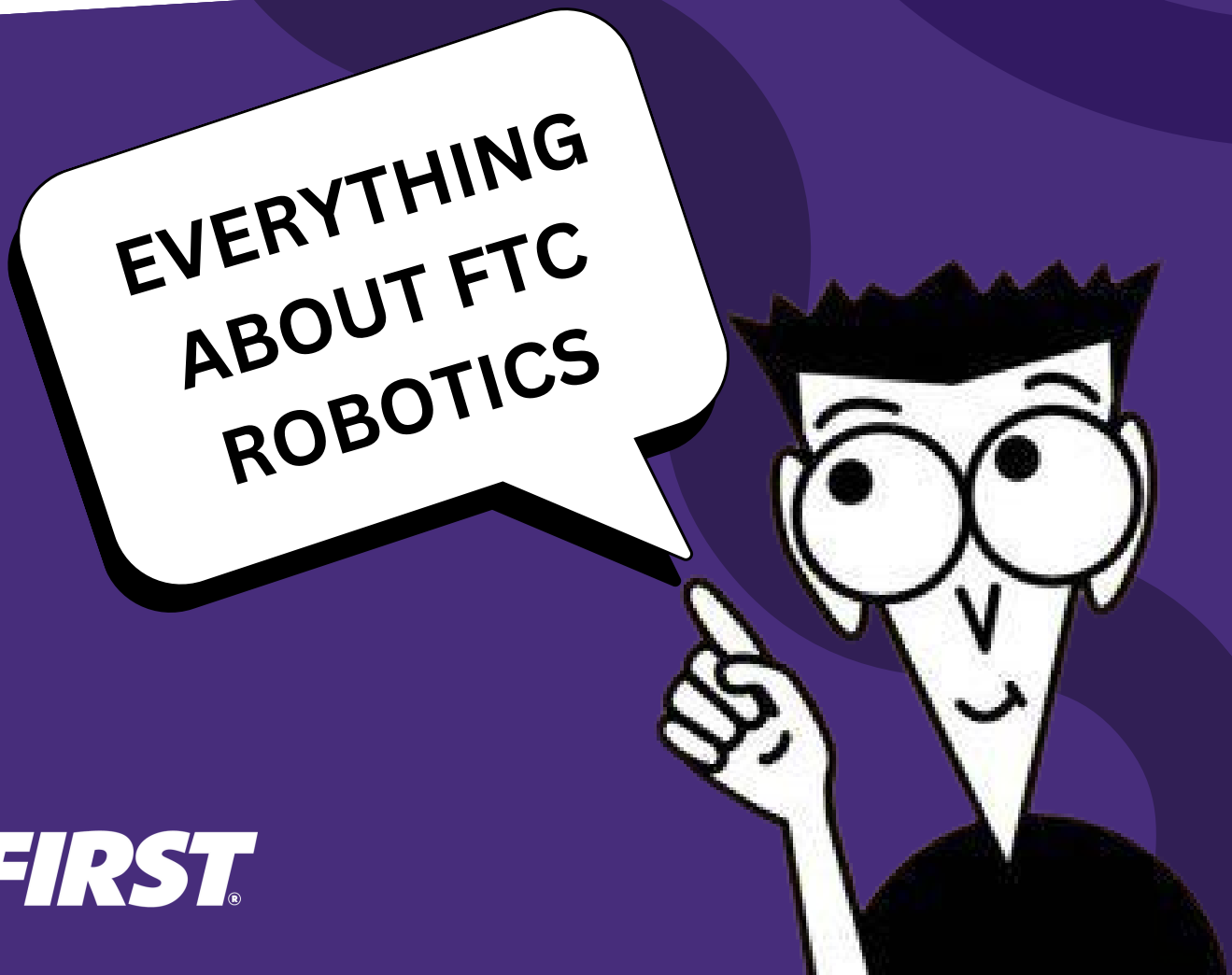
HOW TO LAUGH
YOUR WAY TO WORLDS

THE VIABLE ENGINEERING HANDBOOK

Brought To You By : DEVOLOTICS



FIRST®

1.0 RESOURCES

GAME MANUAL #1

FIRST Official game manual published by *FIRST* every season that goes over general FTC guidelines, including judging and awards information, general robot rules (like allowed parts), and more.

