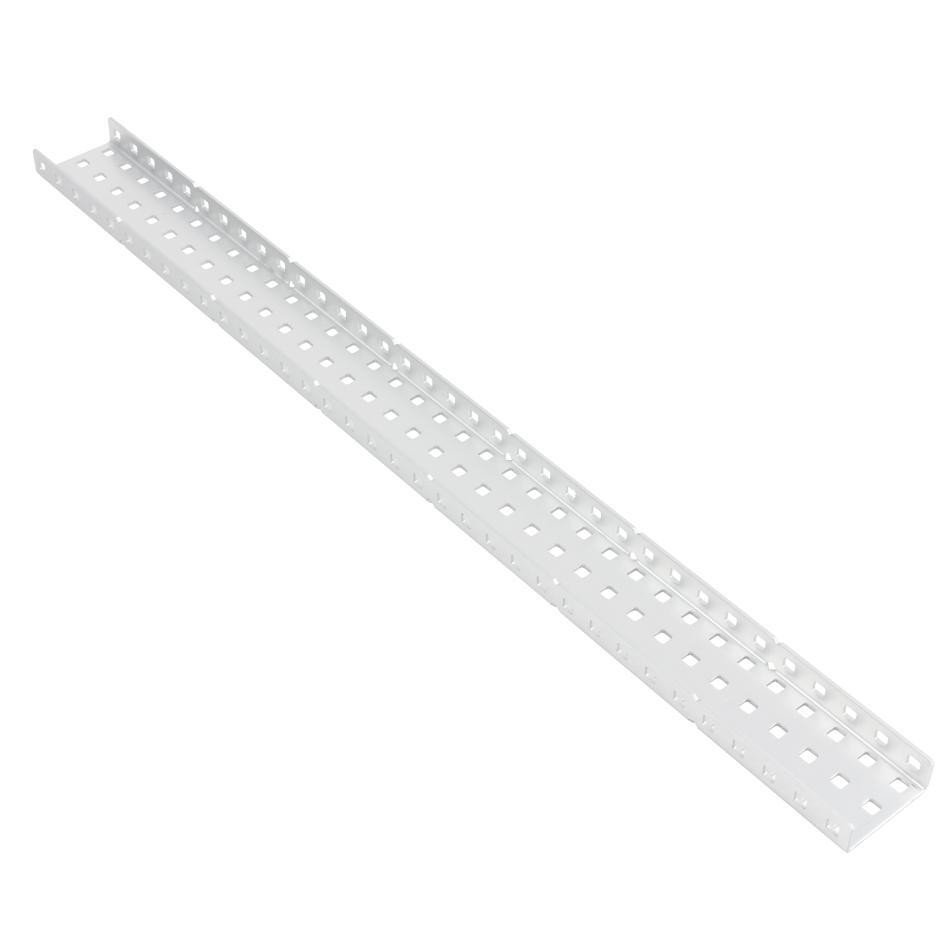
**Vex Robotics Beginner Guide**

*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
      * Aluminumٜ ● 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) |  |

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# 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

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| --- | --- | --- |
| 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

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| --- | --- | --- | --- | --- |
| 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

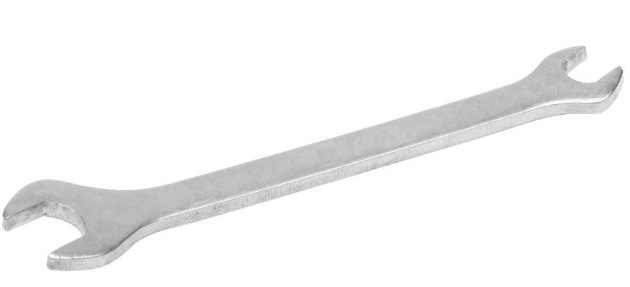
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| Omni-Directional Wheel | * Most commonly used wheel type * It is a large wheel with smaller wheels going along the outside which allows it to have sideways motion   + Allows for good turning |  |
| Mecanum Wheels | * Allows for an x-drive to be built 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 |  |

