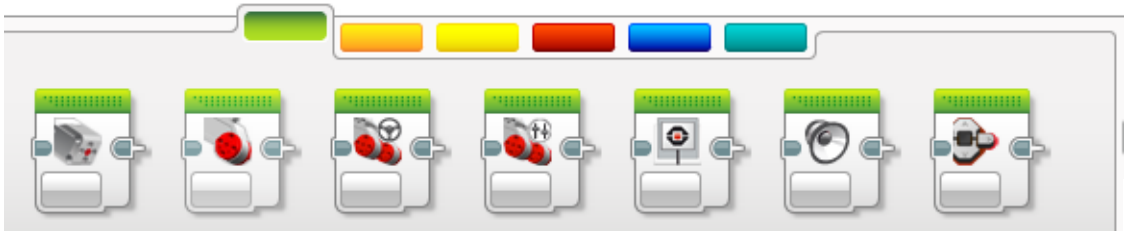


Brake or Coast

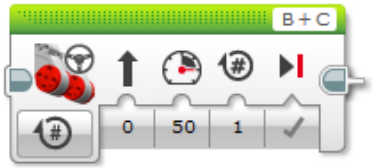
Power (100 to -100); positive number is move forward; negative, moves backward.
<u>Note:</u> small amount of power may cause robot to stall.

Number of motor degrees, rotations or seconds

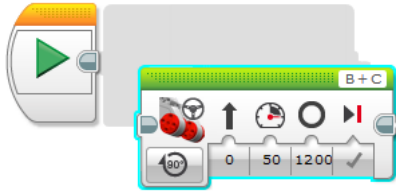
Steps to create a program



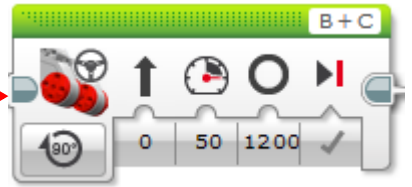
1. Click and hold block with left mouse button to drag it



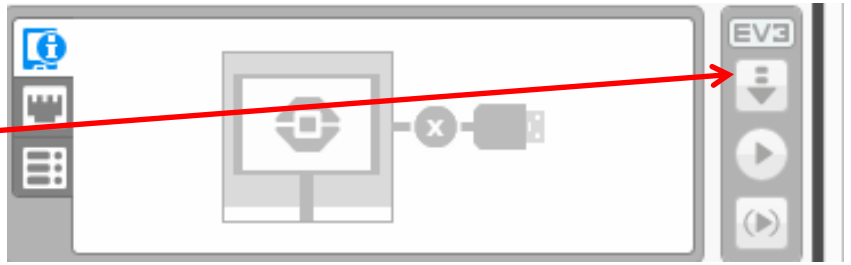
2. Drop the programming block when grey box appears



3. Select / enter options



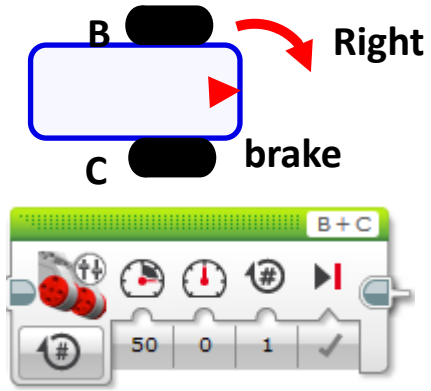
4. Click download to compile and load the program in the EV3 controller



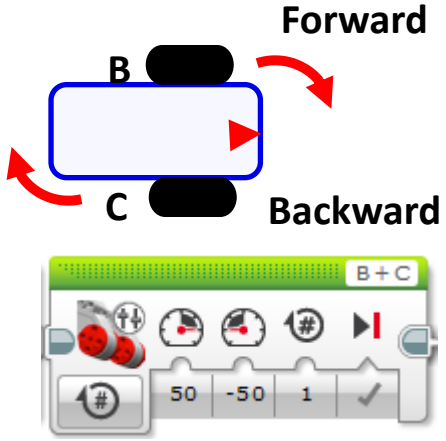
Turn vs. Spin

- There are two ways in which you can make the robot turn
  - Make ONLY one motor move, or
  - Using both motors moving in opposite direction, and this is referred to as "**spinning**"

- One Motor move:
  - Right Turn – Use **MOVE TANK** block and select a power level for the "**B**" motor and zero for the "**C**" motor
  - In this case the robot's right wheel will be stationary and the left wheel will move.