GAME MANUAL #2

The second official game manual is also published by *FIRST* every season. This goes over the season's robot game, including scoring and penalty rules

GAME MANUAL ZERO

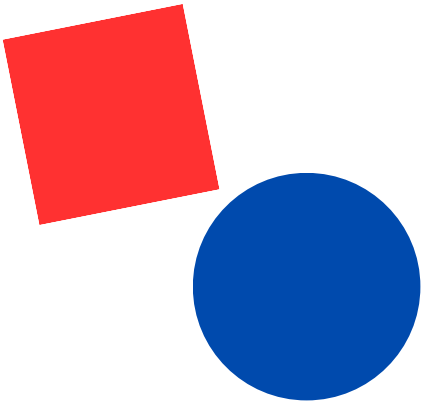
An extremely useful unofficial resource that gives you almost everything you need to know about robotics. Kind of like the Wikipedia of FTC. Includes things like good companies for certain parts, good building and good programming advice.

FTC DISCORD

Filled with nerds from around the world that will help you with any problem you need. These people eat sleep and breathe robotics and will usually respond to your questions quickly. You can also learn a lot just by reading their conversations with each other.

2.0 THE GAME

ALLIANCES

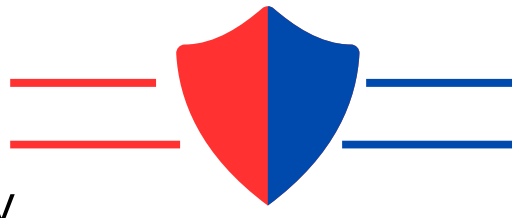


Each game is played with 4 teams, 2 teams on each alliance. The red and blue alliance compete against each other. Your alliance partner from one game could be your opponent for the next match.

OFFENSIVE POWER RANKING

O.P.R. ; essentially gives the number of points a team contributes to a match. There is also autonomous and tele-op OPR. The formula is weird; all you have to know is higher OPR = better

DEFENSE



Pushing other robots to prevent them from scoring points in a legal way. Found often in high-level play. If an alliance is too aggressive with the defense they may receive a yellow card.

3.0 BUILDING

THE BRANDS

REV ROBOTICS

A company that is in the USA and Canada, however not everything on the US site is in Canada. They are generally silver and sturdy. REV also sells control hubs, expansion hubs and power sources.

STUDICA

A company that produces many parts for robotics in Canada. These materials are often blue. THEY ARE ALSO ONE OF OUR SPONSORS

GOBUILDA

A very good company in America that sells high-quality products, however, it is expensive.

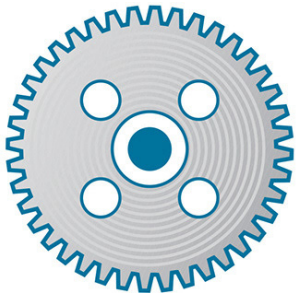
3.0 BUILDING

THE BRANDS CONT.

MiSUMi PITSCO TETRIX AXON MiSUMi PITSCO TETRIX AXON MiSUMi PITSCO TETRIX

TETRIX

A company that has parts for cheap, however low quality. The metal is easily bent.

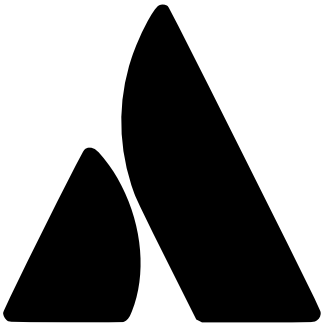


MISUMI

A company tha creates really good linear slides.

AXON

A company that is known for having very high quality parts that are VERY VERY expensive (a servo that studica sells for 30 bucks is 90).

