

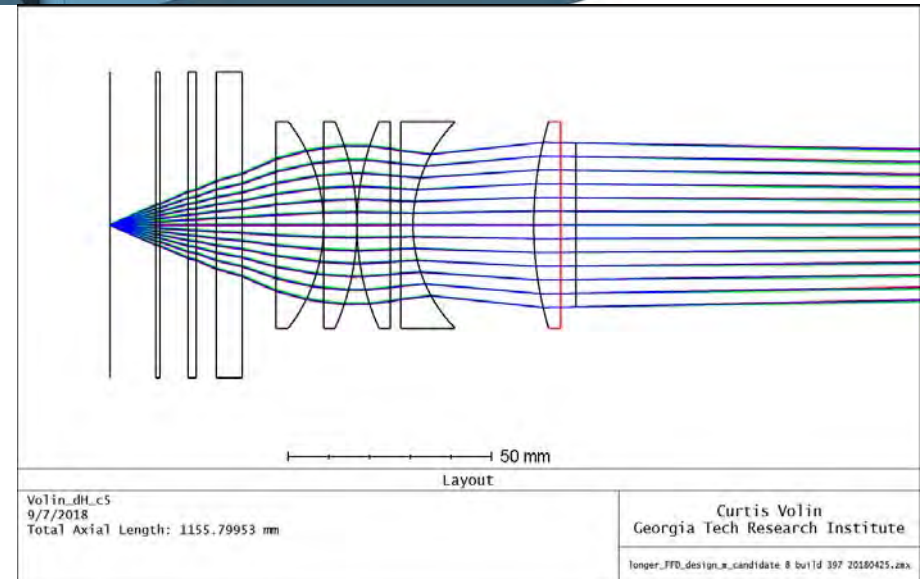
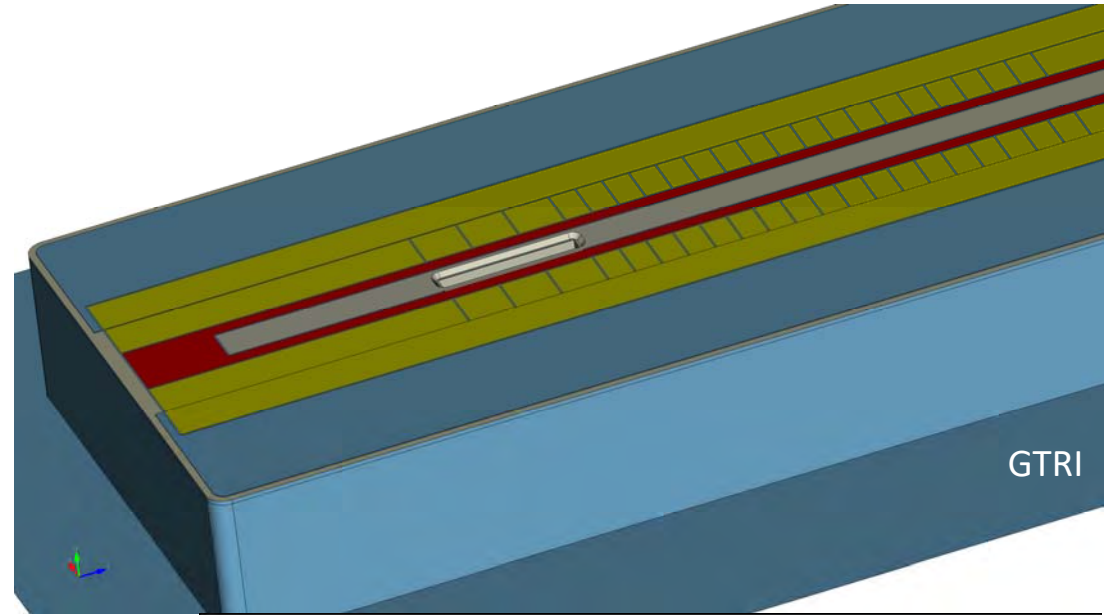
Introduction to CAD for FTC teams

Curtis Volin, Coach, FTC 4631

Eagle Robotics FTC 7373

What is CAD?

- Computer-Aided Design
 - Drawing things for design and prototyping
 - Can also use models as input to simulations (electromagnetic, mechanical, flow, thermal, optical)
- Two basic CAD program types
 - Explicit: draw and edit shapes
 - Parametric: design tree, all design parameters are retained



Volin_dHL_c5 9/7/2018 Total Axial Length: 1155.79953 mm	Curtis Volin Georgia Tech Research Institute longer_FFD_design_x_candidate_8_bu1d_397_20180425_axx
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CAD programs

- Solidworks <https://www.solidworks.com/>
- Autodesk Inventor, AutoCAD, Fusion 360 <https://www.autodesk.com/>
- PTC Creo <https://www.ptc.com/en/products/cad>
- SketchUp <https://www.sketchup.com/>

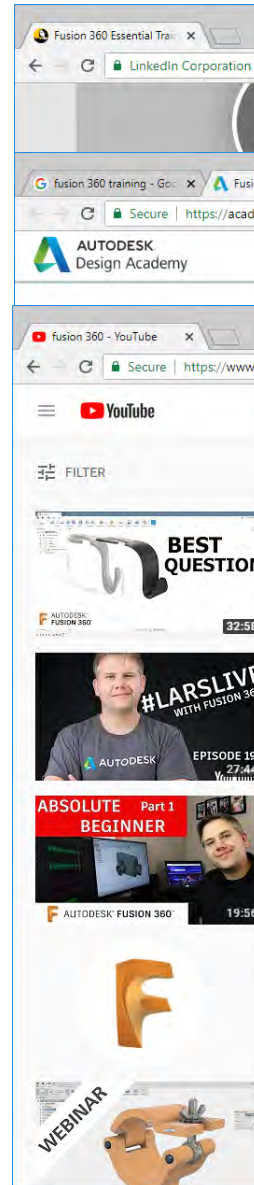
All of these are free for FTC students and mentors

Other useful design tools

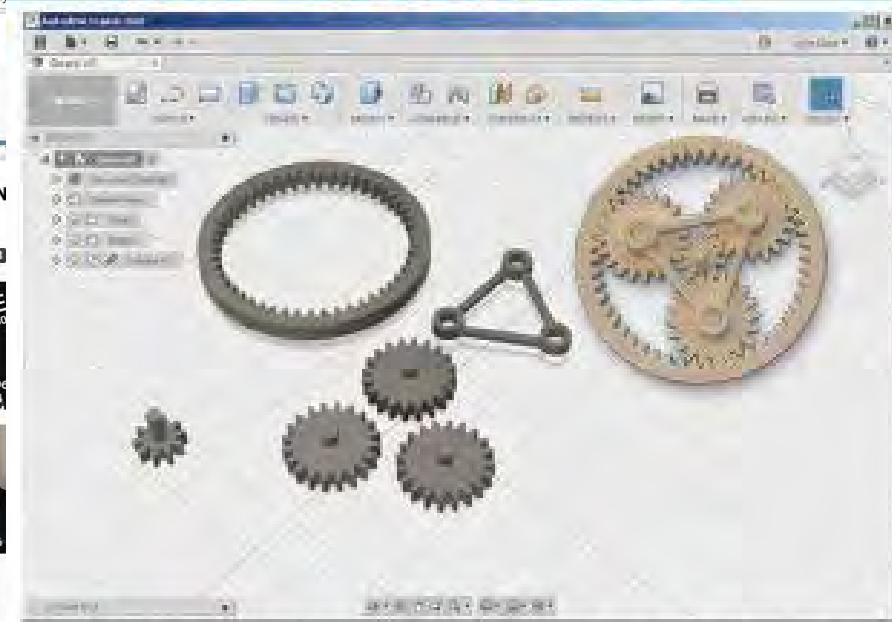
- Inkscape <https://inkscape.org/>
 - free, 2D vector drawing program
 - Graphics, drawings for laser cutting, engraving, waterjet

CAD Training Tools

- Lynda.com
 - Free access through many public libraries
- Training tools from vendors
- YouTube
- Books
 - Not free, but you won't constantly have to pause and rewind the video!



Make: Fusion 360 for Makers



Design Your Own Digital Models for 3D Printing
and CNC Fabrication
Lydia Sloan Cline

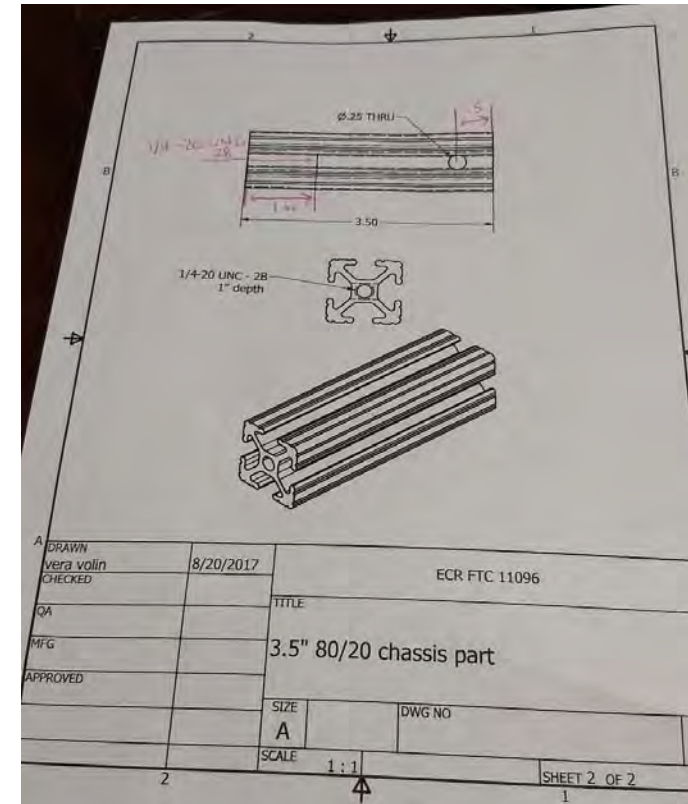
What can your team do with CAD?