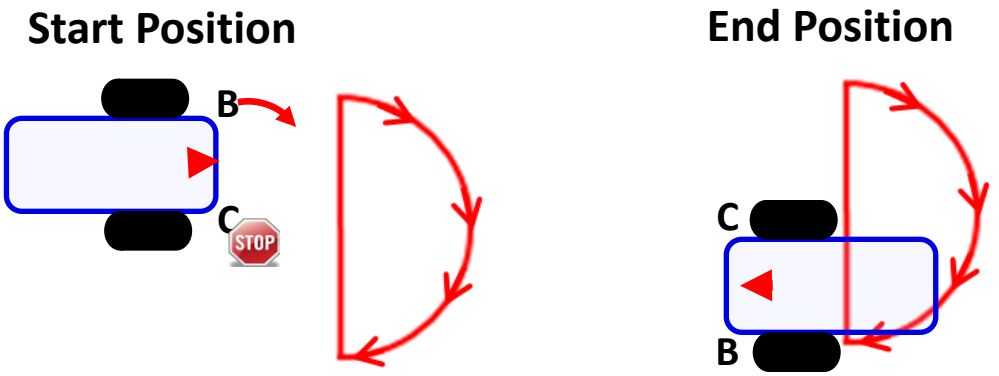
- Turning with two motors in opposite direction
  - To turn right, use the **MOVE TANK** block where the "B" motor will turn clockwise (positive power) and the "C" motor will turn counter clockwise (negative power).



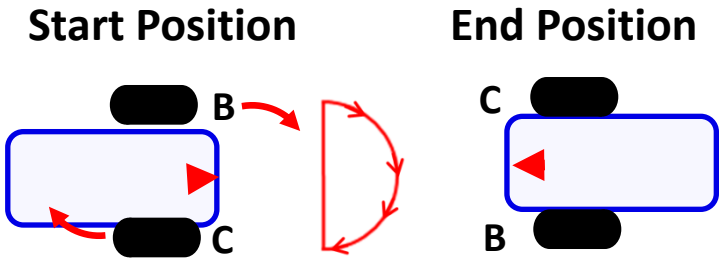
TIP: for turning in a tight spot, use the two motors.

Turns Continued

- To make 180 degree right turn using a tank move or large motor



- To make 180 degree right turn using tank move (spin in place)

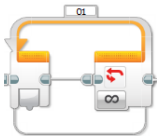


- Note the distance travelled is shorter (exactly half) when using both two motors.

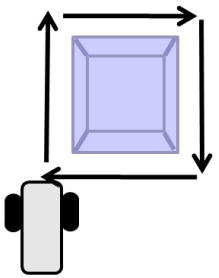
Tips

- For moving straight, the **MOVE STEERING** / **MOVE TANK** blocks have a built-in PID to regulate the movement of "B" & "C" motors. If one motor falls behind, the **MOVE STEERING** block compensate by applying less power to the faster motor.
- For driving the robot, use the **B & C** motor ports; the **A and D** ports should be used for the robot's arm.
- Using full motor power (100%) may cause erratic robot movement, use 75% or less.
- Conversely, too little power (below 25%) may cause the robot to stall.
- Brake at the end of each **MOVE** block to take advantage of the PID which self corrects to achieve more precise moves.
- Using Degrees is a more accurate way to move motors; using time, will be inconsistent when the batteries become weak
- The **MOVE STEERING / MOVE TRACK** block also keeps track of "errors" that accumulate in multiple blocks and adjusts itself.
- Use the ***brake*** option and also use the **RESET** block.
- REMEMBER: the tradeoff between speed and accuracy!