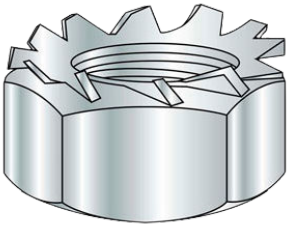


3.1 BUILDING

PARTS

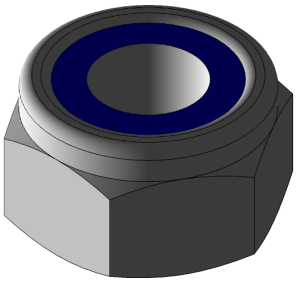
KEPS NUT

A type of nut that is very useful for prototyping, as you can tighten and loosen it with your hand. They get loose easily, so try not to use them for your actual competition robot.
AKA flower nut among our team because the nuts have a flower-like thing on it



NYLOC NUT

Has a plastic insert that holds on the to screw very strongly. Resistant to falling off from vibration but is much harder to get on. TIP - put it on and turn a few time with your hand then tighten with a tool; the first few rotations are easy and it gets tight later

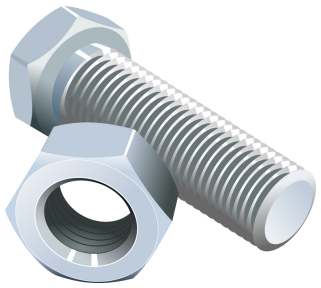


3.1 BUILDING

PARTS CONT.

M2/M3/M4/ETC

Uses the metric system and determines the diameter of the screw system (nut/screw/etc). EXAMPLE - M2 screw is 2mm outer diameter, a M3 nut would be 3mm inner diameter.

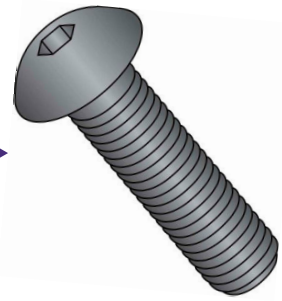


CAP SCREW

A screw with a cylindrical head (top of the screw). These are really common for Tetrix and Studica

BUTTON SCREW

A screw with a rounded head (top of the screw). Not the cylindrical ones; these are kind of dome shaped



SET SCREW

A very small screw that goes on many things like bevel gears, collars, hubs, etc. and locks the part in that place. NOTE - these get loose very easily so tightening them should be a standard practice.

3.1 BUILDING

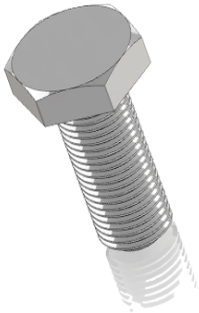
PARTS CONT.

COUNTERSUNK SCREW

A screw that has a slant that goes into the head of the screw. When screwed into a special hole, the screw head doesn't stick out of the material. Refer to the image somewhere

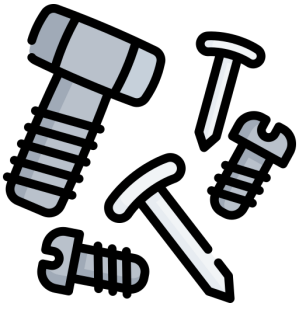
HEX CAP SCREW

Screws that have a hexagonal head without any indent pattern. Can be tightened with a nut driver or wrench but not with a screwdriver or allen key



REV SCREW/TETRIX SCREW/ETC

These are very generic names for certain brands of screws. REV screws are associated with the hex cap screws whereas tetrix screws are generally cap screws.



3.1 BUILDING

PARTS CONT.

THREAD PITCH

The distance/space between each of the threads. This is important to consider because there could be two "m4" screws for example that don't fit the same nut, and that's because their pitch is different.

STRIPPING

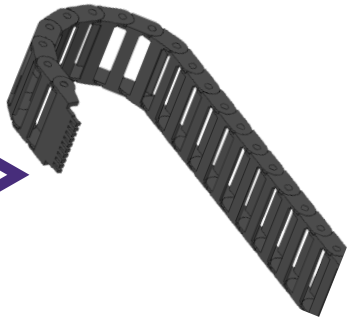
Damage to the metal on a screw head or thread, either making the thread unusable/untightenable or making the head unturnable with the intended tool. If this happens, I'm sorry.

POLYCARB

Polycarbonate is simillar to acrylic. It's a clear plastic which is decently strong however, very flexible.

DRAG CHAIN

A tool that is used for cable management and is composed of many linkages that connect together to form a long chain which can be manipulated.



3.1 BUILDING

PARTS CONT.

BELTS

A piece of plastic with fibreglass embedded within it. It has ridges on it which allows to to translate force with a pulley.