1. Learn to CAD. **Document your learning process in your notebook!**
 - CAD your robot (or components of your robot) as-built.
2. Download and 3D print other people's designs
 - GrabCAD, Thingiverse
 - replacement parts from vendors
3. Make accessories and aesthetic elements for your team/robot (numbers, covers, jewelry, logos)
4. Design simple things that improve your robot's performance
5. Take on projects that promote STEM in your community.



Document your CAD

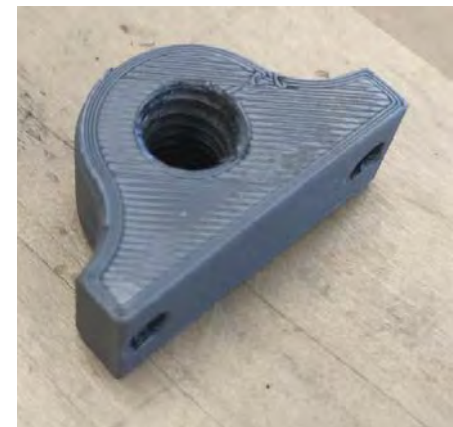
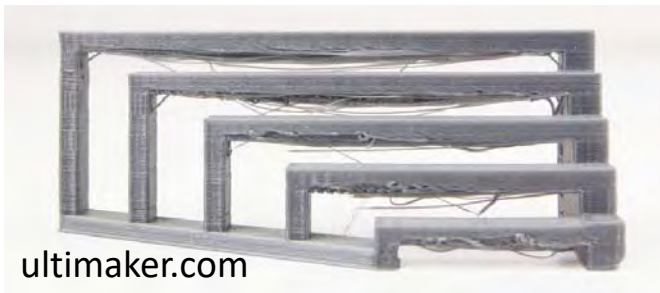
- Make notebook entries for all CAD sessions
 - Even if you are just learning, or you do not make anything useful.
- Explain the underlying design and fabrication choices
- Learn how to make drawings



How to make things you
design

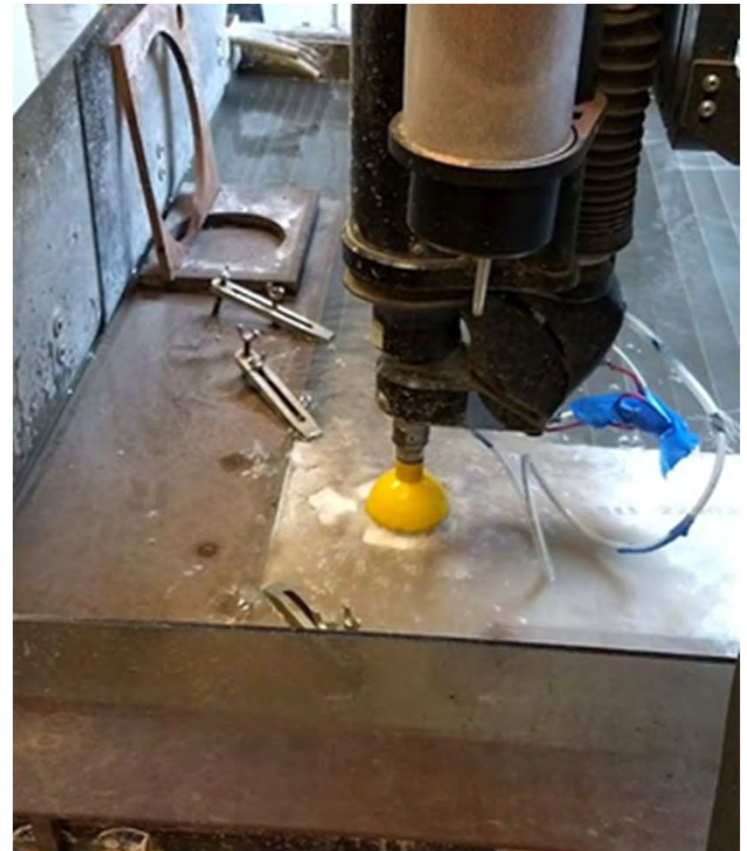
3D Printing

- Inexpensive machines
 - materials can be expensive
- Industrial use is mainly for prototyping
 - Slow
 - Imprecise
 - Limited material set
 - Parts are not mechanically durable
 - Reworking is difficult
- Critical concepts/settings:
 - Orientation
 - Support
 - Fill density, wall thickness
 - Print speed
 - Layer thickness



Water Jet

- Primarily 2D (angle cuts are possible)
- Works for almost any material
 - Can cut through many inches of metal/stone
- Precise feature location, imprecise sizing due to beam shape and walk-off
- Machine is extremely expensive
- Materials and operation are cheap



CNC mill/router

- Computer Numeric Control
 - extremely expensive 3D milling machines
 - inexpensive consumer-grade tools with lesser capability
 - Everything in between
- Inexpensive CNCs cut wood, plastic, and aluminum
- Usually 2D with variable relief
- Precise feature location and sizing



<http://shop.nextwaveautomation.com>

Laser cutting and engraving

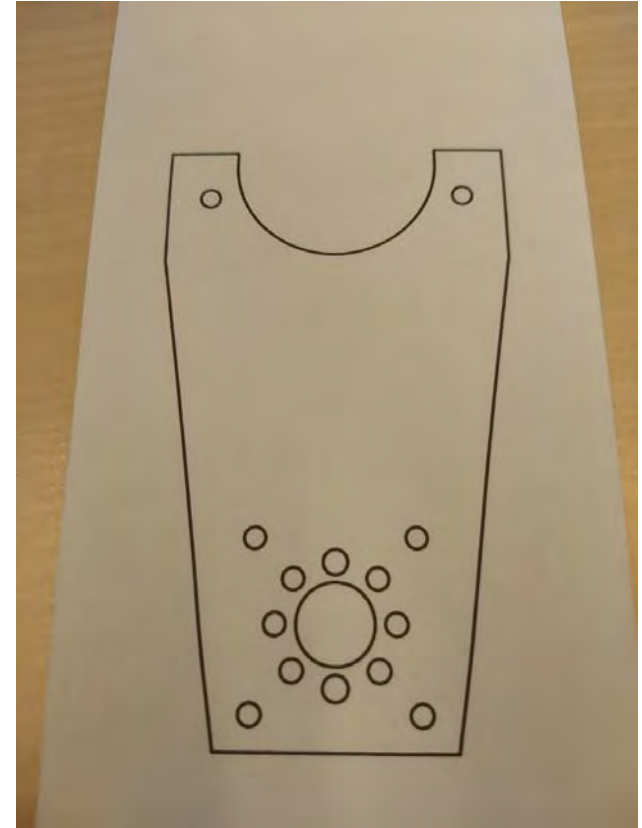
- 2D cutting/relief only (+ curved surfaces)
- Limited material set (paper, wood, acrylic)
- Uses SVG files (inkscape, Fusion 360)
- Machines are expensive
 - Materials and operation are cheap
- Very precise cutting
 - difficult to control width and depth of the cut



troteclaser.com

Hand Working

- Outline: hack saw, bandsaw, jigsaw
- Drilling: center punch, cordless drill, drill press
- Finishing: bench grinder, bench sander, hand file, tap, reamer, countersink, deburring tool



Eagle Robotics Slides

Introduction to 3D CAD

Importing Parts



f t 🔍

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HOME > SHOP ALL > 15MM PLASTIC 135 DEGREE BRACKET - 8 PACK

15MM PLASTIC 135 DEGREE BRACKET - 8 PACK

\$5.00

SKU: REV-41-1310

Quantity:

[ADD TO CART](#)

[Add to Wishlist](#)



Send [f](#) [e](#) [t](#) [l](#)

- Description**
- [Documentation & Resources](#)
- [Reviews](#)
- [Also Viewed](#)

This 135 degree plastic bracket is used with the REV 15mm Extrusion System. Each bracket includes a set of alignment ribs designed to seat the bracket into the extrusion channel increasing joint alignment, strength, and rigidity.

