Vex Robotics Beginner Guide

This is a guide for new people to learn basics terms and concepts of robotics (specifically VEX EDR) faster and does not substitute a mentor so feel free to ask questions to learn more advanced information and processes.

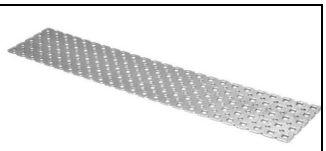
- Rule one to robotics - there is not such thing as too much stability
- Rule two to robotics - it is worth the extra time to make something perfect the first time, it will save you time in the long run

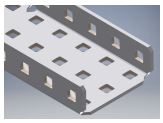
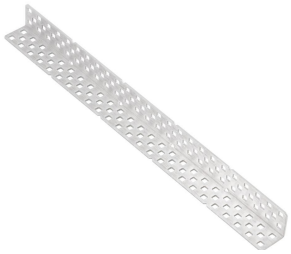
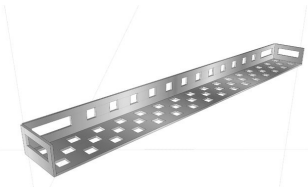
Metal

- Length - 2 holes are around 1 inch
    - Ex. 20 hole long piece of metal is around 10 inches, 35 holes around 17.5
- 2 types
    - Aluminum - white/gray colored, lighter and weaker
        - Most popular because it's strong enough for most situations
    - Steel - cobalt blue colored, heavier but stronger
        - Usually NOT used because Aluminum is usually strong enough

- Aluminum

- Steel

Plates	- Usually 5 (holes) wide - Weak (bendy) so not usually used - Used for mounting things such as a cortex	
1-Bars	- 1 (holes) wide - Long/thin and extremely lightweight - Weak (bendy) so not usually used - Used for slight support or small/unique gadgets	

C-Channel	- 2, 3, 5 (holes) wides - Very strong and sturdy - Used primarily for structure - Most common - There are 1 wide c-channels, but they are usually hand made and are not supported by vex	 5 wide   3 wide 2 wide
Angle	- 2 or 1 (holes) wide - strong and sturdy (less so than a c-channel) - Used primarily for structure - C-channels can be cut in half to make 2 angled pieces for a smaller and lighter piece	
Rails	- 2 wide - strong and sturdy (less so than a c-channel) - Used primarily for structure	
Linear slides	- Very strong and sturdy - Used to translate rotary motion into perfectly linear motion - 2 parts - Both parts are the same shape but one is smaller so it can go into the other - Unstable at distances greater than 18 inches - Generally have a lot of friction - Lubricating decreases it (makes it run better)	

Motion Parts

- Shafts (Axles)
    - High strength (1/4" width) vs regular (0.125" width)

    - Used whenever there rotation is required, screws and sometimes used
        - Generally low strength ones are used
- Shaft Hardware

Bearings (motor mounts)	- Attached to metal, 2 screws + 1 axle - Reduces friction and allows for smooth rotation, prevents damage - Used to connect motors - Also called motor mounts - Pillow boxes perform the above functions but the hole is 90◦ to the orientation - Lock bars restrict an axle from moving relative to the connected metal	

Spacers	- Used to fill empty space on an axle
	  - Prevents side to side motion
	- White spacers, Nylon (⅛”,¼”,⅜”,½”)
	- Black spacers, Plastic (4.6mm, 8mm)
	- Shaft Collar- act as mechanical stops for axles
	- Washers - used for precision spacing
	  - White (Teflon), Gray (Streaks eel)
		

- High Strength vs Low Strength (gears and sprockets)
    - Usually use high strength because low strength is too weak for most situations
    - Use low strength for small things requiring weight reduction
- Gears (4 different sizes)
    - Used to transfer rotation throughout a robot
        - Change the speed/torque of a moving part, or the direction of rotation
    - 4 different sizes: 12 tooth (metal), 36, 60, 84 tooth (plastic)
- Sprockets & Chain
    - The teeth of the sprocket connect indirectly with each other by chain
        - Can change speed/torque but everything spin in the same direction
    - 5 different sizes: 6, 12, 18, 24, 30 tooth (High); 10, 15, 24, 40, 48 tooth (Low)
    - Used to connect different parts of motion over long distances
    - Should **not** be used to link 2 gears that are powered separately
    - Chain can also have tank treads or other accessories attached if needed
- Special gears
    - Consult your mentors for more information

Low Stren.	High Stren.	Special	Low sprock.	High sprock.
				