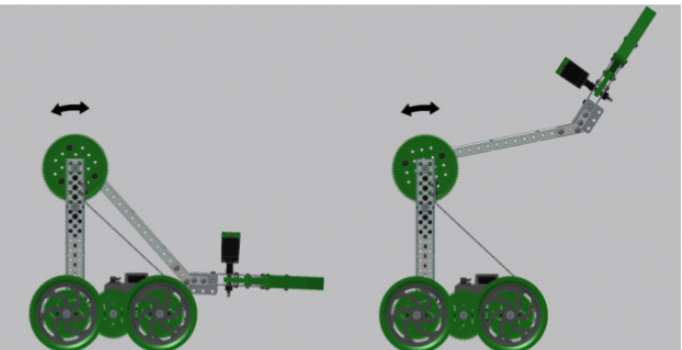
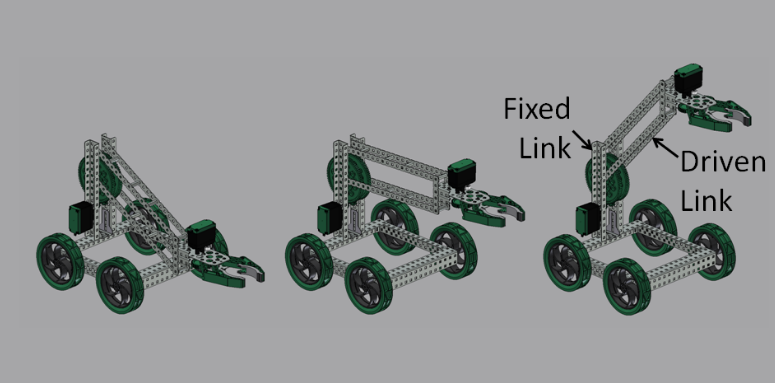
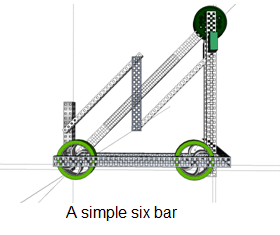
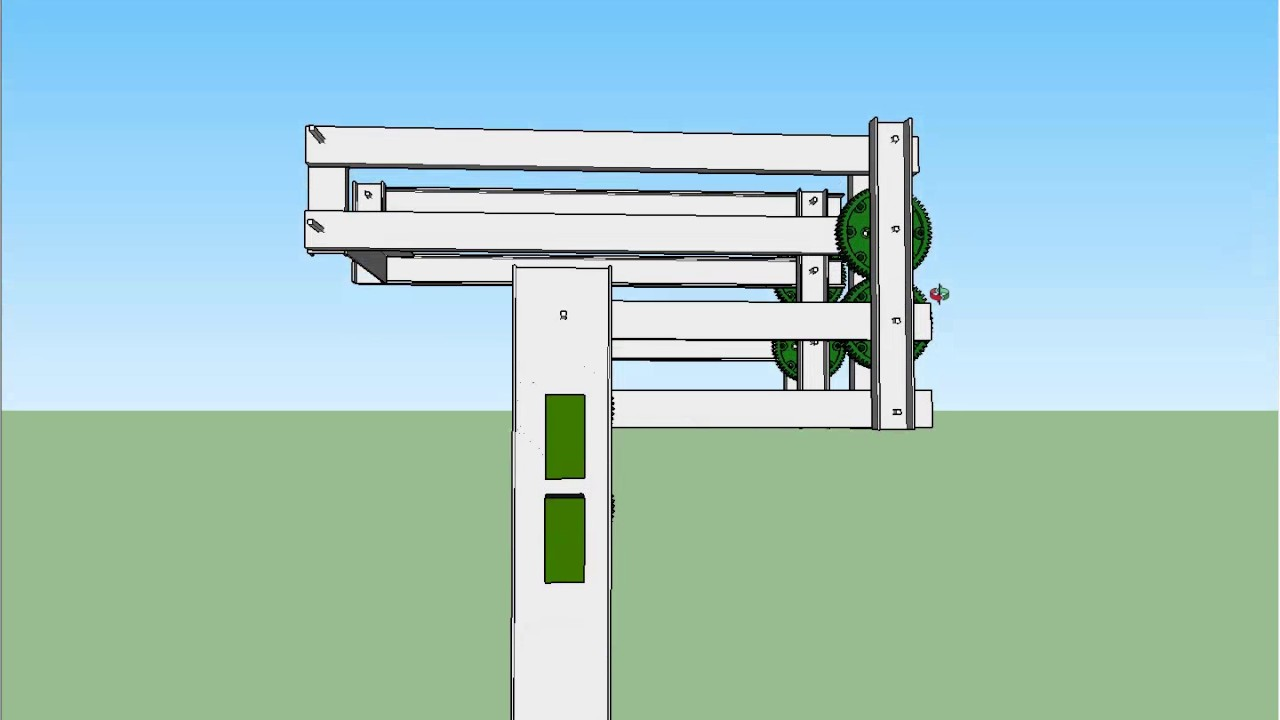
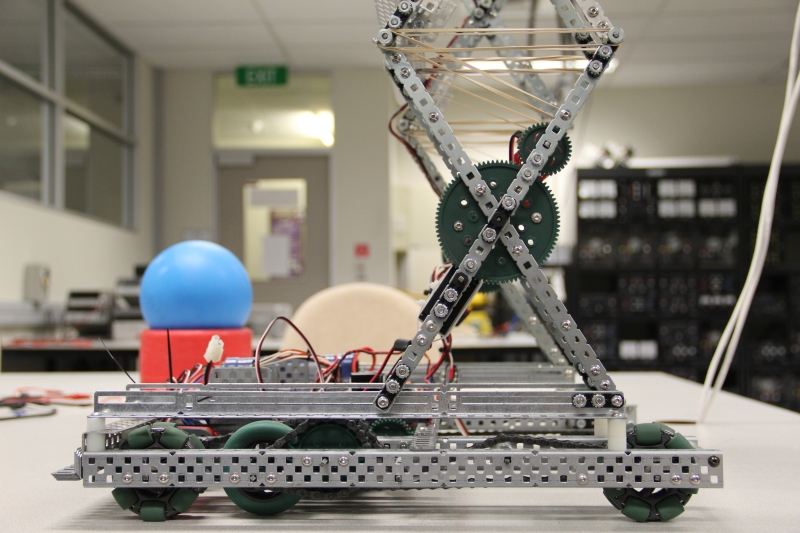
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# Programming

* [Vex Robotics Beginner Guide Programming](https://docs.google.com/document/d/1I6NzbaSs76Run33D8Q0aoYV8eMHSM5NEIJncguyJuoE/edit?usp=sharing)

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# 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
  + 