SPROCKETS

A circle with teeth that latch onto chains which can translate large amounts of force.

PULLEYS

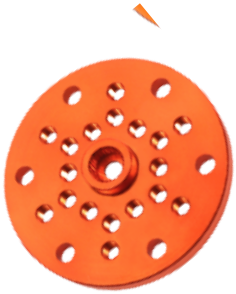
A circle with low profile teeth that latch on to belts which can translate force.

CHAIN

Links of metal that have space in between which allows it to latch on the the teeth of sprockets.

SERVO HORN

A specific piece of metal or plastic that can be attatched to the head of a servo.



3.2 BUILDING

TOOLS

PHILIPS

A cross pattern screwdriver/screw head. Very common in everyday life and probably the third most common screw head in FTC.

NUT DRIVER

Screwdriver except mostly for nuts. In our case, a socket made for 5.5mm hex nuts/hex cap screws.

ALLEN KEY

Screwdriver except mostly for nuts. In our case, a socket made for 5.5mm hex nuts/hex cap screws.

TORX SCREWDRIVER

A screwdriver pattern with a 6-sided star and is compatible with star-shaped AND hex-shaped screw heads. Torx screwdrivers are generally more strip-resistant than allen keys.

3.3 BUILDING

ELECTRONICS

CHUB

Control Hub(the brain of the robot)

EHUB

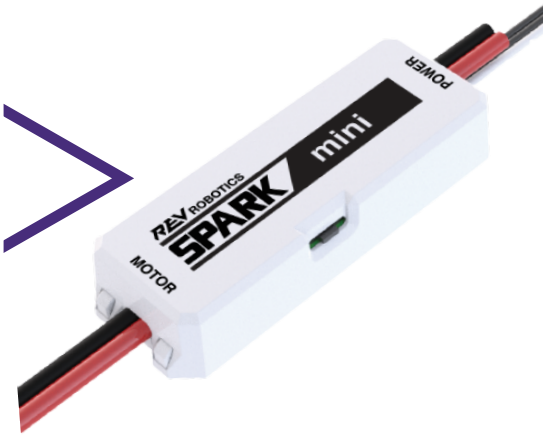
Expansion hub(a literal expansion of the control hub)

SPM

Servo Power Module which allows for the servos to get enough current without damaging either the control or expansion hubs

SPARK MINI

A device that connects to the output of either the control or expansion hub which allows for an additional motor to be powered without taking up a I/O port on the hubs.

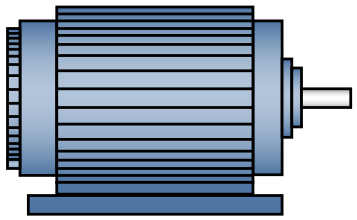


3.4 BUILDING

MOTORS

MOTOR

A device that can rotate fast



GEARBOX

A gearbox is a system of gears that work together to either slow down(gear down) or speed up (gear up) an input shaft to an output shaft.

REV ULTRAPLANETARY

A motor that many people use due to it's versatility. It uses gearboxes that can be swapped out allowing for different input to output ratios of the motor. This allows for the torque to be high and slow or low and fast.

TORQUENADO

A motor that uses a spur gearbox. Generally frowned upon as this gearbox is hard to swap, and is not that strong.

3.4 BUILDING

MOTORS

PLANETARY

Planetary is a type of gearbox that uses 3 planet gears that power a sun gear which allows to to be very strong.

SPUR GEARBOX

Spur is a type of gearbox that translates rotaion from one gear to another.

CORE HEX

A motor that has a 90 degree output shaft. It is highly frowned upon as it has lots of play, is very slow, and has low torque.

SERVO

A very precise motor which can either be set to have restricted motion below 360, or continuous. NOTE - this depends on the type of servo you have.

3.5 BUILDING

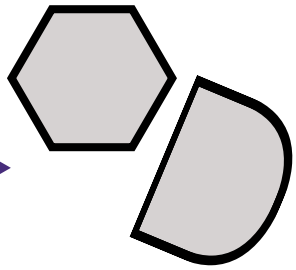
WHEELS

BEARING

A piece of metal that contains ball bearings in a ring. This allows the center of the bearing to rotate, with little friction.