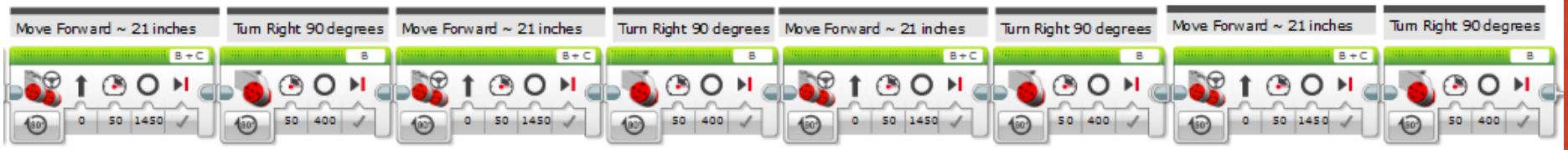
The **LOOP** Block



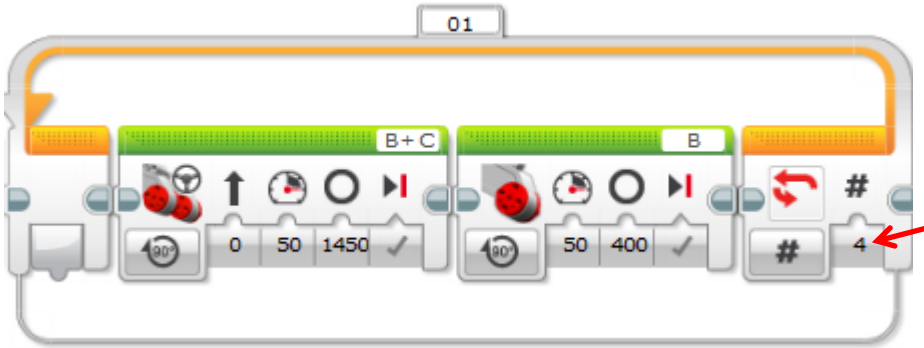
- Sometimes, there are actions that you want to repeat. The **LOOP** block allows you to repeat those actions until an end condition is met (or becomes TRUE).



- Example: make the robot move around a box and return to its starting position
- To move along the box sides, it takes 8 blocks as follows:



Using the **LOOP** block, only



Warning: Deleting the LOOP block will also delete all the blocks within the loop. You can move the blocks out of the loop, then delete it.

Move Steering

- Degrees, rotations, or seconds
- 100 to -100 steering range
- Meaning of degrees
- Meaning of rotations

HANDS ON

- Build basic car - follow book (note quick design)
- Program to go in a straight line for 5 seconds
- Program a 90 degree turn
- Make a square on the floor
- Follow a taped path
- Add sound sensor - avoid mini-figure when the robot hears a sound

TIPS

- Repeatability especially with courses taped on the floor
- Picking up the robot – good for seeing what is going on with the wheels, bad if kids try to adjust/fix the programmed course
- Sound sensor can hear itself. Turn up to 100. Do in a quiet place.
- Don’t solve problems for them

TIPS 2

- Figuring out 90 degree turn.
- Extra kits
- Inventory
- Use USB and not Bluetooth
- Take advantage of Robot Educator

TIPS 3

- Check for correct (or any) wiring
- Use computer to see if wheels turn/sensors work
- Check that robot is running the right program
- Do not need to download program each time
- Build up slowly - no sensors, sensors, loops
- Computer are dumb, they do what you tell them to do, not what you want them to do

Reflection

- What STEM learning did you experience? 21st Century learning?
- How did this differ from the more structured activity?
- How did you experience the engineering design process?