SPECIFICATIONS



\$5.00

SKU: REV-41-1310

Quantity:

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Description **Documentation & Resources** Reviews Also Viewed



CAD




- REV-41-1310 STEP File

DOCUMENTATION

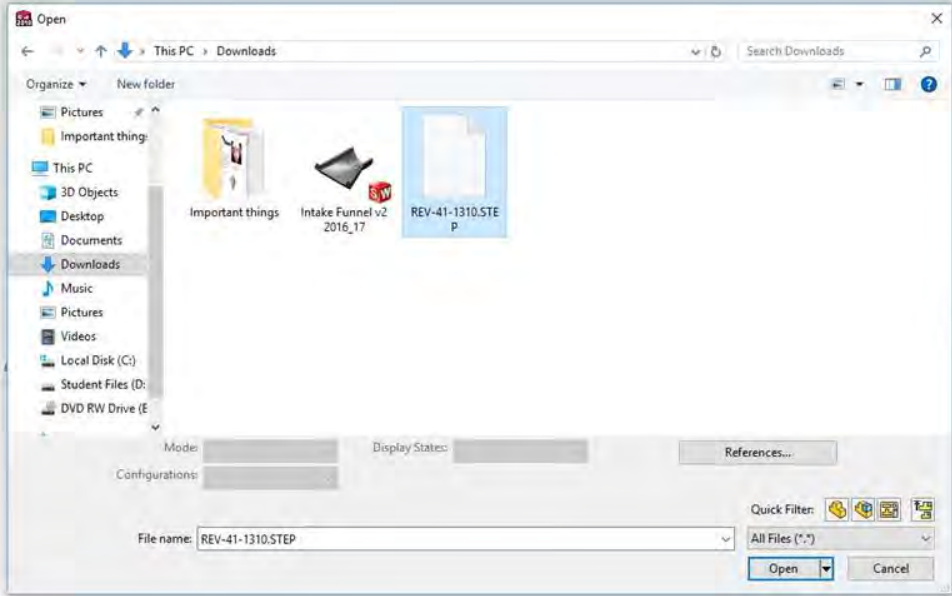
RESOURCES

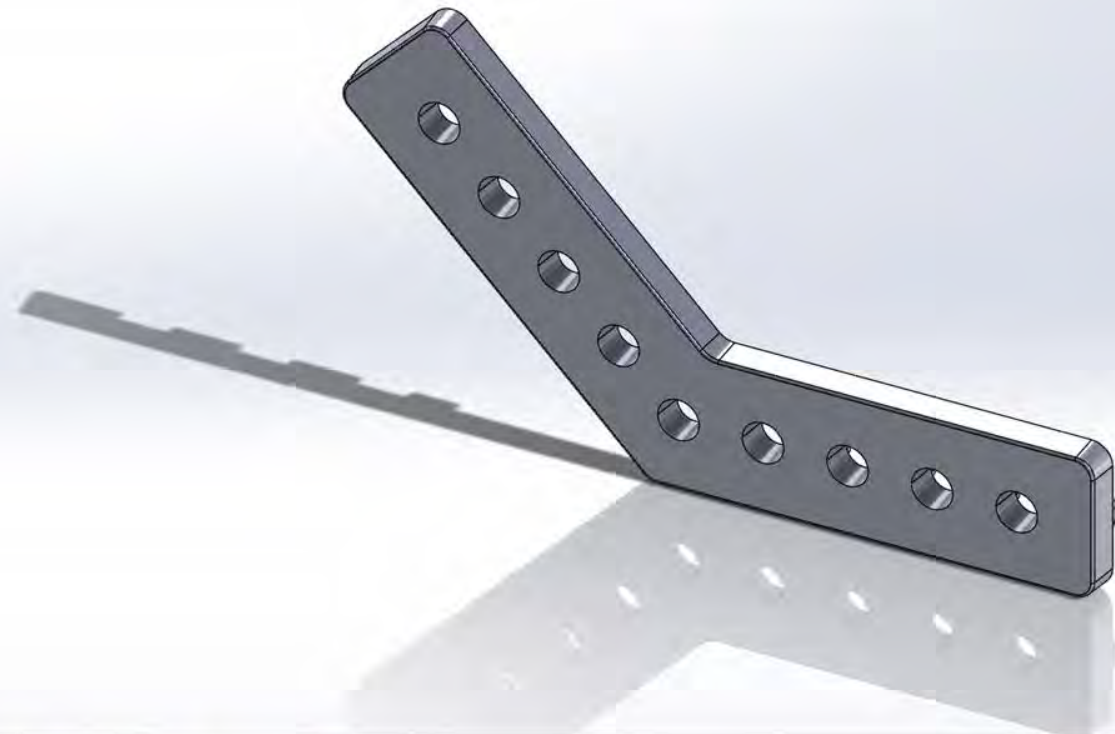
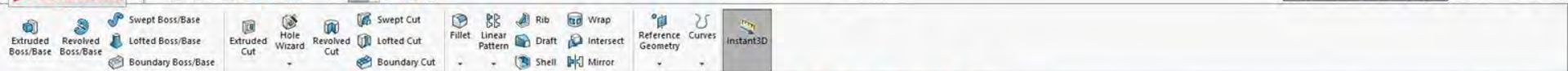
- Building System Guide

-  New... Ctrl+N
-  Open... Ctrl+O

- 1 Intake Funnel v2-2010_17
- 2 Shooter Guide v3
- 3 Master Assembly
-  Browse Recent Documents... R
-  Browse Recent Folders... 

- Exit







Assembly Layout Sketch Evaluate SOLIDWORKS Add-Ins Simulation SOLIDWORKS MBD SOLIDWORKS CAM

Assem1 (Default<Display...)

Mate

Mates Analytic

Mate Selections

Standard Mates

- Coincident
- Parallel
- Perpendicular
- Tangent
- Concentric
- Lock
- 1.00in
- 30.00deg
- Mate alignment:

Advanced Mates

Mechanical Mates

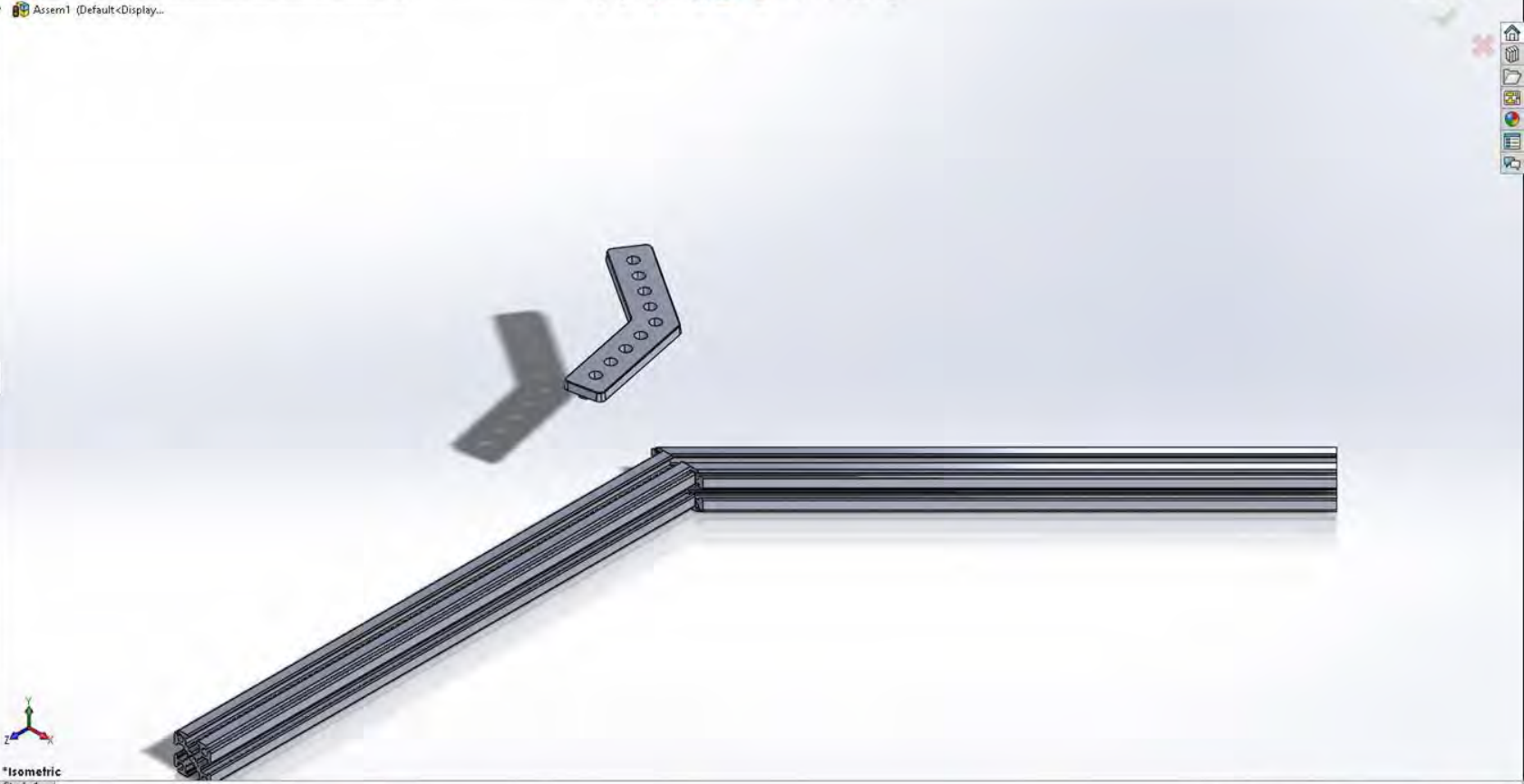
Mates

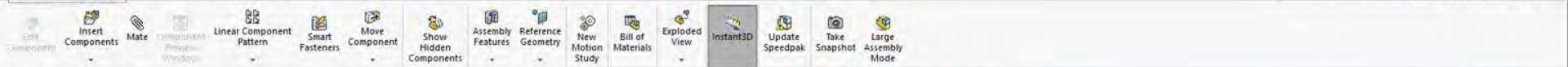
- Distance1 (Extrusion<1>)
- Parallel1 (135 degree bra

Options

- Add to new folder
- Show popup dialog
- Show preview

*Isometric



The Feature Tree on the left side of the interface shows the following structure:


- Assem1 (Default <Display State-1>)
- History
- Sensors
- Annotations
- Front Plane
- Top Plane
- Right Plane
- Origin
- (-) 135 degree bracket <1> (Default)
- Extrusion 45 <1> (Default <<Default)
- (f) Extrusion <1> (Default <<Default)
- Mates
 - Coincident1 (Extrusion 45 <1>, Extrusion 45 <1>)
 - Coincident2 (Extrusion 45 <1>, Extrusion <1>)
 - Distance1 (Extrusion <1>, Extrusion <1>)
 - Coincident15 (135 degree bracket <1>, Extrusion <1>)



Join 5,060,000 engineers with over 3,020,000 free CAD files

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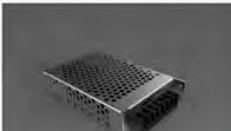
Custom Cat Trailer
by Sasha Vlad
71 likes, 328 downloads, 0 comments
STEP / IGES, Rendering



dodge challenger
by amin j
40 likes, 155 downloads, 2 comments
CATIA V5, Rendering



BALL VALVE
by Mahmut Zahit Kirip
72 likes, 472 downloads, 3 comments
SOLIDWORKS 2013, Rendering




power supply 250W
by max morozov
35 likes, 152 downloads, 3 comments
STEP / IGES, Rendering



maktec
Maktec MT 90 Grinder
by Kasidaje P.
53 likes, 181 downloads, 5 comments
SOLIDWORKS 2017, STEP / IGES, Rendering



H.B.I.
TP4056 Charger Module
by M.B.L.
43 likes, 156 downloads, 6 comments
STEP / IGES, Other, Rendering




EM3 Rev2 (Slider Version)
by Min Tseng
64 likes, 214 downloads, 2 comments




Submersible Centrifugal P...