AXLE/SHAFT

A steel cyclinder which will either be in the shape of hexagon or D. These are called Hex and D shafts.



MECANUM WHEEL

A genius invention, that allows for the robot the travel holonomicaly(any direction without changing it's heading). They are wheels that have multiple rollers that are tiltled 45 degrees.

TRACTION WHEEL

A standard wheel that has alot of grip on the ground.

OMNI WHEEL

Wheels that have multiple rollers that are perpendicular to the direction of the main wheel.

3.6 BUILDING

ATTATCHMENT

SHAFT HUB

A piece of metal which allows for things to clamped onto a shaft. NOTE - this is done through either set screws or clamping screws.

SHAFT COLLAR

A piece of metal which prevents anything from going past a certain point on the shaft.

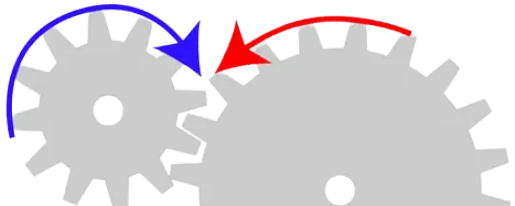
BEVEL GEAR

Gears that are slanted 45 degrees on the end. This allows the direction of roation to be changed 90 degrees.

GEAR RATIO

The ratio between input and output. EXAMPLE - if I spin this gear around a full time, and the gear touching it spins around twice the the gear ratio is 2 because for each rotation it spins twice.

$$RPM_A \times Teeth_A = RPM_B \times Teeth_B$$



3.7 BUILDING

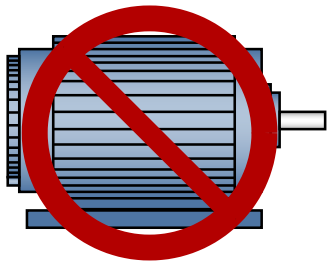
MISCELLANEOUS

DEAD AXLE

An axle that doesn't rotate on bearings. It is completely fixed and is very low profile. Wheels can then be mounted on with the bearings directly attatched.

DEAD WHEEL

A generally small wheel that doesn't have a motor attached to it.



ODO POD

Odometry pods are devices that contain a deadwheel and an encoder. It is used to track the X, Y, and heading of the robot by trakcing how much the deadwheel turns when the robot moves.

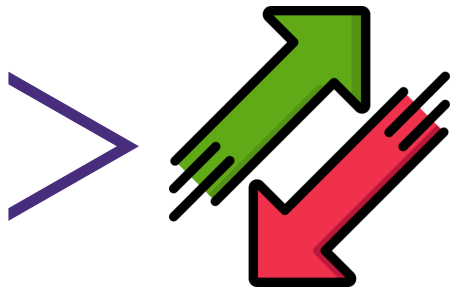
LOCTITE

AKA thread locker, which is used on screws and nuts to prevent them from getting lost (Funny no-move liquid). NOTE - don't always resort to this. It's here but once you use it it's there forever.

4.0 BUILDING CONCEPTS

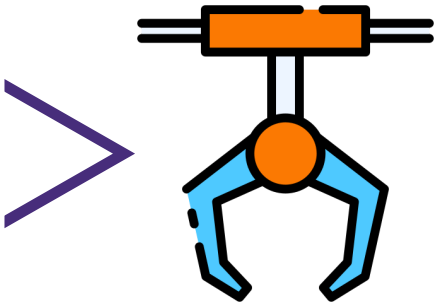
LIFT

A way of elevating something. This could be through many different methods such as linear slides, a virtual four bar etc.



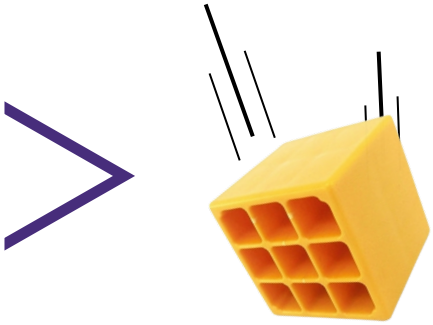
INTAKE

Something that denotes picking up an object.