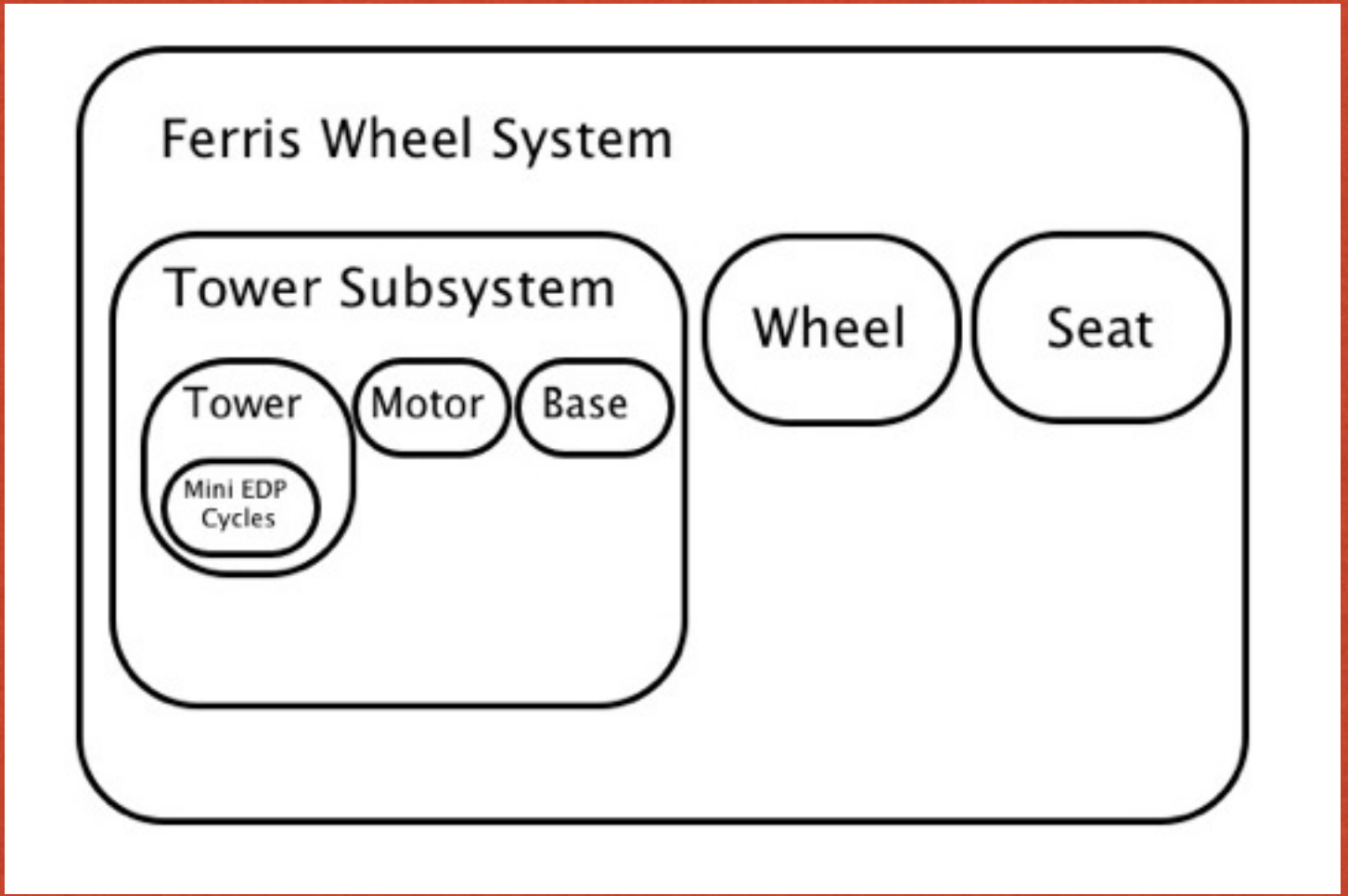
Sharing Out

Grade 6 Clip

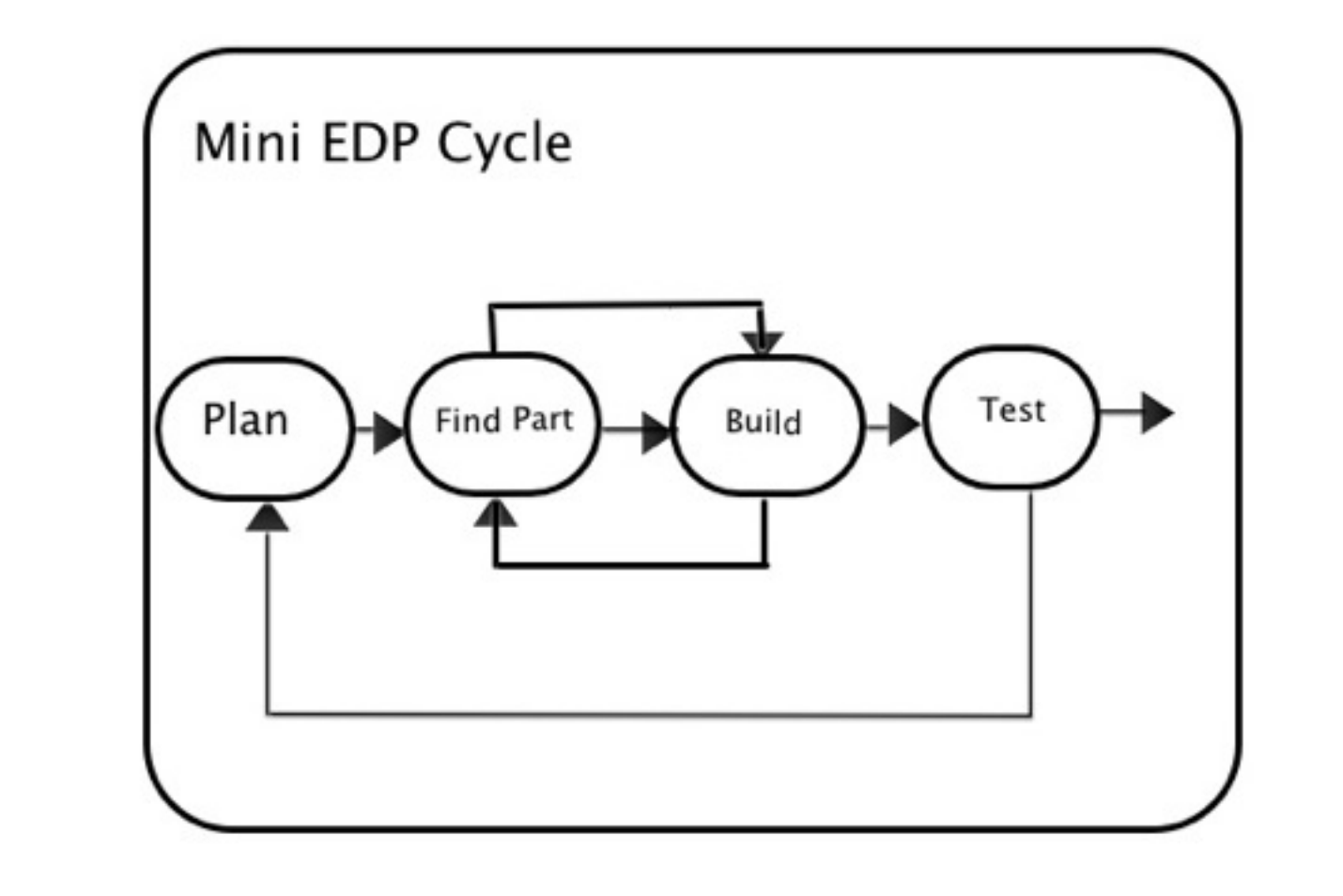
Transcript

- [00:20:29] [PLAN] BOY 11: I was thinking that I could have one that kind of connects on both sides but then all this would get in the way. So then I couldn't really have it go around. [PROJECT-CORRECT] [SYMMETRY]