EM3 Rev1 (Shaft Version)
by Min Tseng
24 likes, 126 downloads, 0 comments

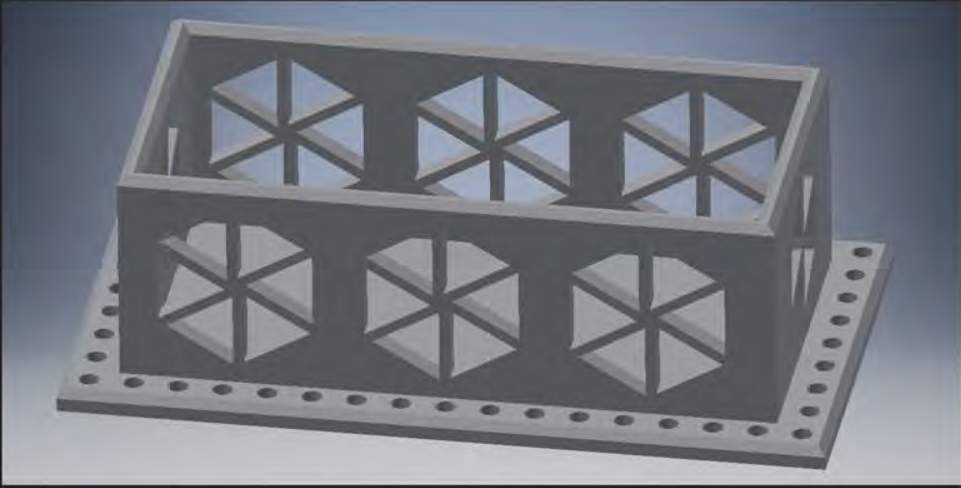


THP Automan120 - CEB Mach...
by nal
41 likes, 129 downloads, 6 comments
STEP / IGES, Rendering

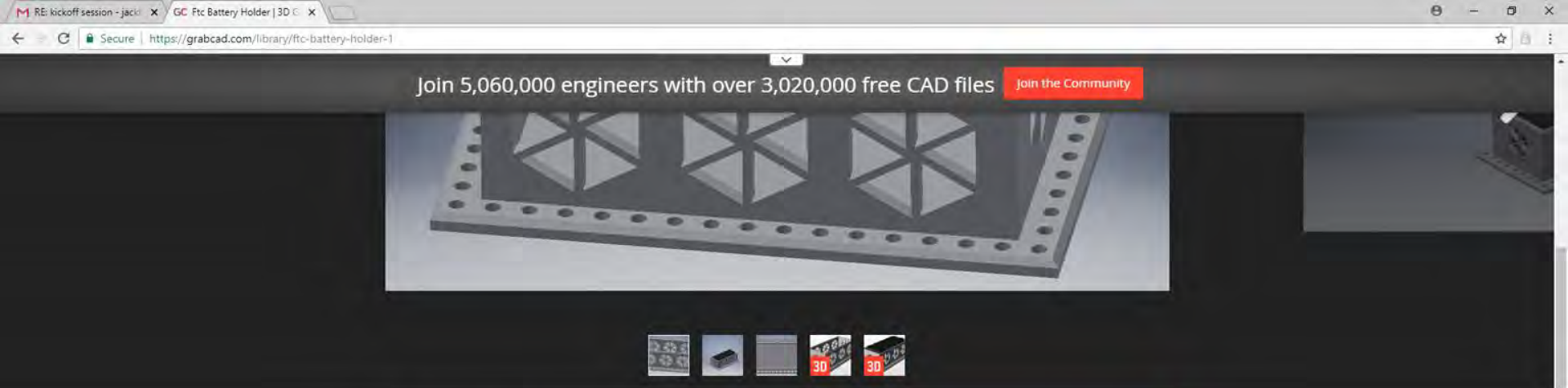
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Ftc Battery Holder

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Ftc Battery Holder

 **Yotam Limpan**
August 17th, 2017

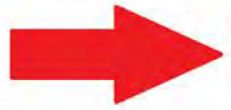
Battery holder for ftc teams.

Files (5)



Ftc Battery Holder /		
	mounter	Folder August 17th, 2017




Comments

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Details

Uploaded: August 17th, 2017
Software: STEP / IGES, Rendering, Autodesk Inventor
Categories: Robotics
Tags: ftc, happynes

 1 Likes

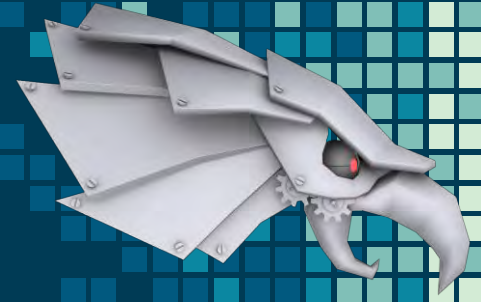


More by Yotam Limpan [View all](#)

CAD Part Suppliers

- Rev Robotics supplies CAD for each part they sell.
 - Each individual part has its own CAD on the product's page
- Textrix supplies CAD for each part.
 - Each individual part has CAD that can be found after clicking on the part.
- McMaster-Carr provides CAD drawings for only some of their products.
 - There is a small CAD symbol by the part name if CAD is included
- VEX Robotics provides CAD for each part.
 - The individual product pages have CAD files for the pieces
- Actobotics supply CAD for their products
 - <https://www.servocity.com/step-files>

Team 7373 Eagle Robotics CAD



Tools We Use

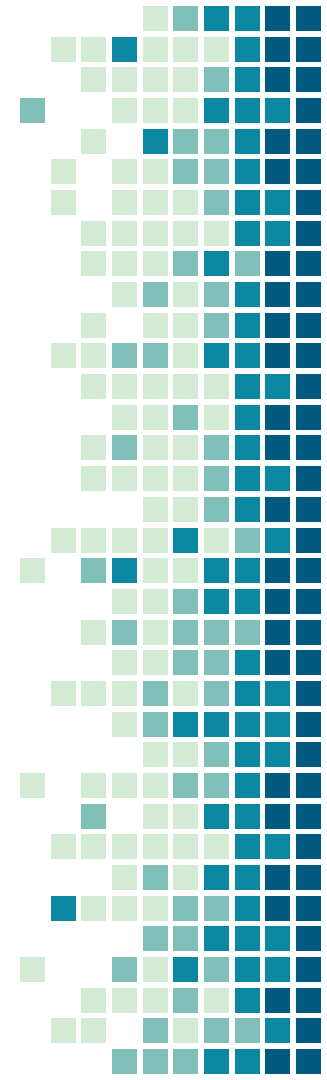
SolidWorks



GrabCAD

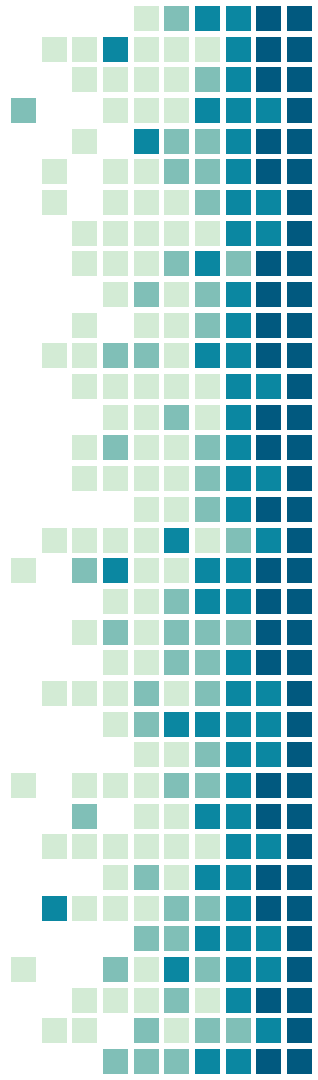


Thingiverse



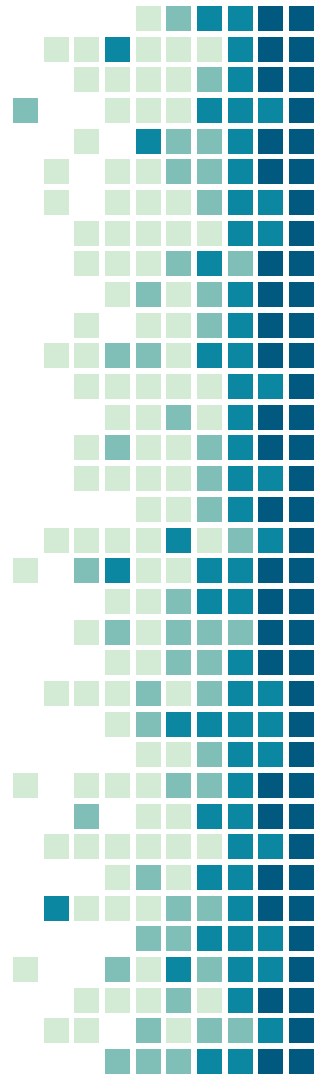
Why do we use SolidWorks ?