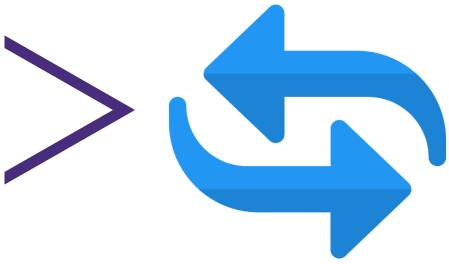
DEPOSIT

Something that denotes dropping an object.



PASSTHROUGH

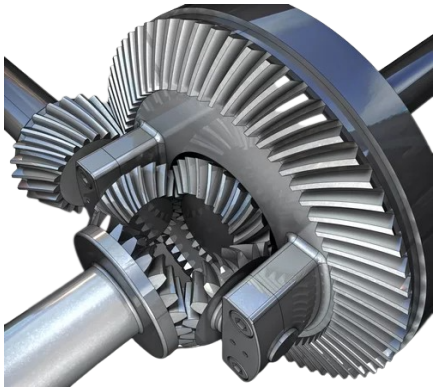
Something that transfers an object from one subsystem to another.



4.0 BUILDING CONCEPTS

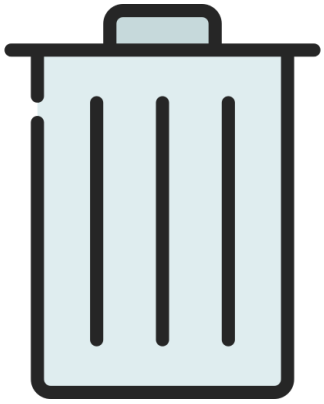
DIFFERENTIAL

A complex method of altering the speed of certain gears in conjuction with one another, can change the speed of multiple things. TIP - this allows for systems to be very light, however it is hard to build and program. (this is also what cars use to turn)



POCKETING

The process of removing material to make it lighter however still maintain rigidity.



COUNTERSPRING

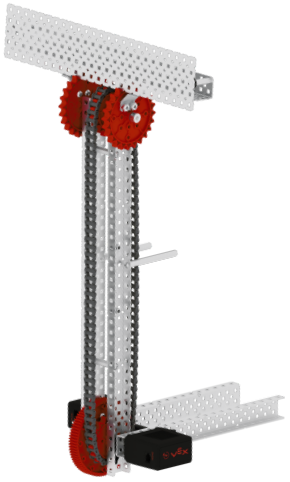
A way of tensioning a system to reduce the torque needed.

4.1 BUILDING CONCEPTS

LIFTS

4B

A system that also allows the top of the arm to have a constant heading but is done through 2 parallel bars that are attatched to joints on either end. The space between the parallel bars directly translates to an angle of the bar which persist regardless of the angle.

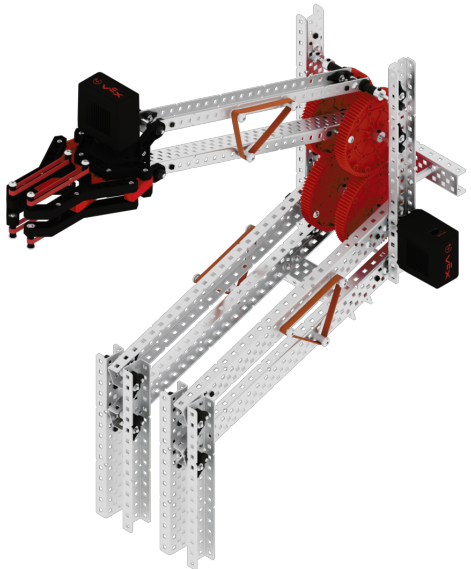


SCISSORLIFT

Bars that are connected in the shape of X's stacked ontop of each other. This method of linear actuation uses a lot of torque and generates alot of friction. It expoilts the fact that an X with a steep angle is tall and skinny and a X with a shallow angle is short and wide.

DR4B

A double reverse four bar. A combination of R4B's allows for the pitch of the middle arm and top arm to remain constant while the arm's angle changes. This is very tall and uses a great deal of torque. NOTE - there is a clever way to tension this system to reduce the torque.