- Gear Ratios
  - The Mechanical Advantage (MA) of a gear system
    - How much it amplifies the force
  - Gear Ratios (# of times a 2nd gear spins in relation to the 1st gear)
    - Driving:Driven or Driven/Driving, most often used, ex. 1:1, 1:5, 1:7
  - Can be geared for more speed or Torque
    - Torque - More rotational force, less speed (rpm), higher MA
    - Speed - More speed (rpm) , less rotational force, lower MA
  - Idle gear - all the gears between the driving and driven gear.
    - Only affect direction unless they are in a compound gear system
      - (different sized gears on the same axle, more complicated)
  - Most gearing in robotics is to torque
- Wheels

Omni-Directional Wheel	- Most commonly used wheel type - It is a large wheel with smaller wheels going along the outside which allows it to have sideways motion - Allows for good turning	
Mecanum Wheels	- Allows for an x-drive to be built with a regular chassis - X-drive - special kind of drive, more maneuverability, less speed - Not generally used	
Random Wheels	- Quite a few types of wheels - Could be used if the situation arises, but generally not used	

- Pneumatics
  - Probably won't use
    - Can be single acting or double acting pistons
    - Consult your mentors for more information

Hardware

8-32 (dia) Screw	- For nuts, standoffs, shaft collars - 0.25, 0.375, 0.5, 0.625, 0.75, 0.875, 1.0, 1.25, 1.5, 1.75, 2.0 inches	
6-32 (dia) Screw	- For motors, rack gear attachments - 0.25, 0.5 inches	
Hex Nut	- Standard nut, not generally used, may be used for prototyping	
Kep Nut	- Most often used, prototyping or final build - Easy to put on, when tightened it grips into the metal with its “teeth” on its bottom - Can come loose if not tightened well	
Nylock nut	- Used a lot as well but hard to put on - Requires a wrench to tighten - Strong and doesn’t come loose - Can be used with a screw for a rotating joint	
Standoffs	- Used to “stand”/attach metal off of each other - Good for structure, lightweight - Can be combined by couplers - (screws with no round top) - 8-32 screws	
Rubber Link	- Can be used to attach standoffs at special angles - Not generally used	
Hinges	- Used to make a joint - Usually for things that need to be deployed outside the 18”	
Gussets	- Various items that help improve structure - May not be used if it’s inconvenient and the robot is sturdy enough	 

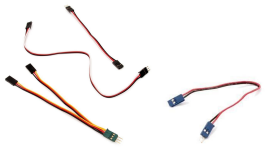
Tools

- Allen Keys/Drivers
    - Used to loosen or tighten screws, most Common Screw Head in Vex is Hex
    - 3/32” Keys used for 8-32 screws (larger),
    - 5/64” Keys used for 6-32 screws (smaller), set screws for shaft collars
    -  or  or 
    - Ball point Hex keys allows for angled used; good for hard to reach areas/angles

- Torx Star Keys
    - New and may or may not be used
    - Screws are the exact same except for the head
    - 8-32 screws with T15 sized keys
    -  ← Screwdriver bit  ← Screw Head
    - 6-32 screws with T8 sized keys
- Wrench
    - Used to rotate nuts and standoffs
    - Larger side for nuts →  ← smaller side for standoffs
    - Used to rotate nuts or keep them still; the long length allows for high torque making it perfect for tightening it really well
- ***Safety Glasses - Wear These when using power tools or a hacksaw, don’t be dumb***
- Power Tools
    - Not for use by new and untrained members (get PERMISSION before use)
    - Rotary tool/portable drill/dremel - Used to cut or sand things in particular metal
    - Angle Grinder- it’s like a dremel, but bigger, shaped different.
    - Drill press- Used for drilling
    - Grinder- Used for grinding
    - Sander- Used for sanding
- Other Common Tools
    - Pliers - used to grab and hold onto things, pull things apart
    - Scissors/Zip-Tie cutters - cuts string, zip times, wires if need be, and other things
    - File/Sandpaper - used to smooth items out or decrease length by a tiny amount
    - Hacksaw - Don't use without permission. Use for cutting metal precisely

Electronics

- The parts that tell the robot to run
- There parts with are before the v5, some may still be usable with “legacy” ports

Cortex	- The brain of the robot - 10 motor ports - 8 analog and 12 digital sensor ports - 3 I2C ports - Code is downloaded and stored on this	
Joystick & VexNets	- Used to control the robot manually - Requires 6 AAA batteries - 2 joysticks, 8 top buttons, 4 back buttons - Can be connected to the robot with a usb-usb cable or wirelessly via vexNets - Need two vexNets - Can be connected to another special joystick for dual control with a cable	 
Motor Controller	- Used to connect motors it ports 2-9 - Convert the motor wire from 2 to 3 pins - Helps control the motor - Ports 1 and 10 don’t require one	
Wires / Y-Splits	- Act as an extension of the wire - 2 pin extenders connect before the motor controller (very rare) - 3 pin extenders connect to sensors and after a motor controller - Y-Cables allow for 2 motors to be connected into one motor (3 pins)	