- ❖ SolidWorks is easy to learn and use effectively
- ❖ Even at a low level, useful parts can be made
- ❖ It is able to convert almost any 3D file into a format it can use for assemblies (.SLDPRT)
- ❖ It can auto-generate engineering drawings



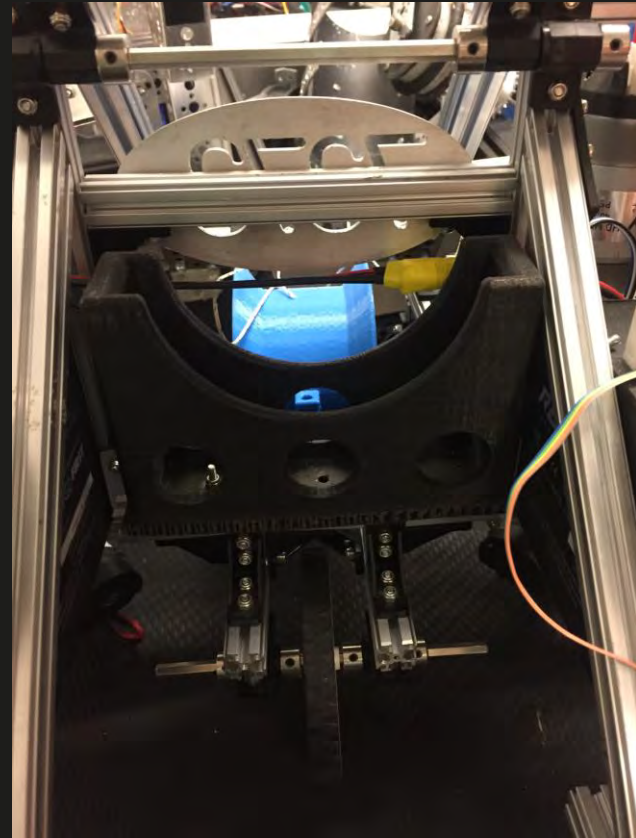
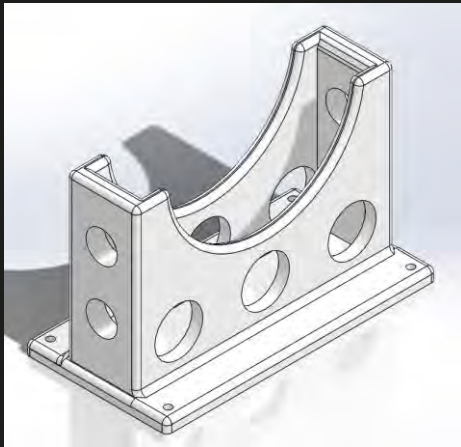
Why do we use SolidWorks?

- ❖ 3D printers recognize .SLDPRT parts and can print them without any changes being made
- ❖ SolidWorks is the standard CAD for mechanical engineering



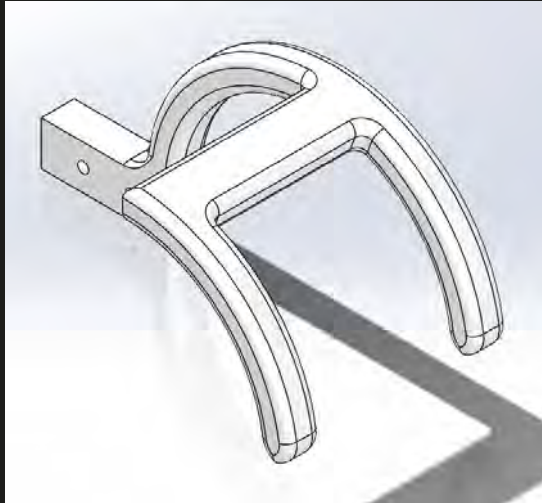
SolidWorks Parts- Battery Box

This is the box we used to hold our battery. As shown in the picture it was modified slightly after it was printed to fit into the tight space.



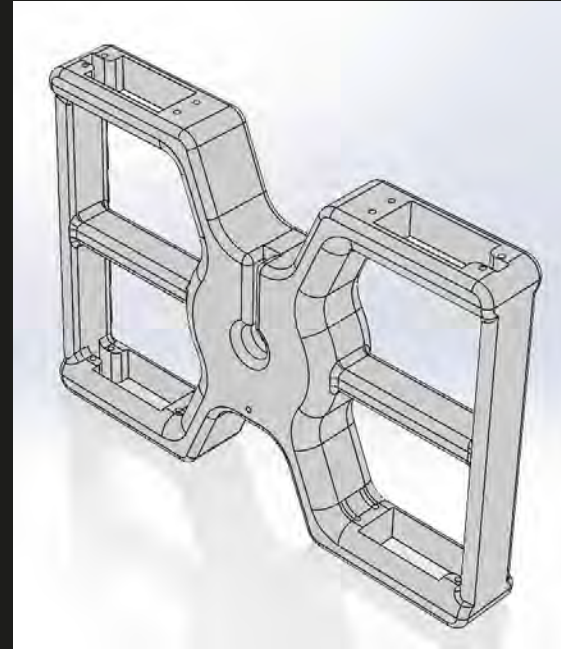
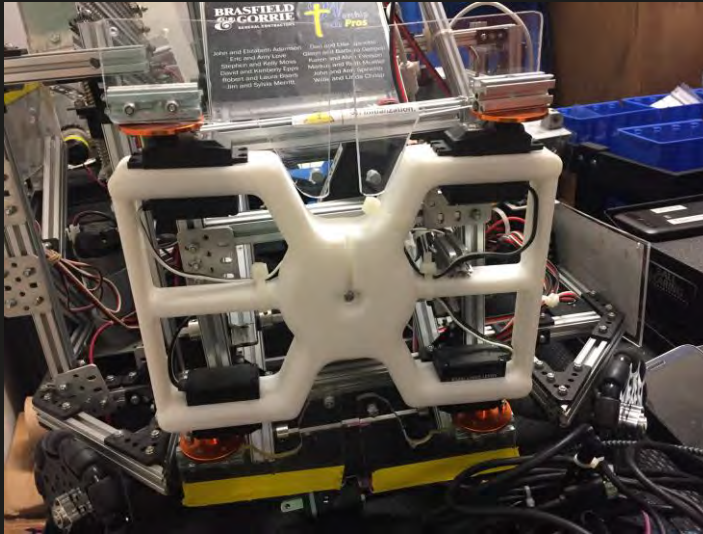
SolidWorks Parts- Relic Talon

This is the talon we used to grab the Relic during last year's game. It was able to be specially designed to fit around the Relic's head because it was 3D printed.



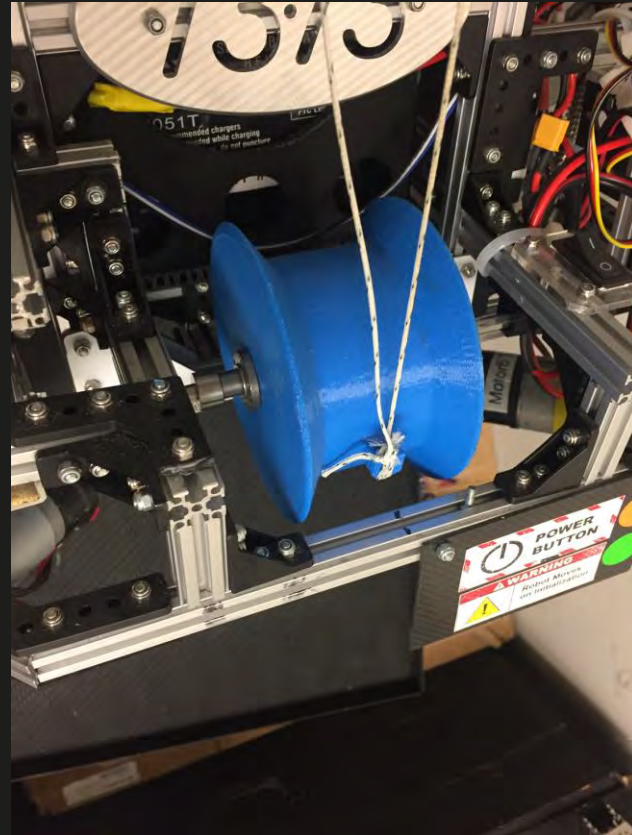
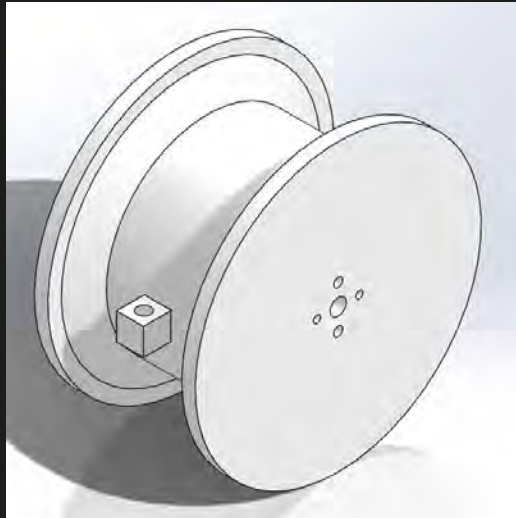
SolidWorks Parts- Glyph Flipper

This is the main feature of our robot. It fit over a motor and rotated 180 degrees to flip a stack of glyphs over to make patterns more easily.