4.2 BUILDING CONCEPTS

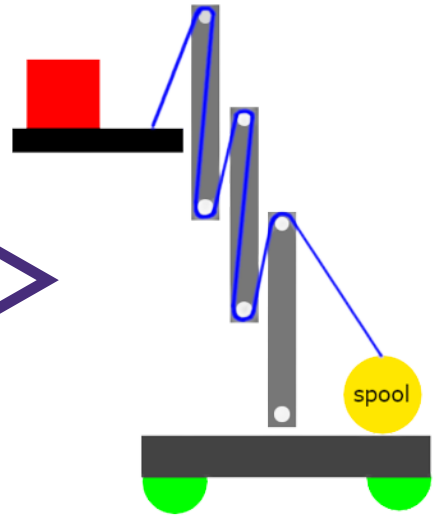
STRINGING

STRINGING

Maneuvering the string through bearings that are put onto the linear slides. This is the process which allows the linear slides to be actuated.

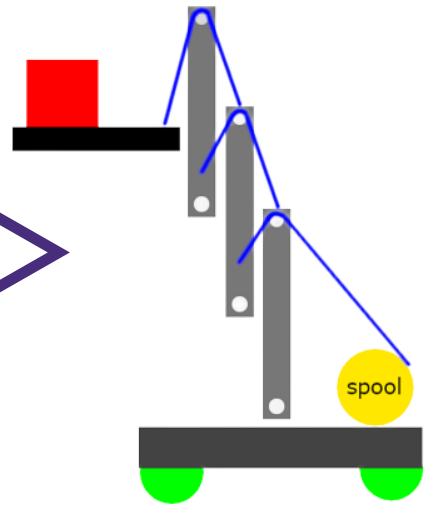
CONTINUOUS RIGGING

A way of stringing a set of linear slides which involves each stage to get extended individually. This uses less torque however is slower. In addition, this method is much easier.



CASCADE RIGGING

A way of stringing a set of linear slides which involves each stage to get extended simultaneously. This uses alot of torque however is very fast. It also involves a complicated system of stringing.

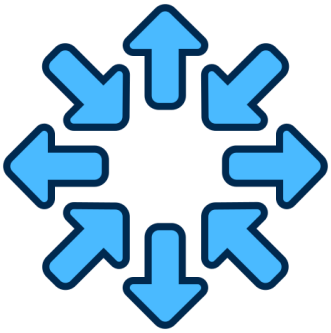


4.3 BUILDING CONCEPTS

DRIVETRAINS

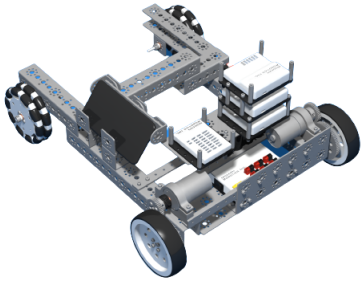
HOLONOMIC

A drivetrain that can go in any direction.



PUSHBOT

A bot with 2 omni wheels in the front and 2 powered traction wheels at the back. This bot is very slow and is NOT holonomic. However, it is very easy to build and program.



MECANUM

A drivetrain that can move holonimcaly due to the wheels have rollers that are slanted 45 degrees. Using *math and physics*, depending on the direction you are going in, you can give a certain amount of power to each wheel allowing to go in any direction.

SWERVE

A complex type of drive train involves have 4 wheels that spin normally, however, can rotate 360 degrees on top of that. This allows it to have very good traction which is good for defense.

4.3 BUILDING CONCEPTS

DRIVETRAINS

LOCKING MECANUM

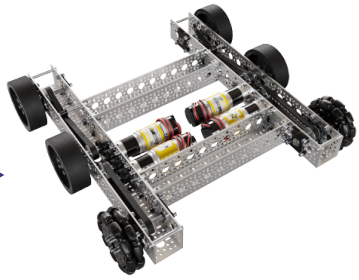
Similar to a mecanum drive train however has the ability to stop the rollers from spinning. This makes it the same as a 4wd which means it can't move holonomically anymore however it has very good traction which is good for defense.

4WD

A drivetrain with 4 wheels. It is pretty fast and has alot of traction.

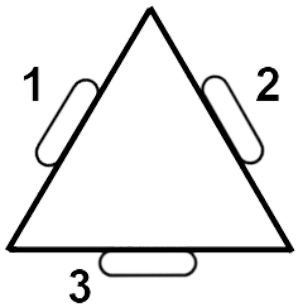
6WD

A drivetrain with 6 wheels. It is very fast, and has alot of traction.