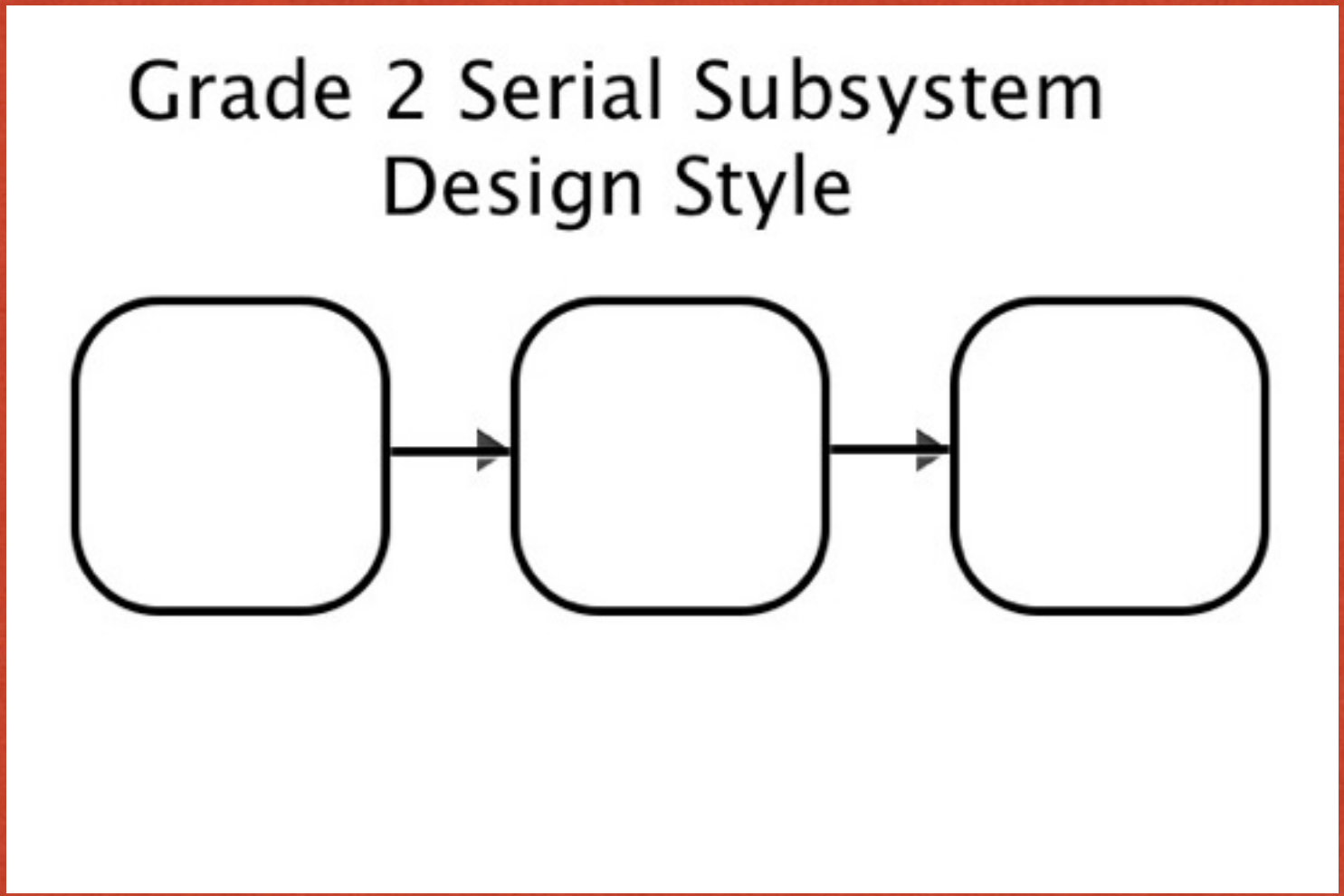
Grade 6 Cycles



Mini EDP Cycle



Grade 2 Process



Next Steps

- Logistics – kit sharing, laptop sharing, parts managment
- Parts management - inventory, custodian, spare part ordering, bank, resource kits
- Support – software, hardware
- Curriculum – sequence, follow up session (video, photos, words)

Classic EV3 Activities

- Line follower
- Sumabots
- Gyrobot

Final Thoughts?

- What is the most important tip you learned?
- What will be a challenge for you?
- How will this program benefit your students?

Resources

- jheffernan@hr-k12.org
- apcalden@gmail.com
- http://www.kidsengineer.com/

EV3 Kit
Laptop, mouse, etc
Laptop Cord
Try remote control with iPhone
Handouts (send to Adena?)
Look up “domabot” directions
Post slides online
Finish slides
Play with EV3 especially turns