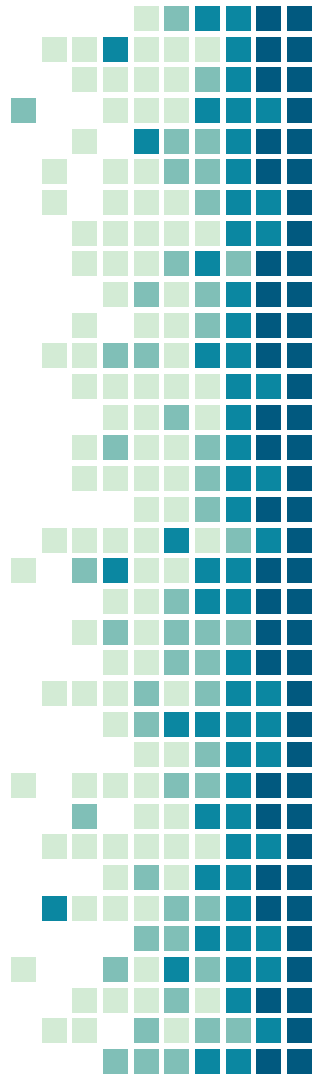
SolidWorks Parts- Spool

The spool allowed us to lift our parallelogram lift to put glyphs on the top half of the glyph box. It was printed to fit around the hex shaft.



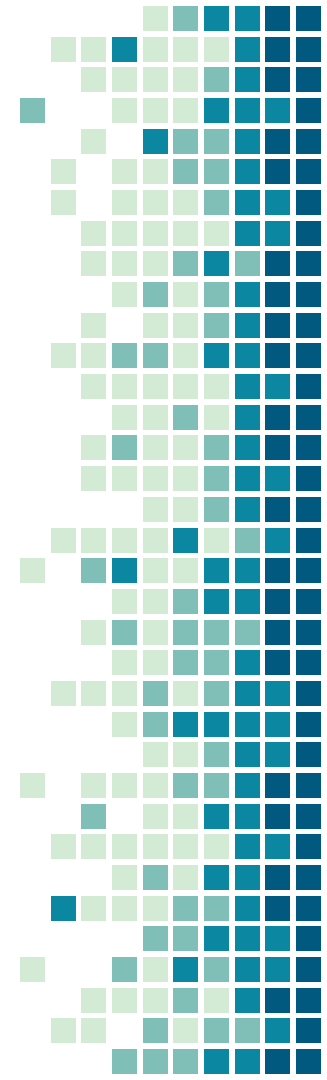
Why GrabCAD and Thingiverse

- ❖ They both provide a bank of parts that people have already made
- ❖ They can save you time in drawing parts
- ❖ Parts posted on the website can provide inspiration to you for your own robot



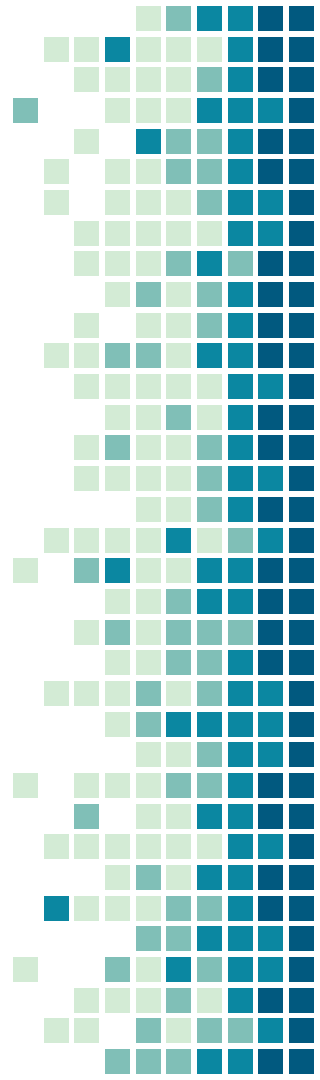
How we started

- ❖ Engineering classes at school
- ❖ Learning from previous members of the team
- ❖ Watching videos/tutorials online
- ❖ Trying to create everyday objects in CAD



How you get started

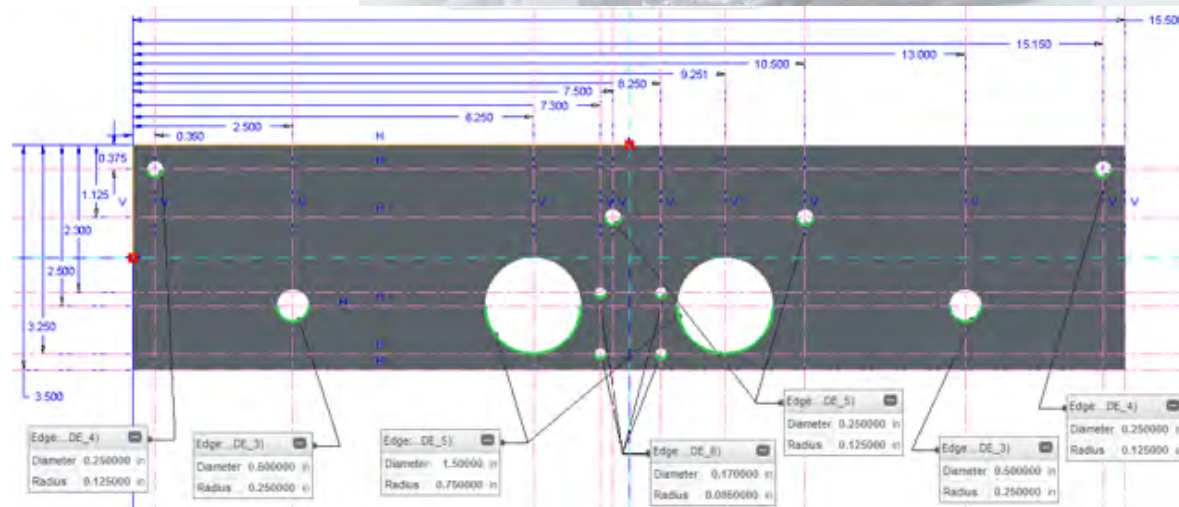
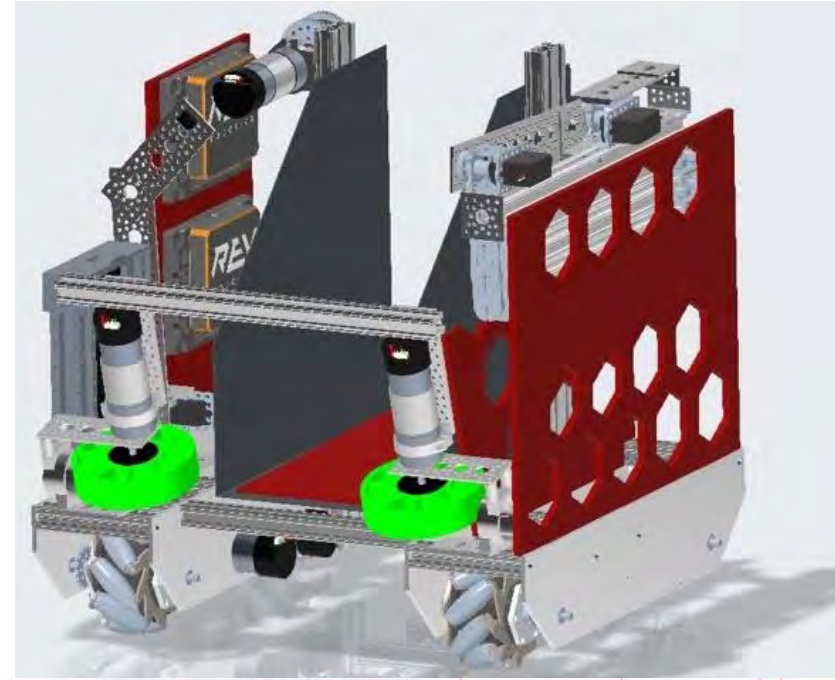
- ❖ Watch online videos/tutorials
- ❖ Visit the SolidWorks website
<https://www.solidworks.com/>
- ❖ Take Engineering classes at your school
- ❖ Search “cudacountry SolidWorks” on google to find more SolidWorks tutorials with all steps included