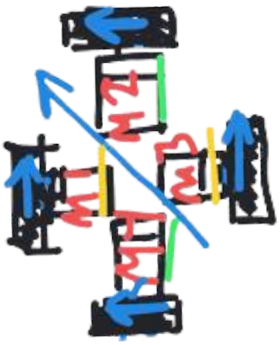
KIWI

A robot that uses 3 actuated omni wheels that are 120 degrees apart from each other. This drivetrain is slow and has low traction, however, can move holonomic.



X DRIVE

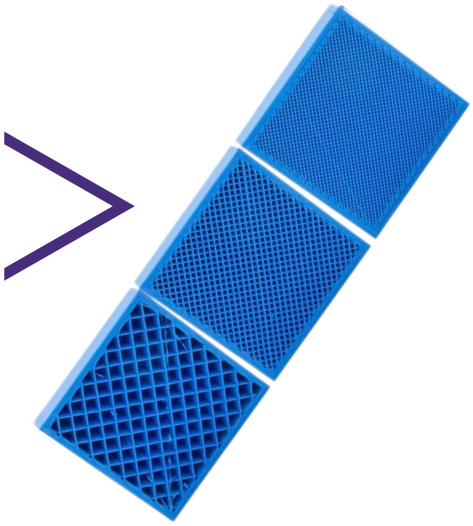
Simillar to the kiwi but has 4 omni wheels that are all angled with a 45 degree offset to what a normal robot looks like. This drive train has little friction and is holonomic.



5.0 3D MODELLING AND PRINTING

INFILL

The percentage of material that is used for the volume of the print. (think of it as the density)

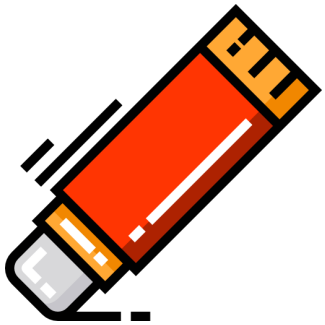


SUPPORTS

Material that isn't part of the 3-d print however is neccessary in order to allow the print to be succesful in realty.
EXAMPLE - if you were to print a part that had a part that had nothing beneath it, supports are necessary as 3-d printers can't defy gravity.

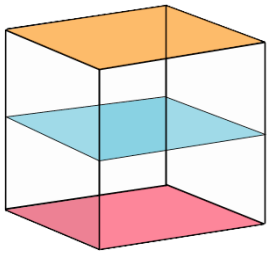
BED ADHESION

The ability for the 3-d printers bed/buildplate/(area that it uses) to keep the filament on without coming off.



SLICING

The process of creating instructions for a 3-d printer to use to create what you want it to make. Converts an .STL file into a .GCODE.



5.0 3D MODELLING AND PRINTING

.STL

A type of file which stores the data of a 3-d object. This could be used to create renders, or converted into a .GCODE.

.GCODE

The instructions that the 3-d printer gets to create your model.

CURA

Software that converts .STL files into .GCODE files. This is where you can change infill, supports, patters etc.

CAD

Computer Aided Design, which allows for humans to create accurate 3-d models.

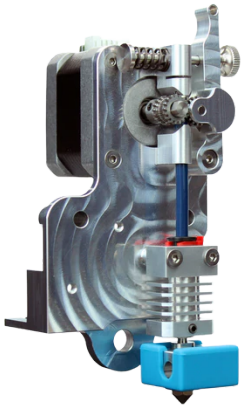
5.0 3D MODELLING AND PRINTING

FILAMENT

The material that the 3-d printer uses. It comes in roles that are 1kg and are typically 1.75mm in diameter.

EXTRUDER

The part of the 3-d printer which extrudes the filament.



ONSHAPE

As a free CAD software, which you have use to model your robot, or create .STL files. This is very popular in FTC and is what we use :)

SOLIDWORKS

A very popular solid modeling computer-aided design and computer-aided engineering application

FUSION 360

a cloud-based 3D modeling, CAD, CAM, CAE, and PCB software platform for product design and manufacturing.

360