Motors (393) /Servos	- The primary source of motion on your robot.
	- You can either use 12 motors OR 10 motors and pneumatics
	- Servos are mini motors with a limited range of rotation, not generally used
	- Can be geared most Torque, speed, and turbo
	  - Torque - most force, slowest
	  - Speed - medium
	  - Turbo - fastests but less force
		

LCD Display	- Has an interactive display that can be programmed (3 buttons) - Used to display information or select auton - Uses a 4 pin Y-cable - Plugs into the I2C ports	

Batteries	- Main (blue) batteries charge everything
	- 2000 mAh (bottom) almost never used
	- 3000 mAh (top) most used
	  - Can run on safe and fast charge
	- Never charge on fast for long periods of time
	- Should be charged upt to 8.5Vs
	- Power expander can be added to spread out the load of motors onto two batteries
	  - Expander contains 4 motor ports
	- Backup Battery - required at competitions
	  - Keeps the cortex/VexNets alive if the main battery dies
		

- Sensors

Limit Switches and Bumper Switch	- Act as buttons, both digital sensors - Give a value of 1 (pressed) and 0 (released) - The limit switch (right) is more fragile and sensitive	
Ultrasonic	- Uses echolocation to determine a distance - From 1.5” to 115”, analog sensor	

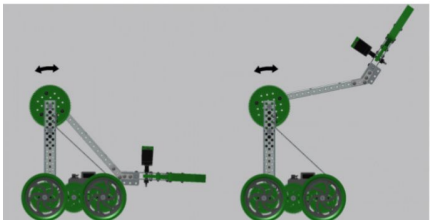
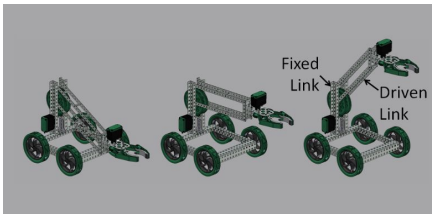
Quaniture encoders	- Detects the amount of rotation
	  - unlimited range, digital sensor
	  - 90 “ticks” for one revolution (360°)
		

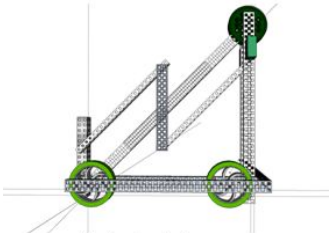
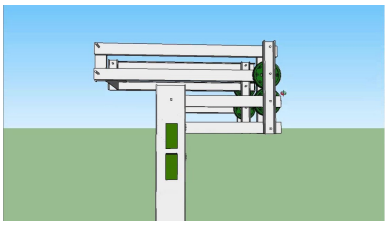
Potentiometers	- Detects the amount of rotation, analog
	  - Only 250 degrees of range
	  - 4095 “points” that the sensor can read
	  - Common among lifts
		

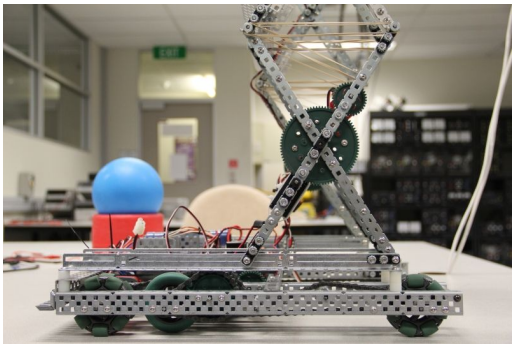
Programming

- [Vex Robotics Beginner Guide Programming]

Lifts/Devices

- Arm
  - Most Basic Lift
  - 
- Four bar lift
  - Similar to the arm lift except it contains more arms/bars
    - The configuration of the joints allow the gadget at the end to keep its original angle instead of changing with the arm
  - 

- Six bar lift
  - Similar to the 4 bar except it has 6 bars in this configuration
  - It goes higher than a 4 bar
  - Theoretically it can go to infinity with even numbers (ex. 8 bar), but people usually stop at 6 because of materials and the number of joints
  - 
- Double reverse four bar (dr4b)
  - Two 4 bars that are connected with a large gear
  - Tall but may be unstable, require a lot of materials to build
  - Theoretically can use an number bar (ex. Double reverse 6 bar) or have infinity bars (triple, quadruple, etc.)
  - 

- Scissor lift
    - Really tall and hard to build
    - Slow and unstable, can easily bend the metal structure
        - Not usually used
    - 
- Flywheel
    - Used to shoot objects
    - Require high gear ratios
    -