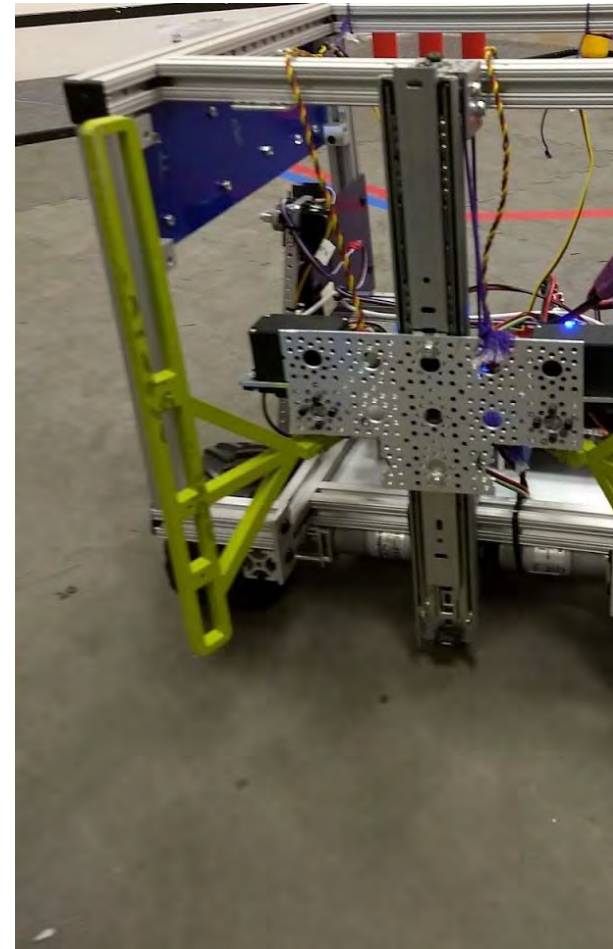
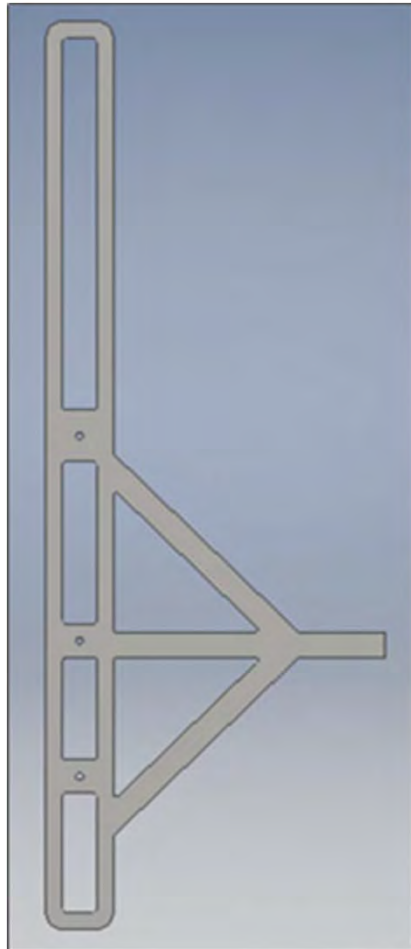
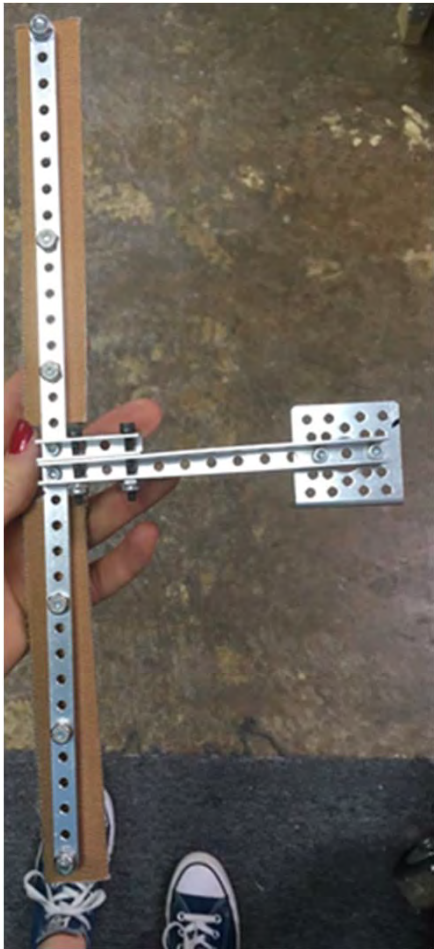
Project examples

Robot Chassis Design

- Twisted Axles, FTC 6047
- Designed in PTC Creo
- Scrap metal from Res-Q
- Hand-worked outline, local shop drilled holes using a mill
- Key features
 - Lightweight
 - Open robot interior
 - Easily modified to add mounting points

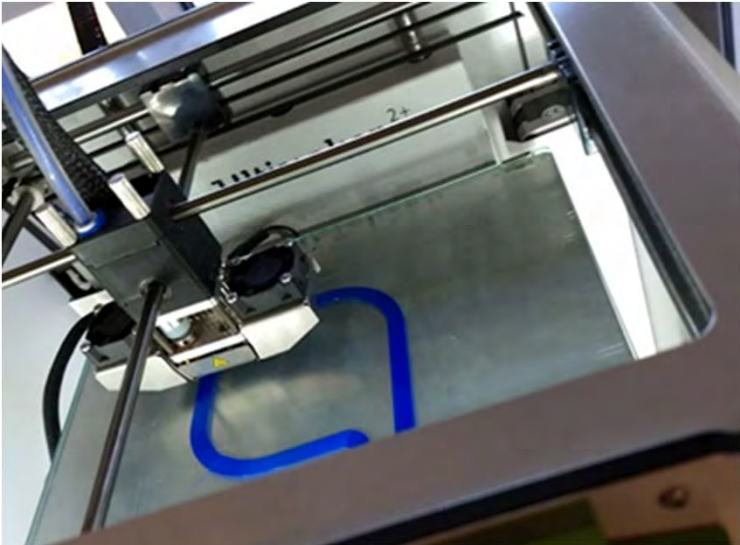
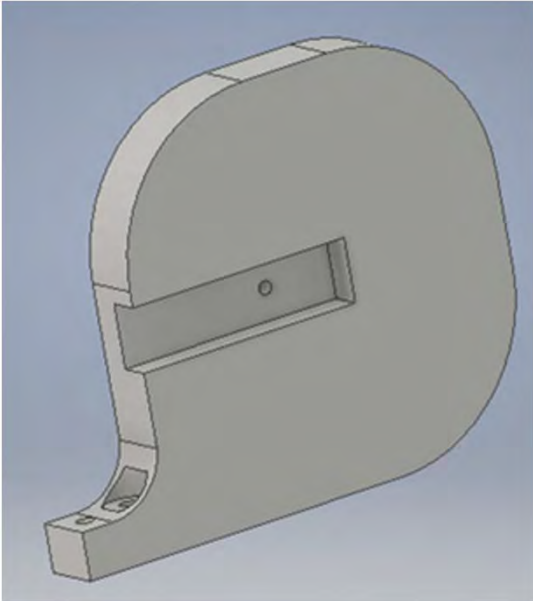
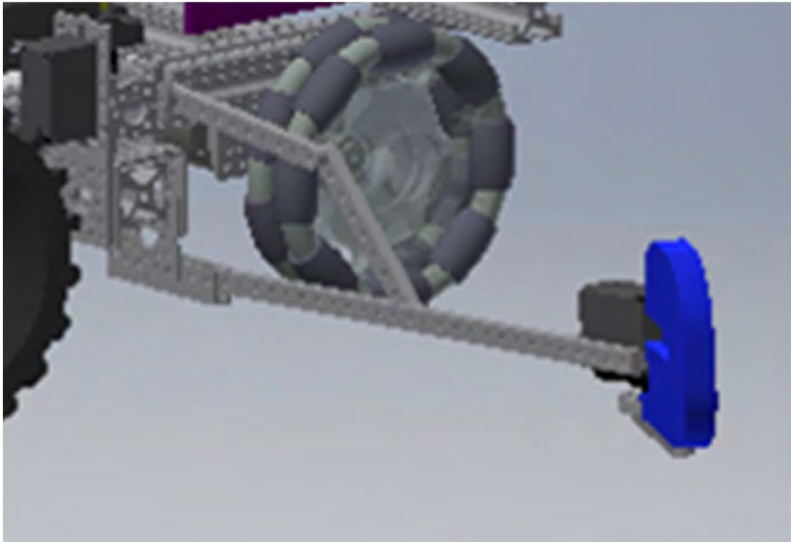


Glyphter Arms – Water Jet

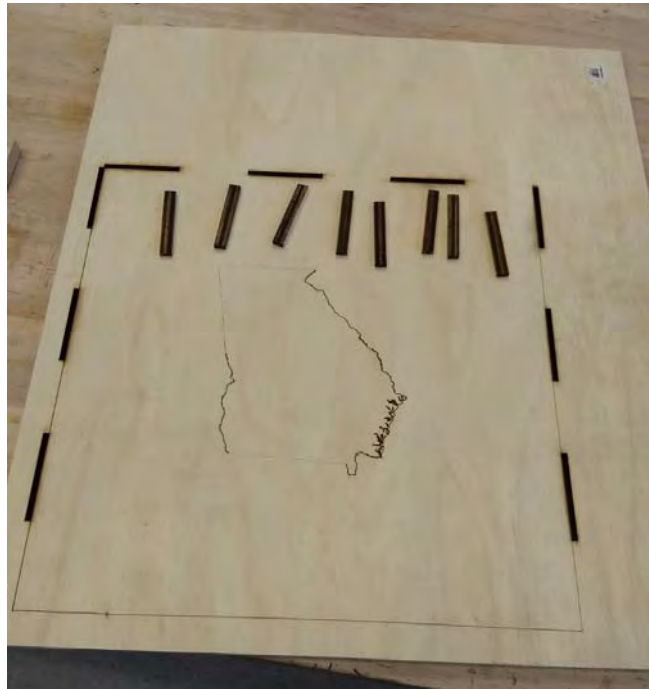
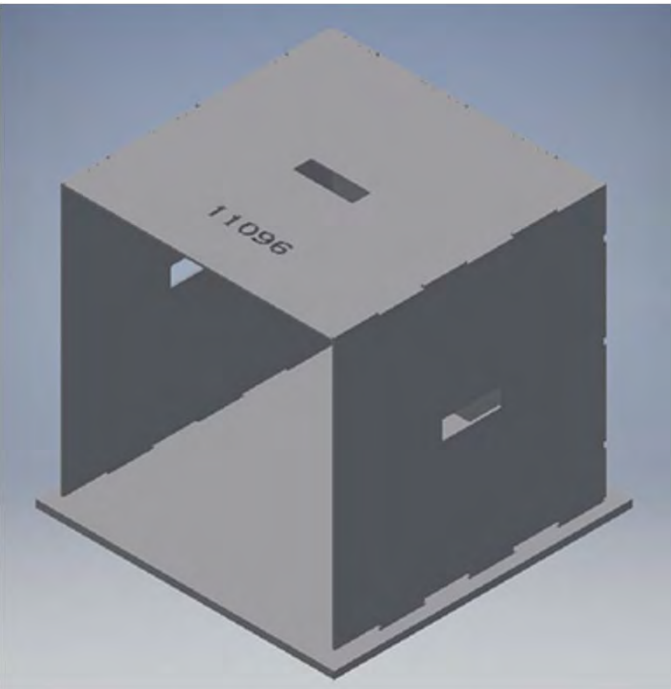


Jewel Stick Paddle – 3D printer

- FTC 11096

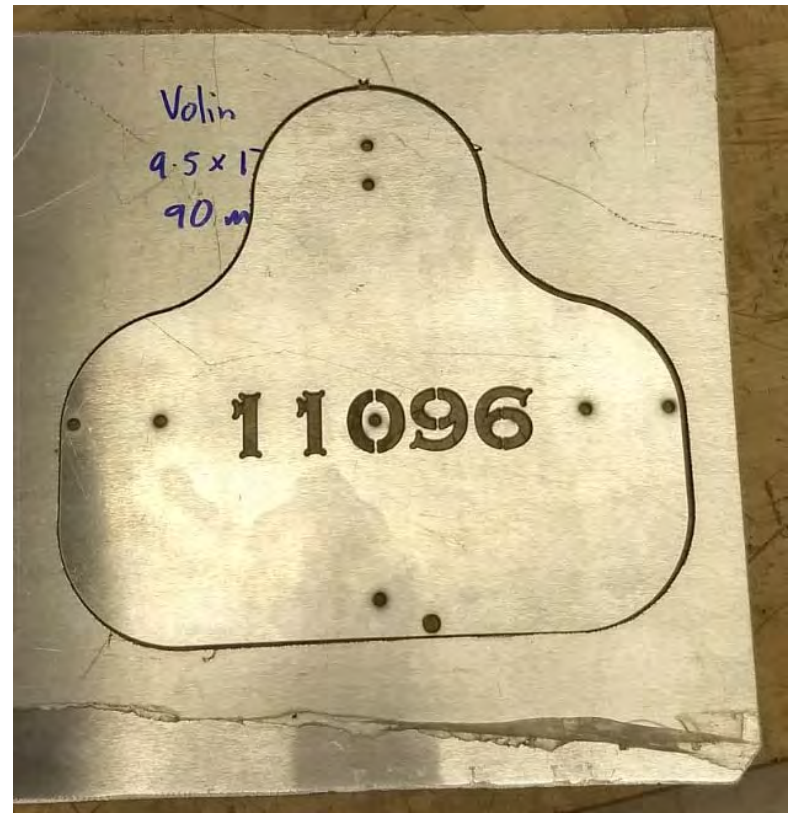
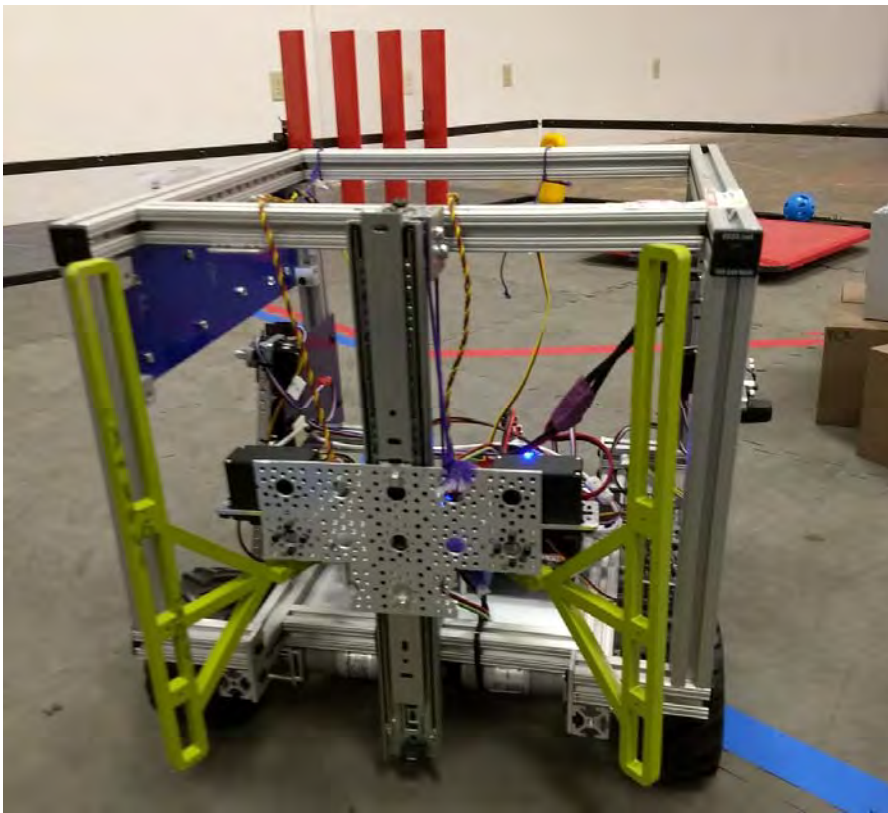


Sizing Box – Laser/waterjet

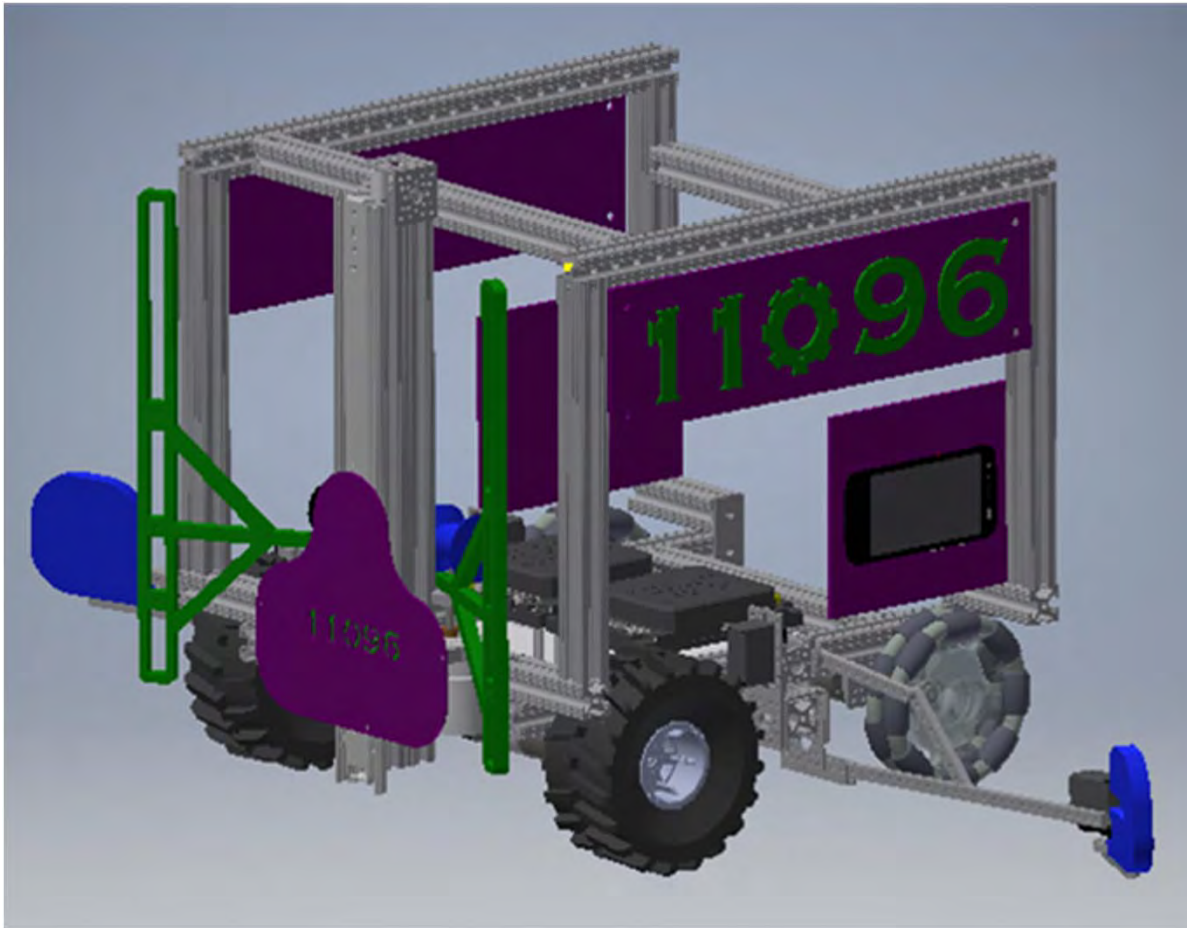


Front Plate - waterjet

- FTC 11096



Robot Assembly – Autodesk Inventor



Robot Chassis Design

- Oscar, FTC 5494
- Aluminum extrusion
- Team-owned CNC router
- Key features
 - Face-mounted motors
 - Gears are meshed at exactly the specified pitch diameter

